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A
MANUAL
FOR
MECHANICS' INSTITUTIONS.

PUBLISHED UNDER THE SUPERINTENDENCE OF THE SOCIETY FOR THE DIFFUSION OF USEFUL KNOWLEDGE.

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MDCCCXXXIX.

NOTICE.

This work has been prepared, and is now published, by the Society with a view to facilitate the establishment of Mechanics' Institutions, and to improve and extend those already formed.

The want of such a work has been suggested by the constant applications made to us from different parts of the country, where individuals were minded to form Mechanics' Institutions, for a constitution and rules such as experience may have shown to be useful and convenient. The present publication is designed to supply this information.

The Society has prepared for the task by an extensive correspondence with those Bodies in different parts of the country, in order to ascertain what plans were found suitable to the circumstances of various communities. Accordingly there are subjoined to the general information contained in this volume sets of rules actually tried and used, to serve as samples of what constitutions are found to answer. Occasional alterations will of course be found requisite in adapting these to particular places.

The important office of digesting and preparing this work for the press was entrusted to Mr. Duppa, who has devoted so much of his time and attention to the subject of adult education; but the result of his labours has undergone the careful revision of the Committee, according to the invariable practice of the Society in preparing all its publications for the press.

The Catalogue of Books fit for Mechanics' Institutions and Apprentices' Libraries, though far from perfect, will, we hope, be found of much service. Constant applications are made to us for such lists.

The various syllabuses of courses of Lectures are likewise calculated to facilitate the very important object of Lecturing. Some of these are the summaries of courses frequently delivered (as that on Political Economy), in different places, under the superintendence of members of the Committee; and a large portion of the Political course is now delivering at the Brougham Institute of Liverpool. But the Society has not done more than approve the heads and summary of these courses.

If these Outlines are found useful, a supplementary volume may be hereafter published, containing syllabuses of courses of Lectures on other subjects.

In submitting this book to the friends of Adult Education throughout the united kingdom we earnestly intreat of them to enter into free and unreserved correspondence with the Society upon any difficulty that may occur in the establishment of new Institutions or the improvement of old. Whatever aid of information or advice we can give will be most cheerfully bestowed. We are also desirous of constant communication from those Institutions already existing in different parts of the country that we may be kept informed of their state and circumstances. Letters may always be addressed, under cover, to any of the members of the Committee who are members of either House of Parliament.

There is nothing to which it is more important that the attention of friends to Popular Improvement should be directed than the encouragement of such Institutions as are intended chiefly for the working-classes. A great number of bodies now called Mechanics' Institutions are in fact establishments for the education of persons in the more opulent classes of society. It is, on every account, most desirable that the means of improvement and of rational amusement should be applied to those who form the great bulk of the industrious classes of the community.

BROUGHAM, *Chairman.*
Thos. COATES, *Secretary.*

August 1, 1839.
59, Lincoln's Inn Fields.

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CHAPTER I.

INTRODUCTION.

THE object of the following pages is to point out the purposes for which Mechanics' Institutions are or may be useful, and the means by which they do or may be made to attain their objects.

In order to arrive at a just conclusion on these heads, the Society for the Diffusion of Useful Knowledge circulated among all the Mechanics' Institutions to which it could gain access questions concerning their origin and present state; and the information thus collected has enabled the writer to mark the causes of the failure of some Institutions, and of the success of others. But, although reports from many Institutions were obtained by the Society, information, of a character sufficiently definite to be of service in arriving at just conclusions, was received from comparatively a small number.

Nevertheless, the evidence which forms the groundwork of the following pages contains matter of considerable importance, and is more ample than has ever before been collected upon the subject.

After touching briefly upon the probable origin of Mechanics' Institutions, the following are the points consecutively treated of in this work:—The classes of persons are first described for whom Mechanics' Institutions were designed, and the classes who actually avail themselves of them. The mode of instruction, whether by lectures or by classes, and conducted by professional or gratuitous teachers, is then discussed. The mode in which Libraries and Museums should be formed is next pointed out, and some suggestions are offered for the uniting of amusement with the more usual and stricter objects of Mechanics' Institutions. The pecuniary arrangements of Institutions are afterwards discussed, their houses and their internal management; and one Chapter treats of some of the causes to which their want of success may in many instances be attributed.

A subject is then handled to which the Society attaches the greatest importance—namely, the advantage which would result from establishing a system of correspondence among Mechanics' Institutions, and between them and some central Body, who might assist them in the attainment of their objects.

After a Chapter containing hints for the esta-bishment of Children's Schools in connexion with Mechanics' Institutions, the volume concludes with the sets of Rules, the Catalogue of Books, and the Outlines of Lectures alluded to in the foregoing notice.

B. F. Duppa.

Lincoln's Inn, June, 1839.

CHAPTER II.

ORIGIN OF MECHANICS' INSTITUTIONS.

Whether Mechanics' Institutions have assumed their present character by a series of steps, or whether they have had it impressed upon them by the wisdom and energy of an individual, has been a subject of somewhat needless controversy. Nearly forty years ago Dr. Birkbeck was undoubtedly the founder of the Mechanics' Institution at Glasgow; and at a later period he contributed mainly, both by his fortune and his labours, to the formation of that of London, in Southampton Buildings. A society, if not so well organized for its purpose, still in many respects of a similar character, was founded in Birmingham in the year 1790, and improved in the year 1797; another society existed in Spitalfields even of more ancient date, called the Mathematical Society; and before Dr. Garnet (Dr. Birkbeck's predecessor) ceased to be Andersonian lecturer at Glasgow, a Mechanics' class was connected with the Royal Institution in London at the instance of Mr. Webster, the geologist, by the exertions of Count Rumford, the late Lord Winchelsea, Sir Thomas Bernard, and the Bishop of Durham, with the concurrence of Sir Joseph Banks, who was then president of that Institution. As a proof that this last was not a mere scheme never carried into execution, it may be as well to state that Professor Pictet, the learned editor of the Bibliothéque Britannique, in an account which he published of a Tour through England, mentions his having visited the Royal Institution, and how much he was pleased with the School for Mechanics.

Mechanics' Institutions appear to have been suggested by the associations of a similar character of the wealthier classes of society. The adult mechanics were in want of fitting instruction; a model of the machinery for supplying it existed; and its adoption in different places and by different persons, without concert with each other, appears to have taken place. Each person was an originator, inasmuch as each acted without a knowledge of what was doing, or had been done, by others. The train of circumstances was laid for each,—each took advantage of them and acted—several simultaneously,—and in this, as in so many other cases, competitors have arisen to claim, and that with perfect honesty, the exclusive discovery of what has been productive of much good to mankind.

It must often happen that more persons than one are bent upon the same subject at the same time: if it is one of science, there must be always minds engaged upon the boundary which divides the known from the unknown; and if it be connected with the urgent wants of mankind, their pressing nature must be continually attracting the attention of those most capable of suggesting the means whereby they may be supplied; while their character must be for ever pointing to the nature of those means. And thus the discovery may be arrived at simultaneously by several persons. For such reasons as this it is that we have Newton and Leibnitz as rivals for the discovery of the differential calculus, and Cavendish and Watt for that of the composition of water. It would be idle to suppose that, in stating these facts, there can be any wish to derogate from the honour due to any of those excellent persons who fostered Mechanics' Institutions while yet in their infancy, and have so materially assisted in bringing them to the state in which we now find them. The names of the individuals thus distinguished are, as far as the writer is acquainted with them, as follows:—Lord Brougham, who has been a constant and early supporter of these institutions; Dr. Birkbeck, Mr. Webster, Mr. Leonard Horner, Sir Benjamin Heywood, Mr. Wedgewood, Sir John Herschel, and Dr. Ure. Nor is it without satisfaction that to this list he can add the names of Sir Joseph Banks and Count Rumford as connected with the earliest existence of such institutions, although probably these eminent men never contemplated the important character which such associations now assume, and the still more important duties which they will doubtless have to perform.

Dr. Birkbeck was, as we have stated, one of the originators of Mechanics' Institutions forty years ago, and, what is more than an originator, he was the founder and munificent supporter of an excellent institution of this class, which has not only endured to the present time, but is in a high degree flourishing, and has been the parent of most of those of the same class throughout the country;* and on this fact, rather than because he was the first in the field, do his best claims for being considered the founder of Mechanics' Institutions rest. The following account, taken from a Prize Essay upon Mechanics' Institutions, by Mr. David Burns, a member of the Glasgow Mechanics' Institution, may be acceptable to the reader.

"The circumstance of Dr. Birkbeck having been repeatedly disappointed by his mathematical instrument maker of the apparatus with which it was necessary to illustrate his lectures (there being only one man in the city of Glasgow regularly established in this line of business at the time), drove him at once to the workshop of the mechanic. Resolving to superintend himself the making of the necessary instruments, he visited the joiner at his bench, the smith at his forge, and the turner at his lathe. Brought thus into intimate contact with the artisans, he enjoyed the best possible opportunities of estimating the strength or weakness of their mental powers,—of ascertaining, by their shrewd observations and

* The large sum required for building the fine Theatre of th London Mechanics' Institution was advanced by him in 1825, and is yet in part unpaid.

acute inquiries, their aptitude to learn, and the benefit which would accrue to themselves and to society by their possessing a knowledge of the principles of science. Accordingly, having by his affable and obliging disposition, and the simple and forcible manner with which he answered the inquiries of the artisans who generally gathered round him on such occasions, excited a strong thirst for further information, Dr. Birkbeck used his influence to procure for some of them admittance to the course of lectures he was then delivering at the Andersonian Institution. The use made of this privilege and the disappointment expressed by those who, from the nature of that institution, could not enjoy it, set him upon devising some other means of imparting to them that information they were so eager to acquire. With a view to the promotion of this object he convened, in February, 1800, the first Mechanics' Class."

The following is a sketch furnished by Mr. Webster of his mode of commencing with the Mechanics' Class at the Royal Institution.

"We built up in our room several chimney fire-places on Rumford principles, as models, set several boilers, ovens, &c., and showed the best modes of warming and ventilating, also of improving old cottage-chimneys, &c. Besides those who were sent by the proprietors of the institution for the purpose of being instructed, we engaged men to work in our place as tinmen, copper-smiths, ironplate-workers, joiners, &c., and made models of various useful inventions. The men (who were at the same time scholars) were practised in actual work as to modes of construction. I laid bricks with my own hands where it was necessary to explain difficult points. I taught them to draw working-plans, and to understand sections; and in our conversations I explained the elementary principles of such portions of natural philosophy and chemistry as I considered to be essential to our various trades, avoiding, however, leading them into abstruse and difficult points in philosophy. Our practice, indeed, was limited to the application of science to the common purposes of life. All this was not accomplished without some expense to the institution. Bricks and mortar were consumed, tin and iron plates used up, as well as wood; and though the institution sold occasionally the produce of our work, this did not repay the outlay. I mention this because since that period some persons who could not appreciate the value of what was done, have spoken of our operations as mere waste—building up and pulling down. I know of no method more effectual of diffusing useful knowledge: ours was not mere talk,—our men learned to do what they talked about, and when they were thus instructed on several subjects of the greatest use, and at that time new, they returned to their several counties from which they had come, practised in what they had learned, and taught others."

CHAPTER III.

BY WHAT CLASSES OF PERSONS MECHANICS' INSTITUTIONS ARE ACTUALLY ATTENDED.

THE class of persons for whom Mechanics' Institutions were originally designed was, as the name indicates, Mechanics or Workmen; but it has been found that, although a considerable and increasing number of this class has joined them, others not contemplated in the original scheme, and supposed to be removed by their circumstances from the need of such means of instruction, have in still greater numbers availed themselves of these institutions.

The same consequences have, to a certain extent, attended the labours of those who have endeavoured to enlighten the great mass of the people by means of cheap publications. The Penny Magazine, and other publications of the Society for the Diffusion of Useful Knowledge, have only, to a limited extent, reached the humblest classes of this country; but other classes have been found who were in want of the information contained in those works, and have been benefitèd by them.

The following is a classification of the subscribers to the Manchester Mechanics' Institution at the commencement of the year 1838 :—

Principals engaged as merchants, manufacturers, and machinists	257
Mechanics, millwrights, and engineers	136
Over-lookers, spinners, and other mill hands	36
Building trades	104
Sundry trades, chiefly handicraft	132
Warehousemen	204
Clerks	150
Artists, architects, engravers, &c.	69
Professional men	7
Schoolmasters	10
Shopkeepers and their assistants	86
No Profession	11
Ladies	17
Youths	173
	1,392

Of these 84 were under 14 years of age.
558 between 14 and 21.
750 above 21.
1,392

The following is a classification of the members of the Edinburgh School of Arts :—

Occupations of the Students of the Winter Course of Study.

Shopmen	58
No trade	44
Joiners	23
Cabinet-makers	18
Smiths	16
Teachers	10
Clerks	8
Jewellers	7
Brass Founders	7
Tailors	7
Masons	7
Curriers	7
Printers	5
Piano-forte makers	5
Gardeners	5
Students	4
Painters	4
Writers	4
Watchmakers	4
Coach-builders	3
Engineers	3
Sugar-refiners, Architects, Brewers, Opticians, Tanners, Chemists, Accomptants, Shoemakers, Dyers, Hatters, Glaziers, of each two	22
Colourers, Basket-makers, Bakers, Fishing-rod makers, Bell-hangers, Figure-casters, Gold-beaters, Engravers, Lithographists, Plane-makers, Book-binders, Die-cutters, Cutlers, Machine-makers, Pupil of Blind Asylum, Sculptors, Carvers and Gilders—of each one	17
Total	288

OCCUPATIONS OF THE DRAWING AND MODELLING CLASSES.

Brass-founders	34
No trade	17
Plasterers	14
Joiners	14
Cabinet-makers	10
Carvers and Gilders	17
Chasers	7
Painters	6
Smiths	6
Masons	5
Shopmen	5
Jewellers	4
Seal engravers	4
Die-cutters	4
Engineers	3
Philosophical Instrument Makers	3
Watchmakers	3
Agents	1
Lithographers	1
Engravers	1
Teachers	1
Millwrights	
Cooks	1
Students	1
Machine-makers	1
Plumbers	1
Engine-turners	1
Colourers	1
Architects	1
Wood-engravers	1
Wire-workers	1
Total	170

From this it is evident that Mechanics' Institutions have been taken advantage of by persons differing in pursuits, information, command of leisure, and age. This fact opposes considerable difficulty to any attempt to determine what the constitution of a Mechanics' Institution should be, and the steps by which it should be gradually perfected. For neither is the mode of dealing with a child appropriate to a grown person, nor can much of the information to be conveyed to a man of some education be comprehended by one ignorant of the most elementary principles, although he may be of mature age. Yet individuals comprised in each of these classes are to be found among those availing themselves of Mechanics' Institutions.

Again, knowledge is desirable for various purposes. To some it is requisite for obtaining the means of subsistence; or for facilitating various processes, and enabling men to attain objects by the direct path and with certainty, which, although they might also have attained without such aid, still they would have reached with infinite labour, and after repeated failures. Other knowledge is valuable, as it makes men acquainted with their social relations; and other, again, for the pure and unmixed delight which it affords by purifying the taste, and elevating the mind. What portion of each sort of knowledge is most desirable for each individual must be determined in great part by the character of his daily occupation, and by the time which he has to expend in its attainment. That the working classes do not avail themselves of Mechanics' Institutions so fully as their friends could desire, makes it doubtful whether there is not something faulty in the constitution of these associations—whether, for instance, the instruction imparted is adapted in its nature and form to Mechanics—or whether it might not be useful to add to the usual objects of the institutions, that which would tend to connect the amusement of the members with their intellectual improvement. Nevertheless, although sight must not be lost of those for whom these institutions were especially founded—namely, Mechanics or Workmen; yet there are many reasons, why it is most desirable that other classes should likewise have the benefit of them.

The union of different classes in pursuit of some common objects is attended with many social advantages; and the want everywhere felt of funds for the support of Mechanics' Institutions renders such a union imperative.

CHAPTER IV.

INSTRUCTION AFFORDED IN DIFFERENT INSTITUTIONS.

Nor have such considerations been neglected by the most intelligent supporters of these institutions. Hence the varied features which the most perfect possess.

Those of the highest class afford not only to persons of matured intellect the means of pursuing the highest branches of science,—evening classes for persons whose education has been neglected, and who stand in need even of elementary information—instruction in particular arts (such as drawing and modelling), which lay the foundation for skill in different occupations—but even schools for children. There are public lectures, sometimes, though rarely, followed by examinations for the purpose of testing the knowledge of those who attend. There are classes in which the pupil is not only a hearer, but is catechised by the teacher. There are libraries and museums, and even arrangements for social meetings, in which recreation and instruction are combined.

We shall proceed to treat, somewhat in detail, the arrangements in institutions of various descriptions. These differ greatly in their character, and may be classed under the following heads:—

I. Those which have—

1. Lectures regularly delivered by professional lecturers.
2. Classes with paid masters.
3. Classes for mutual instruction.
4. Library, museum, apparatus.
5. A school.

II. Those which have—

Lectures and classes, or either of them, with gratuitous instructors, together with a library, museum, and apparatus.

III. Those which have—

Library, museum, &c., without lectures.

From the Report for 1837 of the Manchester Mechanics' Institution it appears that lectures were given on the following subjects, the greater part of them by professional lecturers:—

Application of Chemistry to the Arts and Manufactures.

Gaseous Chemistry.

General Properties of Matter and Heat.

On the Present State of Electricity.

Geology.

Mechanical Properties of the Atmosphere.

On Astronomy, including the preliminary branches of Dynamics and Statics.

Astronomy.

Importance of Geography as a branch of Education.

The improvement to be derived from the Study of Natural History.

Language.

Philosophy of Education.

Vocal Music.

These lectures, as will be observed, were, as regards their subjects, miscellaneous; many of them were little connected with the occupations of the listeners; while the mode of communication did not necessarily command the close attention of the students. Perhaps their value consists not so much in the amount of positive knowledge, which they impart to persons previously unacquainted with the subjects, as in awakening a desire for knowledge,—and in showing that there exist things useful and admirable, which science alone can enable men to know and enjoy. These lectures, in fact, awaken curiosity, and a desire for instruction of a more accurate description. That they need, however, to be followed up by such instruction is obvious from the following considerations:—

1stly. The lecture cannot be selected with reference to the previous knowledge of the individual.

2ndly. The information stops at the end of a lecture, or a course; and, even if comprehended, is necessarily incomplete and unconnected with analogous subjects.

3rdly. The difficulties which present themselves to an attentive listener in the course of a lecture he has neither time to reflect upon nor have solved, as the lecturer cannot be interrupted in the middle of his discourse, and it is frequently too late when the lecture is at an end to ask for explanations. Nevertheless, the perfect comprehension of the latter part of a course of lectures, or indeed of a single lecture, must usually depend upon the right understanding of all which preceded it.

4thly. Lectures of this description give a student an introduction into different departments of knowledge, without, however, dwelling on those which are peculiarly suited to himself: there is consequently some danger of their producing desultory habits and vague and inaccurate information.

With these difficulties before them, the Directors of the Institutions which have been most successful, although employing Lectures for their legitimate purpose, have turned their attention to the communication of accurate knowledge by means of lessons and classes, in which the student bears his part, and is not hurried a step farther than his knowledge enables him to proceed with safety.

At Manchester, during the past year, the following classes were attended by the number of pupils here indicated:—

Writing	250
Grammar Class	200
Arithmetic	400
Algebra and Geometry	60
Geography	30
Elocution and Composition	50
French	55
German Language	12
Chemistry	30

Natural History . . .	26
Architectural Drawing . .	100
Mechanical Drawing Class . .	60
Landscape, Flower, and Figure Drawing	109
Vocal Music* . . .	36

The number of students attending the various classes at the Glasgow Mechanics' Institution for 1836-37 was above 800.

The following is extracted from the report of the Edinburgh School of Arts :—" During the past year 451 students have attended the School of Arts; of these 291 took out tickets for the winter course of study; 70 for the drawing classes; and 90 for that of teaching the art of ornamental modelling. The business of the winter course of study has been conducted with a steady adherence to the plan of instruction agreed upon by the directors. The mathematical classes have been distinguished during the session by a very regular attendance, and highly creditable proficiency in their solution of the

* " The class for vocal music continues to excite great interest under the tuition of Mr. A. Ward, whose lessons have been attended by about thirty pupils, who have given excellent proofs of their proficiency, and the lively interest they feel in this study by regular attendance, and by their readiness at all times, not only to assist in our own concerts and lectures on music, but also in other institutions in the vicinity."—*Report of* 1838.

various exercises prescribed; the subjects taught in the senior class were the fourth book of geometry in the text-book, equations, the use of logarithms, plane trigonometry, and practical mathematics. Fifty-six have been enrolled for this class; of these, fourteen came forward as desirous to be examined, and to qualify for the certificate. It is very pleasing to the directors to be able to state that, during the past and immediately preceding sessions, the numbers who have attended the senior or more advanced class of mathematics have been three times as numerous as on any former occasion; and they regard this as the most convincing proof that the great mass of students do not resort to the school either for amusement or the acquisition of superficial attainments, but to obtain possession of sound practical information."

"In the Natural Philosophy Class, Mr. Lees, the lecturer, states that during the session a great variety of exercises were prescribed to the students, their answers to which were in general not only accurate, but given with a precision and intelligence that were truly gratifying. The students of this class were instructed in the following branches of science:—

"1. Properties of matter illustrated by appropriate experiments, and particularly by reference to the familiar incidents and occurrences of every-day life.

"2. The theory of statics, treating of the general equilibrium of bodies; centre of gravity.

"3. Mechanics, embracing the elements of machinery, with various modifications and combinations.

"4. Dynamics, treating of the motions of solids.

"5. Strength and strain of materials—bridge arches.

"6. Hydrostatics, including the general principles of hydrostatic equilibrium, pressure downwards, lateral pressure, pressure on embankments, centre pressure, hydrostatic press, specific gravity of solids and fluids, strength of spirituous liquors, floatation, centre of buoyancy, meta centre. The highly interesting and useful branch of mechanical science, floatation—a subject at all times necessary in connexion with a very useful branch of the useful arts, ship-building—was introduced last year, and was illustrated by a series of very ingeniously constructed models made under his immediate inspection.

"7. Pneumatics, treating of the phenomena of air-pumps, syphons, fire-engines, barometers.

"8. An account of Robins's experiments on gunnery.

"9. Steam-engine; latent and sensible heat of steam; history of the steam-engine; mode of determining the power of an engine; construction of the most approved form of the locomotive engine, &c."

"In chemistry, Dr. Reid is the lecturer, who not only performed experiments himself before his pupils, but enabled the students to perform them themselves: several of them, he says, performed nearly two hundred. From the progress which the pupils made, I feel confident that many have left the School of Arts this session who are now able to conduct a system of testing and experimenting, which they will in their various occupations have numerous opportunities of applying with advantage, and with an apparatus so economical, that it must be considered as applicable to all.*

"The Directors have now to inform the subscribers, that the classes for architectural, me-

* Chemistry is taught in a similar manner in the Manchester Mechanics' Institution.

chanical, and ornamental scroll-drawing, continue to be eagerly sought after by the students. One class has already been taught this summer, and another is now in progress, each consisting of thirty pupils; and a great many applications for admission were made above the number which it is possible to do justice to in one session. The Directors conceive that, during this last session, they have made a most valuable addition to the instruction afforded by the School of Arts in the formation of a class for teaching the art of ornamental modelling. It has long been a subject of great regret by master mechanics engaged in ornamental occupations, that there were no schools of any kind in which their workmen could be taught the art of acquiring a classic chasteness of expression in the designs of the articles passing through their hands; and the recent examinations of several of the most intelligent master mechanics and manufacturers of this country, before a select committee of the House of Commons, proved that, in this respect, Britain is very far behind France and several other continental countries with whose manufactory ours are brought into active competition.

"The institution of this class was at first of course to be regarded in the light of an experiment; but the great avidity with which the mechanics of Edinburgh have availed themselves of the instruction afforded by it, together with the opinion they have all expressed of its necessity, and the blank in their education which it will so completely fill up, has led the directors to entertain very sanguine hopes that it will form a permanent part of the institution. It is not the object of the directors in the formation of this class to open a nursery for artists, but to teach those engaged in all trades where ornament is in the least concerned, such as silver-chasers, jewellers, plasterers, glass-cutters, brass-founders, smiths, die-sinkers, and a variety of others, to form their ideas of design on the most approved models of ancient and modern excellence; to enable them, instead of servilely imitating existing patterns with a vague uncertainty and want of acquaintance with the laws regulating art, to classify their labours; and by accustoming their minds to contemplate and imitate acknowledged excellence, gradually to lead the way to that creative skill in the execution of their designs, which will eventually open up a new era in such walks of art, and remove the imputation under which this country at present lies when compared with her continental neighbours."

Those students who have regularly attended the prescribed courses, and on examination are found to have properly profited, have a certificate given to them of membership to the school of arts for life, and this solemnly before the annual meeting of the society. The following is the form of the certificate:—

"*School of Arts, Edinburgh.*

"These Presents certify that —— attended the classes of Mathematics, Mechanical Philosophy, and Chemistry, taught in this institution, during the sessions 18—, 18—, 18—; that he was examined according to the prescribed forms, and, being found to possess a competent knowledge of the subjects taught in these several classes, was, at a general meeting of the subscribers held the — day of ——, 18—, admitted a member of the School of Arts for life."

The remarks upon this point in the report are as follows:—"A certificate obtained by a course of study like this, and after examinations so searching and complete, is unquestionably one of the highest and most flattering testimonials which a young man can possess: it certifies at once the correctness of his conduct, the extent of his studies, and the proficiency he has made; and, go where he may, and apply for what situation he may, this certificate of membership, obtained so honourably, must ever be his best recommendation, as well as the most powerful stimulus to a line of conduct which should support the character he has acquired."

In his address to the Manchester Mechanics' Institution of this year (1838), Sir Benjamin Heywood recommends similar certificates to be granted there, and he states that "such is the confidence attached to these certificates, that an eminent engineer here says he should not hesitate at once to take into his employ any one who brought with him such a testimonial."

These classes must be looked upon as forming the most useful and indispensable part of a good Mechanics' Institution. By their assistance students are led from the allurements of vague and desultory reading, and brought to the severer but more useful study of particular subjects, so as to ascertain the nature of the difficulties which surround them, and to grapple with and master them. These difficulties ought not to be wilfully created, nor ought the longest method to be taken for overcoming those which necessarily inhere in a subject, but, wherever they do exist, they should be fairly met and manfully overcome. It is only by acting thus that men can be brought to master a subject, and can obtain from study that wholesome discipline which gives an earnestness and solidity to the character, and has often a value equal if not superior to that of the actual knowledge obtained.

Public lectures, when they do not induce the hearers to study in a closer and more systematic manner, produce listlessness and indifference when the first surprise is past; but this is never the result of earnest and rigorous study. Upon this subject we cannot do better than quote the words of Lord Brougham in his "Preliminary Discourse" to the "Library of Useful Knowledge:"—"But, if the knowledge of the doctrines unfolded by science is pleasing, so is the being able to trace the steps by which those doctrines are investigated, and their truth demonstrated: indeed, you cannot be said, in any sense of the word, to have learnt them, or to know them, if you have not so studied them as to perceive how they are proved. Without this you never can expect to remember them long, or to understand them accurately; and that would of itself be reason enough for examining closely the grounds they rest on. But there is the highest gratification of all, in being able to see distinctly those grounds, so as to be satisfied that a belief in the doctrines is well founded. Hence, to follow a demonstration of a grand mathematical truth,—to perceive how clearly and how inevitably one step succeeds another, and how the whole steps lead to the conclusion,—to observe how certainly and unerringly the reasoning goes on from things perfectly self-evident, and by the smallest addition at each step, every one being as easily taken after the one before as the first step of all was, and yet the result being something not only far from self-evident, but so general and strange, that you can hardly believe it to be true, and are only convinced of it by going over the whole reasoning,—this operation of the understanding, to those who so exercise themselves, always affords the highest delight. The contemplation of experimental inquiries, and the examination of reasoning founded upon the facts which our experiments and observations disclose, is another fruitful source of enjoyment; and no other means can be devised for either imprinting the results upon our memory, or enabling us really to enjoy the whole pleasures of science. They who found the study of some branches dry and tedious at the first have generally become more and more interested as they went on; each difficulty overcome gives an additional relish to the pursuit, and makes us feel, as it were, that we have by our work and labour established a right of property in the subject. Let any man pass an evening in vacant idleness, or even in reading some silly tale, and compare the state of his mind when he goes to sleep or gets up next morning with its state some other day when he has passed a few hours in going through the proofs, by facts and reasoning, of some of the great doctrines in Natural Science, learning truths wholly new to him, and satisfying himself by careful examination of the grounds on which known truths rest, so as to be not only acquainted with the doctrines themselves, but able to show why he believes them, and to prove before others that they are true;—he will find as great a difference as can exist in the same being,—the difference between looking back upon time unprofitably wasted, and time spent in self-improvement: he will feel himself in the one case listless and dissatisfied, in the other comfortable and happy; in the one case, if he do not appear to himself humbled, at least he will not have earned any claim to his own respect; in the other case, he will enjoy a proud consciousness of having, by his own exertions, become a wiser, and therefore a more exalted creature."

The report of the Ipswich Mechanics' Institution for 1837 says, "Public lectures alone on varied subjects which the readers never have studied become, after the novelty is worn off, wearisome;" and, after lamenting the "apparent want of interest, on the part of the members, in the lectures which have been delivered for some time past," it goes on to state, that "The committee entertain a full conviction that the apathy which has for some time prevailed with respect to the lectures has not arisen from any feeling of indifference to the welfare of the institution; but has rather been produced by their frequency and number divesting them of that degree of novelty which would distinguish them if delivered after long intervals." At Chichester the library is considered by the members at large as much more useful than lectures.

The lukewarmness which this extract manifests is in strong contrast with the eagerness displayed in the classes at Edinburgh and Manchester. The reason is obvious—the classes lead to sound connected knowledge, which the lectures alone do not. If students are to be stimulated to enter the classes by public lectures, the lecturers in their turn will obtain their most numerous and enlightened listeners from the classes.

"The objects of these institutions are," to use the words of Sir Benjamin Heywood,* "to teach the workman (be his trade what it may) those principles of science on which his work depends, to show him their practical application, and how he may make his knowledge of them profitable;—to enable him thoroughly to understand his business, and to qualify him for making improvements in it;—to teach him how he may advance himself in the world, and to give him an honourable and delightful employment for his leisure." The subjects taught in the classes at

* Address at the opening of the New Building for the Mechanics' Institution, in 1827.

Manchester and Edinburgh will be found to fulfil the objects pointed out in this definition. For instruction is given in language and number, and the mode is shown in which bodies act upon each other mechanically and chemically, while skill in expressing ideas either with the pencil or the clay has been carefully cultivated.

But in the arrangements of both one and the other there appears to be a void which the increasing wants of society require more urgently every day to have filled up, viz.: morals, in the largest sense,—that science or class of sciences which, while they determine the conduct of man in his individual capacity, or as the member of a private family, mount up to the consideration of the laws which determine the action of large masses of society upon each other, either for good or ill. This science, or these sciences, comprehend, among others, metaphysics; morals, properly so called; political economy; politics, in a scientific sense; the law of nations, or international law; and the law of the land.

Happily, all these sciences possess certain leading facts, the truth and importance of which all well-instructed persons admit; and those facts ought to be impressed on the minds of persons of every class, that they may serve for principles as a groundwork of their reasoning with some assurance. The incertitude of most persons who, from want of time or other causes, have not made those important sciences their study, and the ignorance which pervades many classes of society with regard to some of their most important truths,* renders the communication of sound information upon them absolutely necessary—the more so as the people at large acquire a larger share in the conduct of public affairs.

* The ignorance with regard to the right to property which was found to exist in the district of Kent where the Courtenay riots took place is a strong case in point; particularly as there can be no reason for supposing it to be confined to that spot alone.

CHAPTER V.

LECTURERS PAID AND UNPAID.

Although there are few Mechanics' Institutions which do not owe their first success to the zeal and ability of persons who have gratuitously given courses of lectures to them, yet the reports demonstrate that one cause of their ultimate failure has been their dependence on gratuitous lecturers.

At York, with a population of 28,000 persons, there are only 150 members of the Mechanics' Institution; the lectures are gratuitous, by members; the attendance at the lectures varies from 50 to 80, and has occasionally amounted to 100.

Oxford.—Population 22,000.—There are 110 members of the Mechanics' Institution. Lectures are given by members, and sometimes by an itinerant lecturer. The attendance at the lectures not so full as could be wished.

Lincoln.—Population 30,000.—There are 441 members of the Mechanics' Institution. Lectures vary in number, as gratuitous lecturers can be found. The attendance is various.

Lewes.—A number of classes have at different times been formed, but the teachers, from the circumstance of giving their services gratuitously, have been remiss in their attendance.

The fitness of the gratuitous lecturer cannot be insured; the subject must depend upon his knowledge, not on the wants of the members of the institution: and, as the continued zeal of an individual, and much more that of a series of individuals, cannot be relied on, no system can be pursued; and, consequently, no progressive intellectual improvement can be obtained.

It is too much to expect of any man to give up his time and labour without payment, particularly if he is competent, for then he can command remuneration elsewhere; and, if he is not competent, he is paid too dearly by being attended to. That which is bestowed as a gift cannot be found fault with.

It is, however, almost useless to enlarge upon the inferiority of gratuitous courses of lectures, whilst the means of remunerating professional lecturers are nearly everywhere wanting. Even at Glasgow and Manchester this difficulty is experienced, while in institutions in minor towns it is more severely felt. It is stated* that very considerable difficulty was experienced at Glasgow in procuring able and popular lecturers on Natural Philosophy and Chemistry,—the two branches of science on which the prosperity and usefulness of the institution mainly depended; and the unavoidable consequence was, a very considerable diminution in the number of students. An individual whose talents can command employment, and who relies on them for his support, necessarily requires that, besides being paid for his professional labours as a lecturer, his travelling expenses should be reimbursed to him, and he should be remunerated for the time which his journey to and fro has occupied.

If he has to travel any great distance—as from London to Manchester—expressly for the purpose of delivering a lecture, or even a course of lectures there, the expense would fall so heavily

* See the excellent Prize Essay upon Mechanics' Institutions, by Mr. David Burns, a Member of the Glasgow Mechanics' Institution.

upon the institution which invited him, that there are but few which are able to afford it; and thus recourse is had to gratuitous services.

Lord Brougham, in his pamphlet, published in 1825, upon the Education of the People, remarks that "The difficulty of obtaining a fit lecturer is one likely for some time to be much felt, especially in small towns. One method of removing it is by sending an experienced teacher from place to place."

The following extract from the Report of the Manchester Mechanics' Institution for 1837 will show that this suggestion has been successfully acted upon.

"Throughout the past year a continued series of most valuable and interesting lectures have been delivered. The expense of obtaining first-rate talent in this department will always form a large item in the expenditure: it has, however, this year been very materially lessened by the good understanding which exists with other institutions, by which the directors have been able to receive the services of several excellent lecturers on easier terms than they could afford to come for alone."

And in the Report of the same institution for

1838 it is stated "that the good understanding which exists between it, the Royal Institution, and the Athenæum, has enabled the directors to bring gentlemen of the highest talent and acquirements before the members at a much less cost than they could otherwise have done."

If arrangements were made for a lecturer to visit a number of institutions in the same neighbourhood, in rotation, so that as soon as he had concluded his course at one he might commence it at another not far distant, many advantages would ensue:—1. The employment would be sufficiently lucrative to engage many able lecturers.

2. Regular courses of lectures upon connected and useful subjects could be insured.

3. Much money and time expended in travelling would be saved.

This plan has been acted upon on a small scale in Kent. The directors of the Maidstone Mechanics' Institution induced those of the institutions at Tonbridge, Tonbridge Wells, Chatham, and Sheerness, to join with them in engaging Mr. Webster to visit their several institutions on successive days, and deliver a lecture upon Geology at each. The arrangement succeeded to the satisfaction both of the lecturer and the institutions; an interest was created in the neighbourhood upon the subject; and Mr. Webster was subsequently engaged by a public school to give more lectures.

It would of course be necessary that there should be unreserved previous communications among the neighbouring institutions for the selection both of subjects and of the time for the lectures; any want of concert would defeat the object.

There remains, however, another difficulty, and that not the least formidable—the selection of lecturers. In the instance of distinguished individuals there is no difficulty; but distinguished individuals are few, and the number of lecturers wanted, particularly if Mechanics' Institutions increase as it is to be hoped they will, would be many. All persons who understand their subjects are not good explainers of them; and there are fluent lecturers who do not understand their subjects.

It would be hard to send for a man from a distance and not employ him; and, though it were stipulated that his services would only be accepted if they were found efficient, the leaning would be against rejecting him unless he were grossly incompetent. Even at the London Mechanics' Institution great difficulty is found in obtaining the services of well-qualified persons, particularly for the communication of scientific information.

This difficulty would no doubt be removed if the profession of a lecturer presented any prospect of adequate remuneration for the time and labour expended on the actual exercise of it, and on acquiring the information and skill necessary for a public teacher.

But, notwithstanding all arrangements for sharing the expense among a neighbourhood, there would still be many institutions unable to pay a sufficient sum to secure efficient lecturers. A society in London has been endeavouring to establish some lecture circuits of this description; and it has, in the instance of several large towns, been met by the difficulty of want of funds to pay the expenses, which would thus be so greatly diminished. It would be difficult to point out how the Government could better apply a portion of the funds annually intrusted to it by the legislature for the purposes of education than in thus rendering assistance to Mechanics' Institutions. A sum of money, in itself inconsiderable, would, if judiciously applied, go a great way. Nor would such a mode of proceeding be without a precedent, as will be seen by the following advertisement:—

NOTICE.—"The Lords of the Treasury have placed at the disposal of the Royal Dublin Society a certain sum for the purpose of assisting to defray the expense of their professors in going to deliver lectures in provincial towns where subscriptions have been entered into for that purpose, and from whence applications shall have been received, intimating the nature of the lectures required, and the amount subscribed.

"By Order, E. T. HARDMAN, Assistant Sec.
"*June* 22, 1838."

Lectures have, in consequence of this notice, been since given by two of the professors of the Dublin Society, at Galway, Portarlington, and Wicklow.

The disadvantages of mere lectures have been adverted to; but they are only comparative, and leave very considerable benefits attached to that mode of instruction. The attention of many is thus drawn to the subjects handled, for whom book-reading would have no sufficient attraction. The knowledge contained in the lecture is communicated to many at the same time, and their minds excited to discuss the subject one with another, greatly to their improvement. The circumstance is not to be omitted of the pupils being thus enabled to do without books which the libraries of the institution may be inadequate to supply, while certainly few libraries have the requisite number of sets to supply many readers at once. Lastly, there do not exist perfectly plain elementary and popular works upon the branches of knowledge to which some of the summaries of lectures in the sets subjoined to this volume relate. It becomes, therefore, material to add, that there exists a mode of providing lectures without any difficulty or expense to Mechanics' Institutions, and that this method has been already tried with much success. Sets of Elementary Lectures have been prepared; and all that is wanting in order to their being delivered is, that some member of any institution should read them to the class meetings held for the purpose, with a clear voice and sufficiently slow to be followed. In some cases a method has been adopted with advantage, which may here be added. On each lecture-day the lecture read at last meeting is again read over, and then the new lecture is read. Thus each is heard twice by the learners, and at an interval which leaves time for reflection, and for considering and endeavouring to recollect what was first heard. Nothing can better tend to impress the subject-matter on the memory. It is obvious that, as this mode of proceeding supposes the lecturer to be only a reader, and not better informed than his fellow-students, none of the advantages can be obtained from it which are derived from the performance of experiments, or from explanations given after the lecture in conversation with the student, or from removing difficulties which may present themselves to the pupils in private study. But still, as the method requires no kind of qualification but the power of distinct reading, it has the great advantage of being free from all expense, and of enabling persons (whose time is not at their command for delivering lectures) to compose them, nevertheless, at the intervals of their habitual occupations, so that the lectures may be delivered by others. Such persons are hereby, therefore, invited to contribute in this manner to adult education, as some good and able men have already done.

CHAPTER VI.

LIBRARIES.

One of the most absolute requisites for creating and sustaining a love of knowledge is a good library; but the more perfect a library becomes, the more extensive is its collection of books, and the more miscellaneous is its character.

An uninformed man, desirous of obtaining knowledge in such a repository of the learning of all ages and nations upon all subjects, may peruse the catalogue and wander from shelf to shelf, but he knows not what subject to begin with, or, even if he knows the subject, he cannot select the books he should study, or the order in which they should follow each other. A library is a complete labyrinth to him: he sees here one name, and there another, of persons who have distinguished themselves in different departments of science and literature; he is eager to make himself acquainted with the result of their labours; he opens a volume and finds, probably, that a quantity of previous knowledge is requisite for the comprehension of it; he opens another—reads and understands—but, having arrived at the conclusion, he is at a loss how to carry on his studies in a connected chain. The time which self-educated persons have wasted in perusing books which were either unnecessary or ill-timed or mischievous, from the circumstance of containing false information, is very great; and although they may sometimes at last obtain the thing which they were seeking, with what infinite toil is not this effected!

Again, while connected reading has a tendency to give a steadiness to the character, the miscellaneous perusal of books tends to weaken the intellect: for a line of association is no sooner spun for a short length, than it is immediately put on one side for another line, which is substituted, only to be destroyed in a similar manner.

Although it would answer no good end, and for the sake of the funds would be inexpedient, to exclude works of fiction from libraries for working men, yet it should be borne in mind that the unceasing seeking after such reading is very distinct from, and is rarely found in combination with, a love for knowledge and a desire of improvement. Let those who are seeking to foster the one be careful that they do not create the other. From the lists of books read by different individuals at a Mechanics' Institution, it was manifest that there were several decided novel readers. Novel after novel appeared to be devoured, each in a few days; no other books are relished by such persons. This is the abuse of a library of a Mechanics' Institution.

The libraries of Mechanics' Institutions are accumulated in two ways, — by the gifts of friends, and by purchase from the common funds. Hence the varied and unconnected character of too many of them. A large and good library must, no doubt, be miscellaneous, as containing books on many subjects; but on all the subjects comprised there should be books containing consecutive and full information.

In forming libraries, the sets of books requisite for the study of particular subjects should be completed before other subjects are taken up; and for the purpose of making the presents of friends of such institution useful, lists of books wanted to make up series should be kept and made public, in order that the friends may learn what books would be most acceptable. A correspondent, in giving an account of the Stonehouse and Devonport Mechanics' Institution, states that "Many of the books were presented, but I believe not precisely those most useful to a Mechanics' Institution." So at the founding of the London Mechanics' Institution, the friends of the undertaking made presents of duplicates and of such books as they did not want: hence a most miscellaneous collection upon its shelves.

It is not sufficient that the books should be in the library, and a list of them kept. To make a library accessible to students at Mechanics' Institutions, the books should be classed according to their subjects, and not only the order in which they are to be read, where such order is necessary, but something of their character should, if possible, be found in the catalogue. The most useful of all things would be a full catalogue of all the subjects to be found in all the books of a Library, referring to the volume and page of each work.

But the books suited to a Mechanics' Institution in one place are not necessarily so to another: the pursuits of men differ, and the instruction they stand in need of consequently varies. Although a general catalogue may be framed to assist the well-informed, discretion cannot be dispensed with: the library which should be well suited to an institution in the country, would not necessarily be so to one in a town.

There is no doubt a vast class of subjects common to all men, and the works relating to these should find their way into the libraries of all institutions.

As, with every assistance, it is a very difficult matter to make a judicious selection of books, while it is at the same time one of the utmost importance, all institutions ought to be careful in whose hands they repose the trust of making purchases. It is incredible how rapidly rubbish will accumulate upon the shelves of even well-informed persons from the want of a strict rule with regard to purchases. There is always a danger of such being the case when the works of the day are procured. Beyond those which immediately advance science, and convey information which the world was not before in possession of, new works should be purchased with the greatest circumspection. The circumstance of a work having lived a number of years is greatly in its favour; besides, how many works are there of acknowledged and established merit which every institution is not in possession of; and how few are the new books of value which are immediately necessary!

In referring to the report of the various institutions, we find that the information, with regard to the reading, is by no means so full and definite as could be desired. An accurate account of the books read, and the reading of each individual, would not only enable the directors to ascertain the books each occupied himself upon, but the order and connexion of his reading; and from hence would be obtained data whereupon to ground useful suggestions: for, as has before been stated, the free use of a library, without any guide, may lead a person astray: it is therefore desirable to ascertain, as accurately as possible, without interfering with the free choice of any one, the course which he is adopting; and where error in choice proceeds from ignorance, a little advice opportunely offered might be of the utmost service. General observations upon the subject might also be advantageously made in the annual report, which, grounded as it would be upon certain data, and coming from persons of knowledge and experience, could not fail of having a beneficial influence.

The libraries of a county town are generally,—

1. The library of the dean and chapter, which sometimes contains a good collection of standard works; at others, only a body of controversial divinity. This library is, for the most part, only accessible by the clergy, and those whom they, by special license, may choose to admit. The use made of it is consequently much limited.

2. The library of the municipality, which consists in some instances of valuable records and other documents, often unindexed and unknown, as is the case at York. There is sometimes a good collection of books, the right to make use of which is imperfectly known to the individuals who have it, as is the case at Bristol.

3. A select subscription-library, or book-club, the admission to the benefits of which, besides costing a considerable sum, for the most part requires the candidate to undergo the ordeal of the ballot. This description of library often contains a choice selection of books. The library at Bristol, called "The Bristol Library," contains 18,000 volumes.

4. Circulating libraries, conducted as private speculations. These contain, for the most part, nothing but novels and the lighter literature of the day.

5. The libraries belonging to religious sects of different denominations. The books which compose these are, for the most part, theological, and tend to support the peculiar opinions of the sect to which they are attached.

6. The library of the Mechanics' Institution which, probably from the want of funds, possesses but a slender stock of books, and these, perhaps, ill selected. Such, however, is not always the case, indeed we might mention many exceptions; among which are Manchester, where the library of the Mechanics' Institution contains 4058 volumes; and last year the issues were 41,384, which is more than ten issues for every book in the whole library: Glasgow, where the library of the Mechanics' Institution contains 4000 volumes of the most important works in the English language on science, art, and literature: Sheffield, Bolton, Coventry, and Liverpool.

The Libraries Nos. 1, 2, 3, and 5 are, as will be perceived, exclusive, and of no value to the great mass of the inhabitants. Those of No. 4, if not mischievous, are almost useless; while those of the last, No. 6, are but just beginning to assume an importance in a few leading places.

Seeing that there are now, in all towns of consideration, libraries belonging to different bodies, sufficient, if brought into one repository and thrown open to all persons, to form the groundwork of a good library, which the combined strength of the whole society might without great difficulty complete, it is very desirable that some means should be found to induce the various proprietors thus to unite their resources.

In this the government might greatly assist, by enabling corporations, both lay and ecclesiastical, to place the books and other documents in such public repository; and by giving a collection of public documents or expensive standard books, and granting a sum towards the erection of a public building to hold the books, at places in which a union had taken place; and by enabling municipalities to apply a portion of their borough rates to the maintenance of public libraries.

Beyond the great advantage of thus making a large collection of books accessible to all classes, there would be effected a great saving of expenditure. At present, whenever the books are used, each library must have its librarian and servants to attend the rooms; while, should such a change be effected, one establishment would be sufficient for the whole, and the money now expended in servants would be laid out in books.

But it is not in the chief towns of a county alone that it is desirable such Institutions and Libraries should be formed. They might be established in the smaller towns, and even in villages, where ignorance most prevails. The chief difficulties opposed to their establishment in such places proceed from the want of funds, and of persons who, being interested in their foundation, are qualified to undertake their direction.

Probably at this moment it would be impracticable even for the Government to cause institutions, with their lecturers, teachers, libraries, museums, to be founded and generally resorted to throughout the country. The first steps towards such a desirable object appear to be the founding of good schools and village libraries. As the want of funds and of appropriate arrangements are the chief difficulties which oppose the founding of these libraries, an account is here given of the Scotch Itinerating Libraries, and of the arrangements made at the Chichester Mechanics' Institution, for the purpose of imparting its advantages to the neighbouring rural population.

The following extract is from an interesting Memoir upon the subject of Itinerating Libraries by the Rev. W. Brown:—

"I. The primary feature of these libraries is their *itinerating* character. The books are formed into divisions of fifty volumes each. One of these divisions is stationed in a place for two years, and the books are issued to all persons above twelve years of age, who will take proper care of them. After that period it is removed to another town or village, and a new division is sent in its place, which, after another two years, is again exchanged for another. Thus a perpetual succession of new books is introduced into each town and village, and by this means the interest of the readers is very effectually kept up. It is well known that stationary libraries in country places very commonly cease, after a few years, to excite much interest,—that the funds rapidly diminish, —that the addition of new books which is made from time to time becomes, in consequence of this, too small to inspire any degree of curiosity, —and that most of the volumes lie undisturbed on the shelves, unread and uncalled for. To persons acquainted with the issues from stationary libraries of a number of years standing, the following statement will appear almost incredible. The issues of new books at Haddington to subscribers have, on an average of the last two years, been nearly eight and a half times *per annum* for each volume: the gratuitous issues at Haddington, Gifford, Salton, Aberlady, North Berwick, Belhaven, and Spott have been seven times for each volume; and the issues of the books of the whole establishment (now amounting to upwards of 2000 volumes) have, so far as reported, been five times for each volume, or 10,000 issues of the whole. If the same number of books had been formed into as many stationary libraries, there is reason to doubt whether the issues, several years after their establishment, would have amounted to 1000 a year. Such, indeed, has been the interest excited by the regular removal of the libraries, and the supply of new divisions, that in several places, during the winter season, the whole of the books have been issued at once,—not a volume has been left in the library.

"It is judged better to station the divisions in a place for two years, rather than for a shorter period, as at first the lighter and more entertaining reading is chiefly in demand; and were the books changed every year, there is ground to apprehend too strong a taste might be formed for amusing works: but when they remain two years, the people have time to read also the more solid and useful books.

"On the other hand, it is not perhaps advisable to continue a division longer than two years in the same place. Though in some instances the issues in the second year are equal, or nearly equal, to those of the first, yet, generally speaking, there is a considerable falling off; and in some cases they have been very few indeed: yet no sooner does a new division come to a place, than the number of issues rises to their original, or perhaps to a greater amount. Were the same books continued a third year, the number of issues would probably in most cases be very small.

"II. A second important feature of these libraries is their *cheapness*. This is of importance in every scheme of benevolence, but especially in a scheme which it is desirable should be carried forward on an extensive scale. When the object is to supply, not a single town or village with a library, but a whole country, or a whole kingdom, *cheapness* comes to be a primary *desideratum*. A single library of fifty volumes, with book-case, catalogue, labels, advertisements, and issuing-books, may be procured for from 10*l.* to 12*l.*;

but the cost will of course depend in a considerable degree on the kind of books wanted, and whether they have been recently published. Very good divisions may be selected for from 8*l.* to 10*l.* Taking the medium of these rates,—namely, 10*l.*, the following number of libraries might be established for the sum stated:—

1 for a village	- - - -	10*l.*
5 for a district of villages	-	50*l.*
50 for a county	- - - -	500*l.*

"Supposing the books in these libraries to be read on an average annually, in the proportion which has just been stated,—namely, five times for each volume,—this, in twenty years, the period which a library is found to last, will amount to 100 issues for every volume, or 5000 issues for the whole of the books in each library; and 250,000 issues for the whole of the books in fifty libraries.

"It may be doubted whether so much good as may be anticipated, from such a number of well-chosen libraries, could be effected at so small an expense by almost any other means."

The following are the arrangements of the Chichester Mechanics' Institution:—

Branch societies are formed in the county, to which boxes of books are sent, and which are periodically visited by a lecturer. One of the farmers undertakes to be secretary and treasurer; collects subscriptions; makes applications for such books as are wanted, and takes care that those which have been forwarded are duly returned. No plan can be more simple than this; and by it every town in which a Mechanics' Institution exists may become the means of enlightening the neighbouring rural district, while it would, by so acting, obtain additional means for its own support. Should there be any difficulty in finding an intelligent farmer willing to undertake the task of librarian and treasurer, schools, when established generally throughout the country, might easily be used for those purposes. The school-room might be the lecture-room; and the master, or even one of the boys, the librarian; while a small sum out of the village subscription might be given to him for his trouble.

We subjoin an account of a village library, at Dukenfield, near Ashton-under-line, and for that purpose borrow the words of Mr. Robinson, one of its Vice-Presidents, from his excellent address, at the second anniversary of the Institution:—

"In laying before you at the annual meeting the situation of our Village Library, I think that we have no reason to be ashamed of its present state. It has been in existence only two years, and already we have on our shelves three hundred and thirty-three volumes. In looking over the catalogues of two other libraries in the neighbourhood, I have no hesitation in saying that, if not so numerous, our selection is better made, and is more varied than either. Ours are not books presented to us because, by time, they have become useless to their owners, or bought cheap because they have been supplanted by better ones: they are almost all modern, containing the latest information; they are all by excellent authors, and have the advantage of being chosen with an express reference to the wishes and the wants of the working-man. A single glance at our catalogue will satisfy, I think, any one acquainted with books, that no useful branch of literature or science has been entirely neglected. Some books, and good ones, we possess in almost every class; and it depends solely on yourselves to have many more. Now mark the change of circumstances. Three or four hundred years ago the richest man in England could scarcely, without difficulty, have acquired a collection of works containing so much sound and correct information; and now the humblest individual has within his reach a fund of knowledge which would, in those days, have procured him the reputation of a philosopher; perhaps the high distinction of being burnt as a wizard or dreaded as a magician. And all these means of enjoyment, and all the advantages which are to be derived from knowledge, you may have for the trifling sum of one penny a-week.

"One hundred and nine volumes have been added to the library within the last year: of these sixty-eight have been purchased, and forty-one have been presented as gifts.

"The weekly penny-subscriptions for the last year have amounted to 14*l.* 0*s.* 6*d.*, and the honorary subscriptions to 7*l.* 17*s.* 6*d.*; making together 21*l.* 18*s.*, of which 5*s.* 2*d.* have been deducted for small incidental expenses, and 21*l.* 12*s.* have been paid over to the treasurer, and by him, with the exception of a small balance, disbursed in the rent and the purchase of books. The rent, for which the subscribers have the use of the school-room two evenings in the week, is only 1*l.* annually.

"The number of subscribers, usually rather fluctuating, is at the present moment only seventy-six, of whom eighteen are honorary, and fifty-eight are ordinary members. The number of ordinary members is rather less than in the first year; in this there is nothing very discouraging; indeed it is rather in appearance than in reality. At the first establishment of a new undertaking it was natural that several should put down their names on the books who afterwards fell off from a variety of causes. I am informed that the present subscribers are regular and constant readers, and take an interest in the success of the library; and I am also assured that their number is regularly, though slowly, increasing.

"Now this number, in a population so large as ours, is certainly not great; yet let it not, therefore, hastily be said that our library does no good. If only fifty individuals are weaned from idleness or dissipation, and are taught to amuse themselves in an innocent and profitable manner, it is something gained to human happiness; and it is not easy to estimate the advantage reaped by society from the influence and example of even fifty persons who have acquired more information and juster notions than the mass. Each becomes the centre of a little circle, to whom he teaches what he has learned himself. His children, at all events, are likely to be better instructed, and taught to avoid many evils to which they would otherwise have been exposed. Is not such ever the progress of society?

"The following was the plan on which it was proposed to conduct the Institution :—

"1st. That every individual who shall subscribe one penny a week shall be an ordinary member of the institution.

"2nd. That every individual who will subscribe half-a-guinea a year, shall be an honorary member of the institution.

"3rd. That the choice of the books, and the general business of the society, shall be conducted by a committee of twelve or more members, one-third to be chosen out of the honorary members, and two-thirds out of the ordinary or general members of the society, to be elected annually out of the whole body of subscribers.

"4th. That any member shall have the privilege of entering into a book, to be kept for that purpose, any work which it may appear to him desirable to have in the library; and that the committee shall meet once a-month, and decide if such book be admissible.

"This was the plan proposed, and it has been strictly carried into effect with only one deviation: the constitution has been made even rather more popular. Twelve members, instead of eight, have been chosen out of the ordinary members to compose the committee, and only three out of the honorary; so that the honorary members form only a fifth part, instead of a third of the whole. This alteration I see no reason whatever to regret.

"The subscription, which is only one penny a week, gives to every subscriber the privilege of reading three hundred and thirty-three volumes at his own home. It gives him the privilege also of naming any work which he thinks it desirable that the library should possess. All the works named are entered in a book kept for the purpose; and every month a committee of twelve individuals, chosen by the whole body of the subscribers at their annual general meeting, take them under consideration, and decide whether they shall be admitted or not."

CHAPTER VII.

MUSEUMS AND EXHIBITIONS.

DISCOVERERS and other leaders in science have ever made use of all the aids they could obtain in testing the perceptions of one sense by those of another, scrutinizing the objects presented to their contemplation by every means in their power, and seizing upon every aid which others have made use of or their own ingenuity could devise, and instead of wasting their time in speculating upon what the results of various combinations might be, have ascertained what they were. No less useful is the same help in teaching: but the difficulty and expense of obtaining and conveying from place to place collections of natural objects, of models, and of philosophical apparatus, and of the materials required for conducting philosophical experiments upon a large scale, have, with other causes, occasioned teachers to confine themselves to the conveying instruction mainly by words alone. But the conceptions which can be obtained by these means are very indefinite; and he who, after such teaching, does not take other means for gaining an acquaintance with the matters discoursed of, will find his information vague and unsatisfactory.

Museums and philosophical apparatus are very large terms. By the term museum, however, is here meant a repository which enables the lecturer to place not only the description of a thing before his auditory, but the thing itself. It will therefore comprise, among other things, specimens, such as geological, mineralogical, and chemical; models, as those illustrative of the mechanical powers, of machines, and of architecture; maps, globes, &c.; casts of statues; prints, medallions, &c. In forming museums it must be borne in mind, that it is not the extent of the collection which constitutes its value, so much as its adaptation to the purposes in hand. The geology, the mineralogy, the botany, and the zoology which the inhabitants of a county town or country district most require to be made acquainted with is that of their own neighbourhood. The specimens illustrative of them are at hand, and the students have but to carry a recollection of their studies out of doors to be the best purveyors of specimens for their museum.

There are few things more improving or more interesting than an intimate acquaintance with the natural objects connected with one's native place. It is impossible to read such a book as White's Natural History of Selbourne without feeling that this sort of knowledge must have a tendency to attach us more closely to the spot. Nor would the advantage to be derived from the attention of local institutions to the objects in their neighbourhood be confined to their respective members. A more minute and accurate acquaintance with the whole country would be thus obtained than could be procured by any other means; science would be extended by it. Mr. Wyse, in the second volume of the Central Society of Education, has the following interesting passage:—

"Each museum and collection is formed on too wide a plan; too little attention is given to local objects and purposes. The results of this affect materially both the society and the community. A certain stock of specimens is necessary (as a general apparatus) for public instruction; but this is soon acquired: the great mass of our museums look much beyond this; they seek specimens from abroad, as much for display as use, at great cost and labour. Yet it is precisely what is nearest at hand and cheapest that, after all, is the most valuable. On no objects are the faculties so likely to be well exercised as on objects within every-day reach: the results of inquiry are sure to be more accurate, subject as they are to much stricter and more frequent tests; they lead to more immediate utility; they are the very materials of all after-knowledge; they are more or less interwoven with all the purposes of local life. The formation of a local museum, carried on by the institution according to the peculiar dispositions and opportunities of its members, necessarily leads to all this. Whilst one party, or individual, is engaged with local mineralogy or geology, another with local natural history, a third with local antiquities, a fourth is occupied with local statistics and economics; and all more or less pass through a course, of all others, to themselves and their districts the most beneficial, a course of thorough study of those very matters in which, one way or other, they are for the rest of their life most likely to be engaged. In the meantime the collection proceeds without drawing on their purse; the materials are found in their daily walk. But it must not on that account be considered less precious to others as well as themselves. Where communication is so easy, and science ready to avail itself at the earliest notice of every discovery, the more complete these local museums, the quicker must be the general progress of all science. What the traveller looks for on arriving at a town is, not what he has left behind him in another,—not indifferent duplicates of the great collections of the larger towns; but what is special to the town, however small, and to the district itself. No one can enter the museums and model galleries of Italy, France, Belgium, Germany, &c. &c. without being struck by the extensive and important additions made by this local spirit, working on its special territory, to the general treasures. Archæology profits by it in Italy. It sets the excavator to work in every field, on every hillock; and has thus done more to detect the ancient world of their forefathers than the purses of princes. Neither is the natural world neglected. Who would exchange a second-rate general museum for the Vesuvian collection at Naples, and the almost perfect Ætnæan museum of the Cavalier Gioieni at Catania. In France and Belgium model collections illustrative of local industry are frequent. The collection at Brussels, of models for bridges, sluices, canals, windmills, &c., is not more instructive and interesting to the nation (and the numerous visitors, even from the humblest classes, are the best proof of such interest) than to the stranger travelling through: at a glance he has before him the characteristic improvements of the place. Statistical science is scarcely less benefited: data, apparently of no moment in their detached state, become often of the deepest consequence when they come to be placed in juxtaposition with others. There is no man, however humble, however restricted his sphere, who cannot contribute his quota to the stock, and as far as in him lies, and often beyond what he can easily in any way imagine, assist in forwarding the progress of science. Finally, it must not be supposed that this precludes or militates against more general collections; on the contrary, it greatly facilitates their formation. A regular system of exchange once established, between one museum and another, of their local specimens, would soon, at the mere expense of carriage, give each, besides their local, a general museum, sufficient for all ordinary purposes of private or public study."

Models of machinery for agricultural and manufacturing purposes,—the plans of cottages, sheds, manure-pits, &c., would also appropriately find a place in the museum of such institutions; for the inquiries of such institutions need not be confined to abstract science, but might be most usefully directed to improving the arts of life with reference to the advantages and disadvantages of the particular spot. They might be directed to the agriculture of the neighbourhood, to the condition of the labourer, and the means for improving it, whether by advice to him, or suggestions to those who employ him.

The special knowledge of the spot is what the traveller and scientific man seek, while the suggestions which they could give in return by the aid of more extended experience would be highly valuable. Improvements in small matters, particularly those which relate to rural affairs, take a long time to travel out of the spot in which they had their origin. It is difficult for any individuals, and particularly for those who stand most in need of them, to collect and test them. Mechanics' Institutions, however, might advantageously become the repositories of such information. On the continent we have seen a cottager by the aid of some hollowed firs and a few trussels, form a moveable aqueduct, by which he irrigated his garden, in any direction, with little labour; while a peasant here would perhaps be toiling backwards and forwards with his pails or watering-pots at infinite cost and labour, though the same simple machinery might be had at the cost of a few shillings and a little ingenuity. The eave of the house or lodge will in some countries be so projected as to form a covering for fuel and domestic implements; while, in another, a separate building will be erected at some considerable expense for the purpose, if they are not, as is sometimes the case, left to spoil for want of protection. In Norway, where the climate, like ours, is uncertain, they fix the sheaves, in harvest time, upon short poles, so as to prevent their being affected by the wet. In England, although the farmers are often greatly annoyed by rain in the autumn, no contrivance is had recourse to.

Models of such contrivances as these, with an account of the means by which they may be constructed at the cheapest cost, would be productive of the best effects, and should find a place in the museum; nor should the simplicity of a contrivance be any reason for its exclusion. In books knowledge may be closely packed for years without ever being taken out for use; but models bring a matter visibly and tangibly before those who are unaccustomed to much reading.

Nor need museums be confined to things of this primary utility alone, provided that the funds are sufficient to extend its objects. It is most desirable that a taste for works of art should be cultivated among all classes of society. That utility is indeed narrow which is bounded by the mere profit in pounds, shillings and pence to which a thing can be turned: utility extends to all, and not merely the sensual, enjoyments of life,—to all things which tend to make us better and happier, —to all things which shed comfort, beauty, and order around us, which enlarge our perceptions, and quicken our imagination; and for this purpose, next to drawing and modelling, few things are more beneficial than to have specimens of the best works constantly around us, or at least on the walls of places which we are in the habit of frequenting. A few well-selected casts or prints will, at a very trifling expense, throw an air of comfort and refinement over the humblest dwelling. Although there are in England at this moment many splendid collections of paintings and sculpture, works of art are by no means generally dispersed throughout the country; although there are means of procuring them at very moderate cost. Lithographs, such as have been made of the pictures in the Dresden Gallery, convey, with the exception of colour, very just notions of the design and beauty of the original pictures. Such prints as these, with the portraits of eminent men, might be hung round the walls of Mechanics' Institutions in frames of oak, or even painted deal. Casts are still more perfect representations of statues than prints can be of pictures. Yet, in galleries where there are often inferior marble statues purchased at a great cost, it is rare to find casts of the finest works of art. Plaster may be made the means of procuring very many beautiful objects at a cheap rate; medallions, reliefs, such as the frieze of the Parthenon, and architectural designs. If by such means a taste were to be generally cultivated, good prints and casts would not be long confined to Mechanics' Institutions, but would be found gradually supplanting the exaggerations or tame representations of nature which are now to be found on the walls of mechanics and cottagers. The love for pictorial representation appears to be so strong that it must be gratified; for, by an inquiry which has lately been conducted in a populous district, it has been found that at least one-half of the houses had pictures of some sort or other upon their walls. Although the limited funds of Mechanics' Institutions preclude the possibility of buying pictures, still the occasional exhibition of them might probably be arranged in many places without difficulty. This object might be effected in two ways: 1st, by individuals in a neighbourhood who have good pictures lending them for the purpose of exhibition: 2ndly, by arranging for the loan of modern artists' pictures. This latter scheme would be attended with little difficulty in large towns, as the artists would obtain an additional opportunity of disposing of their works, supposing the exhibition to be open to the whole town and neighbourhood, upon payment of a moderate fee. It might be desirable, however, to mingle the exhibition of the two descriptions of pictures: viz. those of the old masters, and the productions of the artists of the day; as means would thus be obtained of comparing the two and approximating to a just standard of taste.

Nor is it desirable to confine museums to towns:

wherever a library can be founded or a school established, there may also be a museum; not certainly containing many objects of curiosity to the learned, but conveying much of the information required by the neighbouring population.

Another means of exciting the interest of the labouring classes, is the periodical exhibition of models, objects of natural history, and works of art. The following is the account of one which lately took place at the Manchester Mechanics' Institution, extracted from the report of the present year:—

"The President's suggestion for the establishment of an exhibition of models, natural history, and works of art, occupied the attention of the Directors during the early part of the year; the subject was deliberated upon and discussed at their monthly meetings, and the attention of the members was called to it by several of the speakers at the anniversary meeting, last April.

"A committee (especially appointed) issued a circular announcing the intention of the Directors to open the exhibition during the Christmas vacation; describing in general terms the objects to be included in the exhibition, and earnestly appealing to the members and friends of the institution to render assistance by the donation or loan of specimens of natural history, paintings, and other works of art, models of machinery, and philosophical apparatus.

"A great variety of objects were promised, and gradually collected: at first three rooms were set apart for their exhibition: the long class-room was devoted to models of machinery and apparatus; the drawing class-room was laid out for specimens of natural history; and the reading-room for paintings and works of art: but as soon as the scheme was more fully understood by the public, specimens rapidly flowed in, to so great an extent, as to render it requisite to appropriate three additional rooms for the reception of the various contributions.

"The different objects being duly arranged, the exhibition was first opened to private view on the morning of Tuesday, the 26th of December, which day was set apart for the contributors, donors, and other friends of the institution, and on the following day it was opened to the public generally; and from that period until its close, on Saturday, the 3rd of February, the interest remained unabated.

"For, during the short period of thirty-five days that the exhibition remained open, no less a number than *fifty thousand persons passed through the rooms,* and especially on New Year's Day, the great festival of the working classes, the rooms were completely crowded, and the interest continued so to increase throughout the week, that on the following Friday nearly three thousand persons visited the exhibition, which afforded them unmingled pleasure and delightful surprise.

"The intense interest which was thus excited in the whole district, and the frequent solicitations from the public, compelled the Directors to trespass on the kindness of their friends and the ordinary business of the institution, and obliged them to keep the exhibition open much beyond the time at first intended; but in addition to the pleasure it afforded to the town, it conferred on the Directors the pleasing opportunity of admitting gratuitously the children of the following schools:—Chetham's Hospital, Deaf and Dumb, Manchester and Salford Workhouses, Ladies' Jubilee, our own Boys' and Girls' School, as well as our subscribers, and also all the military stationed in the town, with the schools attached to the respective regiments.

"It affords the Directors great gratification in being able to state that no wilful damage was done to the various articles exhibited; and where accidents occurred through the crowded state of the rooms, instant compensation was offered."

Sir Benjamin Heywood, in alluding to the exhibition, thus expresses himself:—

"Where shall I begin in the enumeration of its happy influences? Shall I speak of the spirit which animated those who undertook its preparation and arrangement, of the days and nights of labour they devoted to it,—of the readiness and kindness with which contributions of all kinds were offered? Shall I speak of the gratification afforded by it to thousands and tens of thousands who had never seen anything of the kind before,—of the new and nobler taste which it has awakened in the minds of many of them?—or shall I speak of its value as an example to other institutions, possessing rich and beautiful collections, from which the public have been hitherto excluded? It was delightful to see the countenances, beaming with pleasure, of the working men, their wives and their children, as they thronged through the rooms, and gazed upon the different objects. I could not help feeling, when I saw every article of the exhibition exposed before them, and immediately within their reach, and learned that the exhibition closed without injury to a single specimen, how false an estimate those have formed who dare not trust their collections to public inspection."

The following list of the classes of objects desired to be exhibited at the Manchester Mechanics' Institution was previously circulated for the purpose of guiding the friends of the Institution.

EXPERIMENTAL PHILOSOPHY.

Statics and Dynamics.—Instruments to illustrate the laws of equilibrium and motions of solid bodies. Elements of machinery, various kinds of levers, wheel and axle, pulleys, inclined plane, screw, and the wedge, their application to modify motion; illustration of centrifugal force.

Hydrodynamics.—Instruments to illustrate the laws of pressure, equilibrium, cohesion, and motions of fluids. Hydrostatic paradox, press, bellows, balance, &c.; hydraulic machinery, water-wheels, machines driven by the re-action of water; clepsydræ, hydraulic ram; Archimedes' screw, blowing machines, &c.

Pneumatics.—Instruments for exhibiting the mechanical properties of air and other elastic bodies; air-pumps, condensers, barometers, machines for raising water, various kinds of pumps, syphons, fire-engines, &c.

Heat.—Instruments for illustrating the theory of heat; such as thermometers, pyrometers, parabolic reflectors, &c.

Light.—Sectional and other models of various optical instruments, such as telescopes, microscopes, camera-obscura, camera-lucida, &c.—Instruments for exhibiting the polarization of light, optical delusions, machines for grinding lens and specula.

Electricity.—Comprehending instruments for illustrating the phenomena of electricity derived from friction, galvanism, magnetism, electro-magnetism, and thermo-electricity.

Astronomy.— Models of instruments for the purposes of observation and computation, such as mural circles, transit instruments, &c. Contrivances for illustrating the motions and phenomena of the heavenly bodies, such as planetariums, orreries, armillary spheres, &c.

Geodæsy.—Instruments in use for surveying and division of land, theodolites, levels, circumferenters, perambulators, pentagraphs, &c.

Chemistry.—In addition to the apparatus usually employed in chemical demonstrations, it will be desirable to obtain samples of the various drugs used in the arts, particularly in the processes of bleaching, dyeing, and printing.

THE FINE ARTS.

Architecture.—Models and drawings of public buildings, specimens of materials used in their construction.

Specimens of sculpture, modelling, carving, painting, engraving, &c.

THE USEFUL ARTS.

Brickwork, Masonry, and Carpentry.—Specimens of building materials, such as stone, marble, brick, lime, cement, &c.; models of roofs, centres for bridges; specimens of various kinds of wood, &c.

Mill-work.—Models to illustrate the elementary parts of mill-work, the different methods of engaging and disengaging machinery; contrivances for equalizing, transmitting, and converting motion from one species to another. Models of various kinds of mills, wheels, &c.

Steam-engines.—Sectional models and drawings, to exhibit the various parts of the modern steam-engine under various forms, and their application in the single and double acting engine, high-pressure engine, vibrating engine, &c.

Models for illustrating the application of steam-power to mining, to navigation, to locomotive engines on railroads and common roads.

Civil Engineering.—Models and drawings of works of public and domestic utility: such as sea, river, canal, railway, and common road works, gas-works, water-works, mining, &c.

Manufactures.—Models for illustrating various manufactures from fibrous materials, with specimens in cotton, silk, flax, wool, worsted, &c.

Models to illustrate the arts of bleaching, dyeing, and calico-printing.

Models connected with the production and manufacture of cast and wrought iron and other metals.

Models connected with the manufacture of artificial substances, as porcelain, glass, acids, salts, pigments, &c.

Models to illustrate the arts of letter-press printing by presses and machines, copper-plate and lithographic printing.

Natural History.—Specimens of crystals, minerals, geological charts, fossils. Specimens in botany; specimens in entomology, ornithology, ichthyology, zoology, &c.

Of a kindred nature with exhibitions of this description are horticultural shows of flowers, fruits, and vegetables, such as have lately become prevalent in many parts of England, where prizes have been distributed for the best specimens. The produce of cottagers' gardens has been included in many of these exhibitions, and benefit has already been experienced from the stimulus to industry and improvement which has thus been imparted. It is desirable that these exhibitions should become as general as possible throughout the country; and it would be well worthy of consideration whether Mechanics' Institutions might not be made available for the purpose. In cases in which it was found impossible to collect money for the purpose of giving prizes of value, prizes of honour might be devised, which perhaps would answer the purpose as well.

CHAPTER VIII.

AMUSEMENTS.

The subject of amusements for the working classes is daily becoming one of greater and more serious importance; and involves the most important considerations, with which the future civilization of the country is intimately connected.

At Boughton, Herne Hill, and the Ville of Dunkirk, in Kent, where the late outrage was committed, there exists in the midst of a general mental prostration a dearth of all kind of healthful excitement, an absence of all circumstances calculated to arouse the interest and enliven the spirits. Life, in such circumstances, is unnatural; excitement of some sort is requisite. What wonder then that the desire of obtaining it should break forth into the nature of a disease, and that these poor peasants should seek from morbid sources what they cannot now obtain from any other!

"There is," says Sir John Herschel, "a want too much lost sight of in our estimate of the privations of the humble classes, though it is one of the most incessant cravings of all our wants, and is actually the impelling power which, in the vast majority of cases, urges men into vice and crime—it is the want of amusement. It is in vain to declaim against it. Equally with any other principle in our nature it calls for its natural indulgence, and man cannot be permanently debarred from it without souring the temper and spoiling the character. Like the indulgence of other appetites, it only requires to be kept within due bounds, and turned upon innocent or beneficial objects, to become a spring of happiness. But gratified to a certain moderate extent it must be in the case of every man, if we desire him to be either a useful, active, or contented member of society. Now, I would ask, what provision do we find for the cheap and innocent and daily amusements of the mass of the labouring population of this country? What sort of resources have they to call up the cheerfulness of their spirits, and chase away the cloud from their brow after the fatigue of a day's hard work, or the stupefying monotony of sedentary occupation? Why really very little. I hardly like to assume the appearance of a wish to rip up grievances by saying how little. The pleasant field walk, and the village green are becoming rarer and rarer every year. Music and dancing (the more's the pity) have become so closely associated with ideas of riot and debauchery among the less cultivated classes, that a taste for them, for their own sakes, can hardly be said to exist, and before they can be recommended as innocent or safe amusements, a very great change of ideas must take place. The truth is that, under the pressure of a continually condensing population, the habits of the city have crept into the village. The demands of agriculture have become stern and more imperious; and while hardly a foot of ground is left uncultivated and unappropriated, there is positively not space left for many of the cheerful amusements of rural life. Now since this appears to be unavoidable, and as it is physically impossible that the amusements of a condensed population should continue to be those of a scattered one, it behoves us strongly to consider of some substitutes. But perhaps it may appear to some almost preposterous to enter on the question. Why, the very name of a labourer has something about it with which amusement seems out of character: labour is work, amusement is play; and though it has passed into a proverb, that one without the other will make a dull boy, we seem to have lost sight of a thing equally obvious, that a community of dull boys in this sense is only another word for a society of ignorant, headlong, and ferocious men."

"After a hard day's work," says Sir Benjamin Heywood, in one of his addresses to the Manchester Mechanics' Institution, "a man wants refreshment and ease. I would urge the Directors, who are this evening to be appointed, to let this be one of the earliest subjects of their consideration—think, for instance, whether social evening parties, with tea and coffee, might not be more encouraged amongst you." Sir Benjamin Heywood then read portions of a work upon the subject of amusement for the people, by Mr. Devey, an American clergyman, from which we extract the following paragraphs:—

"There is another view in which the subject of amusements, light as it may be thought, goes deep into all questions about our national improvement and happiness. We are making great efforts in America to bring about various moral reforms. At the head of these enterprises stands the temperance reformation. And the public attention, as was natural in the appalling circumstances of the case, has been very much occupied with the immediate evil, and the obvious methods of supplying the remedy. But it seems to me that it is time to go deeper into this matter, and inquire how the reform is to be carried on and sustained in the country. 'By embodying the entire nation in a temperance society,' will it be said? I think not, even if that point could be gained. We must have some stronger bond than that of formal association, some stronger provision than that of temporary habit to rely on. We must lay the foundations of permanent reform in the principles of human nature, and in the very frame-work of society. Suppose that this nation, and every individual in it, were now temperate, how are they to be kept so? The zeal of individuals in this cause will die away; the individuals themselves will die; how is the people, supposing it were made temperate, to be kept so? There was a time, in former days, when our people were all temperate—when a small bottle of strong waters sufficed for a whole army—when, that is to say, ardent spirits were used only as a medicine. Why, from those early days of pristine virtue and rigid piety, did the nation fall away into intemperance? And how, I ask again, are we to expect to stand where our fathers fell?

"In answer to this question, let me observe, that there is in human nature, and never to be rooted out of it, a want of excitement and exhilaration. The cares and labours of life often leave the mind dull, and when it is relieved from them—and it *must* be relieved—let this be remembered—there must be seasons of relief, and the question is, how are these seasons to be filled up? When the mind enjoys relief from its occupations, I say, that relief must come in the shape of something cheering and exhilarating. The man cannot sit down dull and stupid—and he ought not. Now suppose that society provides him with no cheerful or attractive recreations; that society, in fact, frowns upon all amusements; that the importunate spirit in business, and the sanctimonious spirit in religion, and the supercilious spirit in fashion, all unite to discountenance popular sports and spectacles; and thus, that all cheap and free enjoyments, the hale, hearty, holiday recreations are out of use, and out of reach—what now will the man, set free from business or labour, be likely to do? He asks for relief and exhilaration, he asks for escape from his cares and anxieties: society in its arrangements offers him none; the tavern and the ale-house propose to supply the want; what so likely as that he will resort to the tavern and the ale-house? I have no doubt that one reason why our country fell into such unusual intemperance, was the want of simple, innocent, and authorised recreations in it. I am fully persuaded that some measure of this sort is needful, to give a natural and stable character to the temperance reform.

"Let it not be said, as if it were a fair reply to all this, that men are intemperate *in the midst* of their recreations. The question is not what they do, with their vicious habits already acquired, but how they came by these habits; and the question again is not, whether a man may not fall into inebriety, amidst the purest recreations as well as when away from them, but what he is *likely* to do. In short, to do justice to the argument, it should be supposed that a people is perfectly temperate, and then may fairly be considered the question—how it is most likely to be kept so. . . . . If there were among any people authorised holidays and holiday sports—if there were in every village a public promenade, where music might frequently be heard in the evening, —would not these places be likely to draw away many from the resorts of intemperance?

"Men *cannot* labour or do business always. They must have intervals of relaxation. What is to be done with these intervals? This is the question, and it is a question to be soberly answered. It is to be met, I repeat, with answers, and not with surmises of danger. Men cannot sleep through these intervals. What are they to *do?* Why, if they do not work, or sleep, they must have recreation. And if they have not recreation from healthful sources, they will be very likely to take it from the poisoned fountains of intemperance. Or, if they have pleasures which, though innocent, are forbidden by the maxims of public morality, their very pleasures are liable to become poisoned fountains."

In-door amusements of a tranquil character, and consequently suited for those who have spent the day in hard labour, may be multiplied to infinity. An instance was given in the Penny Magazine some time ago, in which the game of chess had been introduced into a country village in Germany, with great advantage. And Sir J. Herschel, in his address at the opening of the

Windsor and Eton Library, told the following anecdote of the interest created by a person reading aloud:—

"The blacksmith of the village had got hold of Richardson's novel of 'Pamela, or Virtue Rewarded,' and used to read it aloud on the long summer evenings, seated on his anvil, and never failed to have a large and attentive audience. It is a pretty long-winded book, but their patience was fully a match for the author's prolixity, and they fairly listened to it all. At length, when the happy turn of fortune arrived which brings the hero and heroine together, and sets them living long and happily, according to the most approved rules, the congregation were so delighted as to raise a great shout, and procuring the church keys actually set the parish bells ringing .... Now let any one," continues Sir. J. Herschel, "say whether it is easy to estimate the amount of good done in this simple case. Not to speak of the number of hours agreeably spent, not to speak of the good-fellowship and harmony promoted—here was a whole rustic population fairly won over to the side of good—charmed, and night after night spell-bound within that magic circle which genius can trace so effectually, and compelled to bow before that image of virtue and purity, which (though at a great expense of words) no one knew better how to body forth, with a thousand life-like touches, than the author of that work."

Concerts might, without much difficulty, be performed, if a music class were taught in each Institution: music forms so soothing and so delightful a recreation, that it is desirable to see a love for it extended as widely as possible.

The London Mechanics' Institution has concerts; and the last Report of the Manchester Mechanics' Institution mentions that "A social coffee-meeting was held in April last, to commemorate the thirteenth anniversary of the establishment of this Institution, and one of our vice-presidents, the Rev. J. G. Robberds, presided on that interesting occasion. From the coffee-room the members adjourned to the lecture-room, where the vocal music class interested the company with songs and glees: after which the phantasmagoria afforded considerable amusement. From the lecture-room the company retired to the large class-room, where additional refreshments were provided; and the remainder of the evening was spent in listening to

F

many animated and eloquent speeches relating to the history and advantages of the Institution."

It would conduce to the health, happiness, and morality of the people, if, in institutions such as these, some arrangements could be made for amusements of another and more active character. The inhabitants of manufacturing towns, when they have quitted their sedentary employments, require something which will put their blood into action, exercise and brace their muscles, and impart vigour, strength, and cheerfulness.

In the Lyceums recently established in Manchester and the neighbourhood, recreation has been a primary object. Besides classes for music —vocal and instrumental, which are well attended by the members—concerts of a superior character are occasionally given at each institution, the expense of which is defrayed by a small payment from each member, increased to strangers. The several music classes (which have been combined under the title of the Popular Choral Society) also give periodical concerts to their respective members free of expense. Tea-parties, either open to the public, or confined to the members of particular classes, enlivened by singing, recitations, and philosophical experiments, assemble once or twice in each quarter.

CHAPTER IX.

FUNDS, BUILDING, AND MANAGEMENT.

For any Institution to flourish, it is necessary that its pecuniary arrangements should be made prudently and judiciously. Upon examining the Reports and other documents collected by the Society for the Diffusion of Useful Knowledge, it has been found that many Institutions are burdened with a debt, incurred either for building, or for some other purpose designed to give an immediate maturity to a young Institution.

It may be much questioned whether, in any circumstances, a debt should be incurred for the purpose of more effectually founding Mechanics' Institutions; for it afterwards so greatly trammels their operations, as almost to neutralise the benefits which would otherwise arise from them. The Directors of Mechanics' Institutions, in places of consideration, have mentioned such a debt as a reason why they were unable to employ paid lecturers and teachers, or even to bear the comparatively trifling expense attendant upon the establishment of a lecture circuit.

From the information collected by the Society it appears that the Directors of Mechanics' Institutions have, for the most part, aimed at an early maturity in their organisation, before those for whose benefit the Institutions were established were fully, or perhaps at all, prepared; and that it would not only be more suitable to the slender finances of young Institutions, but more in accordance with the gradually increasing wants of the people, to bring them more slowly to perfection than has hitherto been attempted. The whole scope and purpose of an Institution should, from the first, be comprehended by its projectors, but its attainment should be gradual. The information supplied would create a want for more. Further arrangements would be necessary to supply that want; and as the purpose for which funds were required would be obvious, they would probably flow in. Local circumstances must determine in each case what is proper to be done; but it may be assumed, as a general rule, that a low rate of payment by the members is more productive than a higher one, and that debt is not less injurious to an institution than to an individual.

At Maidstone there is a library at the Institution: three-fourths of the books contained in it belong, not to the Institution, but to individuals. There were not sufficient funds for the purchase of books; and the gentlemen who undertook the organisation of the Institution, instead of burdening it with a debt, adopted the following course: "We have all," said one of them to the assembled members, "some books belonging to us which we have read; some have more, others less. Those belonging to me which I have read you may desire to read, and those belonging to you which you have read may be acceptable to me. Let us make the Institution the repository of our common stock, and thus, instead of our reading being confined to what each individual has been able to purchase, each will have the benefit of what all have purchased; and, without burdening our new society with a debt, we shall have a useful and respectable library."

The library of the Maidstone Mechanics' Institution contains about 400 volumes. It is true that the selection might be more choice than it is; still, upon the whole, it is creditable to the owners of the books.

The collection of a library at little cost is generally a task of greater difficulty than that of procuring a suitable building; for wherever there is a school, the room may well be appropriated to the double purpose of school-room and lecture or reading room for the Institution: for a school meets in the day-time, whereas most of the arrangements of a Mechanics' Institution are for an evening. For popular lectures, at which strangers as well as the members of the Institution attend, the Town Hall, or some other public building, can generally be obtained at little or no cost. But even if it is impossible to make any economical arrangement for the use of a suitable building, it is more judicious to do without one for a time, than to incur a debt, especially as one of the most substantial benefits of an Institution, viz., the circulation of books, can be secured without one. In the infancy of a society the founders of the Institution might permit the rooms of their own houses to be used for the purposes of the Institution; in the house of one member a class might be taught, in that of another the books of the Society might be read; while in those of others, the game of chess, music, or some other amusement might be going forward. Indeed, it may be questioned whether such an arrangement would not be productive of very beneficial results in improving the social character of a neighbourhood.

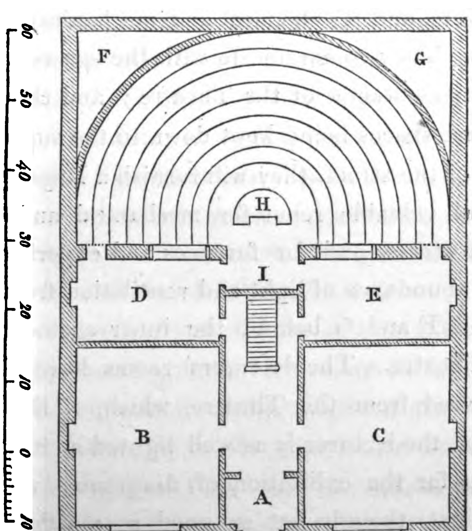
As these Societies are formed for the express purpose of raising the intellectual and moral character of the population, the funds ought to be applied to these purposes in the first instance: for it should be recollected, that it is men, not a building, that constitute a society; and that it is by lectures and books, and not a public room, that the purposes of their association are to be attained. When a society has acquired strength in point of numbers, thirst for knowledge, and funds, then let a suitable building be erected; but before the numbers of students are sufficiently great to fill the benches, and the funds are sufficient to pay for the erection of the building, let building be left alone. The foundation-stone should be laid in the presence of an assembled society, ready to take possession of it as soon as erected, and at once to benefit by it. A building in such circumstances has a meaning. The scholars of the foundation of William of Wykeham (a name ever to be held in profound veneration by those interested in the subject of education) took possession of the magnificent buildings which he had erected at Winchester, chanting in procession. They had previously, during the six years which the building of the college had taken up, occupied temporary lodgings.

It however sometimes happens that a building not only is unattended with loss, but is a source of revenue. At Keighley, in Yorkshire, the Mechanics' Institution derives, from letting its rooms for the meetings of religious and other societies, an income sufficient to pay the interest of the debt incurred in the building, and to contribute something towards the maintenance of the Institution.

In places so circumstanced, or where the funds are sufficiently large for the purchase of land and the erection of a building, the subjoined plan which has been kindly communicated to the society by Mr. Ainger, is recommended.

This design has been made to suit a situation in which light and access can be obtained only from the front; a circumstance not unlikely to occur in the central situations best adapted to the object in question. Where the opportunities are more favourable there will be no difficulty in taking advantage of them.

The front of the building should be set back six or eight feet from the highway, and the intervening space enclosed with rails to preserve the reading-rooms from interruption. For the same and other reasons a rise of half a dozen steps at the entrance is desirable. A small lobby A,



GROUND-FLOOR

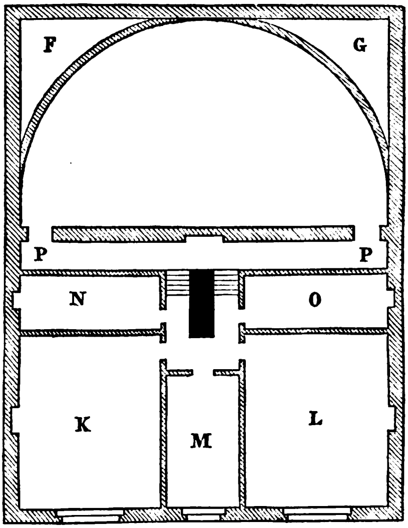
and screen doors, protect the building from cold, and immediately within them are the entrances to the Libraries, B and C, each 25 feet by 20 feet; the one serving the further purpose of a Reading-room, and the other that of a Board-room. At the further end of the Hall is the stair leading at once to the upper level of the Theatre, in order that the late comers may not disturb those already seated.

Right and left of the staircase are the rooms D and E, 20 feet by 12 feet, for the use of the lecturers, and for chemical and mechanical apparatus. They communicate with the spaces under the raised stages of the Theatre; and the floor of these spaces being kept down to the supposed level of the street, they will furnish a large quantity of valuable room for mechanical and chemical stores, and for furnaces and experiments, with abundance of light and ventilation from the corners F and G behind the inner enclosure of the Theatre. The lecturers' rooms have lights borrowed from the Theatre, which, if the wall behind the lecturer is as well lighted as it ought to be for the exhibition of diagrams, will be sufficient, though not so good as a side light, where that can be obtained, instead of, or in addition to the borrowed light. Both the lecturers' rooms, and of consequence the apparatus, furnaces, &c., are in immediate connexion with the lecturers' table H, by the doors under the stair-landing, I. The Theatre is 52 feet by 30 feet, and will seat 300 persons.

In forming the stages of the Theatre a semi-octagon will be found cheaper and in all respects as good as a semi-circle; but the following point should always be attended to. The stages should rise by an increasing progression; that is to say, suppose the first stage to be 4 inches above the floor, the next should be 10, the next 18, and so on, making the ascent from stage to stage a series of numbers, as 4, 6, 8, 10, 12, 14, 16, and 18 inches. The reason for this is, that the more remote spectators require a greater amount of elevation above those immediately before them than those nearer the table.

The best and cheapest light for such a Theatre would be a straight window about 20 feet long by 5 feet high, inclined to a right angle with a line from its centre to the place where drawings were most likely to be shown. If appearance is consulted, it may be made circular on the plan and concentric with the Theatre.

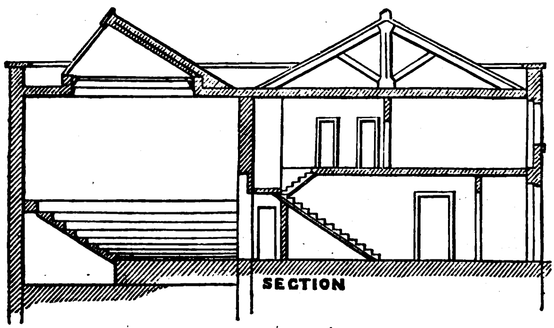
In the plan of the upper floor, K and L are class-rooms, 25 feet by 20 feet; M, N, and O are rooms for the housekeeper and for stores.



UPPER-FLOOR

The two last mentioned are supposed to be lighted by skylights; but the remark before made as to side light, where it is practicable, may of course be applied to them. The staircase and the passages, P P, leading to the Theatre would be best lighted from above. A back entrance to the Theatre is useful where it can be obtained; in which case a distinct staircase for the Theatre would probably occupy one of the corners F or G.

There are many situations in which the ground may be excavated 8 or 10 feet for the lower part of the Theatre. In such cases the visitors arrive at the upper stages by merely proceeding along the ground-floor, which is better than ascending a staircase for that purpose. In this, however, as in the light and access, we have chosen the more difficult set of conditions. Bad soil, imperfect drainage, and liability to floods, frequently prevent any useful depth of excavation.



The building in question would cost in London about 1400*l.*; one of about two-thirds the size, with a Theatre for 200 persons, would cost 1000*l.*

With regard to those from whom the funds to support a Mechanics' Institution should come there can be little doubt, viz., those who are to benefit by it. The rich may subscribe to give it an existence; but those whom it does not immediately concern, neither ought nor would, for any length of time, supply the means of its support. The permanent means for carrying it on must come from those to whom it is a benefit. "I have said," says Lord Brougham, in his Observations upon the Education of the People, published in 1825, "that the independence of these undertakings, as well as their success, is to be considered. I really should be disposed to view any advantage in point of knowledge gained by the body of the people as somewhat equivocal, or at least as much alloyed with evil, if purchased by the increase of their dependence upon their superiors."

The members of Mechanics' Institutions, those for whom the Institutions are founded, should be ultimately the directors of their own affairs. They will best understand their own wants, and calculate upon the means of supplying them. The management of the Glasgow Mechanics' Institution is vested in a committee of sixteen, chosen from and by the class; one-half retiring annually. To these sixteen are judiciously added three councillors, elected annually from and by twelve honorary members or councillors, chosen by the committee of management.

The Manchester Mechanics' Institution admits the principle of self-government. The Directors were, in the first instance, and for several years, chosen exclusively from the honorary members, persons paying a donation of 10*l.*, or subscribing a guinea a-year in addition to the ordinary subscription of 20*s.* In the year 1829, five of the working class were selected by the Directors to assist them in the management; in the following year this number was chosen by the mechanics themselves; in the next year the election from their own body of one-half of the directors was assigned to them; and in the year 1834, the Institution having been in active existence nine years, it was declared that the directors should be thenceforward elected wholly by and from the general body, with no other restriction than that a director must be twenty-one years of age, or upwards, and of two years' standing as a member of the Institution; and that an elector must be eighteen years of age or upwards, and of six months' standing in the Institution. This gradual delegation of power has been attended with the best effects. The class receiving it were prepared by education for the right exercise of it; they became gradually familiar with the objects of the Institution, and they had begun to feel its beneficial tendencies. In 1837 Sir Benjamin Heywood expressed his wish to resign his place of President, in order that it might be occupied by one of the mechanics. In his address to the members upon the subject, he says, "I feel that my services are not now needed. I like to see those who do the work in the places of honour, and you have individuals in your Board of Directors, to whose services you are deeply indebted,—single-minded, zealous, and able men, and in the discharge of the duties which devolve upon them most exemplary. Let your choice be from among them."

The history of the Manchester Mechanics' Institution must, it is conceived, be the history of every other Institution which is founded effectually, except that too small a proportion of its members are of the working-classes. External support, both in funds and in direction, must be afforded at first; but these must be gradually withdrawn, and those for whose benefit the institutions are designed must eventually be their sole directors and supporters. If, after a course of years, an Institution has not the power to support and direct itself, there is something defective in its constitution, and it must fall. External aid cannot be for ever propping that which ought to support itself.

There is, however, much danger to be apprehended from placing the affairs of an Institution too rapidly in the hands of the body of the members. They must first well comprehend the objects of the Institution, and to understand its objects, they must have been submitted to its training. Again, the directors should not be too often changed; there should be sufficient permanency to permit the designs of one body of directors to be matured before it is displaced by another; and those who have acted should be re-eligible. At the London Mechanics' Institution one-half of the directors go out of office every six months, and are not re-eligible; and this practice is attended with serious inconvenience.

CHAPTER X.

CAUSES OF FAILURE.

Besides the usual difficulties arising at the commencement of a new undertaking, the founders of Mechanics' Institutions have had to contend with another of a more serious description, and one for which it is difficult to prescribe an immediate remedy, viz., apathy on the part of the mechanics, arising partly from their not duly appreciating the advantages to be derived from such institutions; partly, perhaps, from the instruction given at them being often ill chosen, with reference to the occupations of the working-classes of the district, or not being conveyed in an efficient manner.

Where ignorance, and a taste for mere sensual enjoyments prevail, these institutions will of course not be the resort of the population at the end of a day's work; and it cannot be expected that, in the present state of education in this country, Mechanics' Institutions should at once impart those benefits to the working-classes which they are destined one day to confer. But when the education in the schools throughout the country has become more extended in its objects, and more efficient in its character, the apathy with regard to Mechanics' Institutions will assuredly disappear.

This is not the place for entering at length into the general state of education, but the following statement, taken from the Report of the Manchester Statistical Society, is so remarkable as to render its insertion here desirable.

"It appears that the population of Manchester borough is about 200,000, and that the numbers at present attending the different schools in it are 10,008 at day and evening schools only; 10,011 at both day and Sunday schools; 23,185 at Sunday-schools only; making a total of 43,304. If a deduction of 10,000 be made for scholars under five and above fifteen, which is probably somewhat less than the truth, about 33,000 are left as the number of children between the ages of five and fifteen receiving some instruction. The whole number of children between the ages of five and fifteen in the Borough of Manchester being calculated at 50,000, or one-fourth of the whole population, it would thus appear that about two-thirds of this number are receiving some instruction, and that one-third are receiving none at all. The total population of the borough of Liverpool is calculated at 230,000. It appears, first, that the whole number of children, male and female, attending schools of one kind or other, is 33,183, which is about $14\frac{2}{5}$ per cent. of the whole population. 2nd, That of this total number of 33,183, about 6,000 are children either under five or above fifteen years of age; and that, consequently, the number of children either under or above fifteen attending school is about 27,200. Now, if 57,500, or one-fourth of the whole population, be assumed as the total number of children between the ages of five and fifteen in the borough, it would appear that of this number 27,200 are receiving some kind of education in these schools, and 30,000, or more than one-half of the whole, attend no school whatever. 3rd, It appears that, of the total number of children receiving education,

17,815	attend day or evening schools only.
11,649	attend both day and Sunday schools.
3,719	attend Sunday-schools only.
33,183	

"The population of the borough of Salford is found to be 55,000, and the number of children attending the different schools 12,975; of whom

3,131	attend day or evening schools only.
3,410	attend both day and Sunday schools.
6,434	attend Sunday-schools only.
12,975	

Of these, about 2,235 were found to be either under five or above fifteen years of age, leaving about 10,740 as the number of children between the ages of five and fifteen under instruction. The total number of children between these ages in the borough of Salford being computed at 13,750, it would thus appear that 3,010 are receiving no instruction whatever.

"The population of the borough of Bury is at present estimated at 20,000. The number of children attending the different schools in the borough are 5,727, of whom

1,503	attend day and evening schools only.
1,122	attend both day and Sunday schools.
3,102	attend Sunday-schools only.
5,727	

Of these 5,727 scholars, about 1,427 are either under the age of five years or above fifteen. Thus only 4,300 children between the ages of five and fifteen are under course of instruction in Bury, out of the total number of 5,000 estimated to be between those years, leaving about 700 children who are receiving no education whatever.

"The total population of the four boroughs is 505,000, and the number of children between the ages of five and fifteen years, 116,250. The total number of children attending the different schools will be found to amount to about

	94,795	
Deducting	19,662	for children under five and above 15.
Thus,	75,133	is the number of children

receiving some kind of instruction; while 51,117, nearly one-tenth of the whole population, are quite destitute of any."

The account given of the various schools in the four boroughs makes it manifest that even the children who frequent the greater part of these schools are not subject to any system worthy of the name of education.

An observation of the efforts which in almost all parts of the country multitudes of the working-classes are making to compensate in after life for the defects of their early education—defects for which they are in nowise responsible—gives a well-grounded confidence in the ultimate success of Mechanics' Institutions; and assuredly in comparing the present habits of the working man with those which prevailed but a few years since, when the ferocious amusements of the bull-bait, the cock-fight, or the prize-ring, were the main occupations of his leisure hours, we have abundant reason for hope in his rapid progress towards that refinement of taste and those intellectual pursuits from which no rank of life is excluded.

Where lectures of a purely scientific character and libraries of books of useful knowledge are found not to afford sufficient attractions, recourse may be usefully had to exhibitions which unite amusement with instruction. Thus the oxy-hydrogen microscope and phantasmagoria were found to be great attractions in the lecture-room at Manchester.

Again, when science is first introduced to the notice of mechanics, it should, if possible, have some reference to the pursuits of the majority of them, and, by its immediate usefulness, become a subject of individual interest to them. Perhaps the disregard of their immediate wants has been one cause of the indifference of mechanics to lectures. The Potteries Mechanics' Institution is an illustration of this observation. Its President is the son of one who, by first moulding the domestic utensils of this country in the graceful forms of Greece and Etruria, has conferred a lasting benefit upon the country—Wedgewood. The Committee of that Institution, in their Report of 1832, say, "The three classes at present in operation are the chemical, drawing, and philosophical. The two former being essentially connected with the nature of the manufacture carried on in this neighbourhood, and consequently deserving the anxious solicitude of the Institute, the Committee beg particularly to recommend to the fostering care of their successors. In transforming the crude mineral productions of nature into forms of usefulness and ornament, should science and art continue their choicest efforts, the result will be equally pleasing. Whilst, therefore, your Committee recommend these classes to the earnest attention of all future Committees, they have reason to believe that, at this time, both drawing and chemistry are practically made known to the students of the Institution.

"The manufacture carried on here is an important branch of the useful and ornamental arts, a most wonderful conquest of human skill and ingenuity, and involves some of the most intricate processes of the first of sciences. It becomes, therefore, a question of momentous import to the whole neighbourhood, whether we shall have a school for the education of potters in the arts and sciences they are called upon to practise or not. The chief manufacturers of the district are the proper patrons of this Institution, its leaders, and directors. It is an Institution subservient to their interests; promotive of the usefulness and happiness of those who unceasingly depend upon them for employment, and all its agreeable consequences."

The evil effects which result from confining the instruction in many Institutions to lectures, in which the person who is to profit is a mere hearer, have already been shown.

From a statement of the causes of failure of many Institutions may be collected the means whereby success may probably be obtained, viz.—

1. A sound system of early education.

2. The introduction into Mechanics' Institutions of innocent and rational amusements.

3. The preferring that sort of instruction

which has reference to the immediate wants and occupations of the population of the district.

4. The blending the two modes of instruction, viz., lectures, in which the learner is merely a listener, with classes in which his progress is tested by examination and written exercises.

CHAPTER XI.

INTERCOURSE AMONG MECHANICS' INSTITUTIONS.

But prosperous as some of the Mechanics' Institutions of which we have taken notice have been, it must be evident, from the foregoing pages, that all have suffered from the want of co-operation; from the want of that information which one Institution might afford to another; and from the want of that increased power in commanding the services of able men, and securing the other advantages, which combination would afford. At present each Institution in this country stands insulated, unconnected by any tie with another. Each fights its own way, without profiting by the success or errors of others; which again cannot benefit by its experience. Nor are we without a model as to the manner in which an intercourse is to be effected. Mr. Wyse, who has collected so much of what is available for our own country from others, has given a sketch, in the second volume of the Central Society of Education, of the Lyceum system which has been commenced in

America; and it may in many respects serve as a precedent for that of which we now stand in need.

"There are four classes of Lyceums, one subordinate to the other: 1st. 'Town Lyceums;' 2nd. 'County Lyceums;' 3rd. 'State Lyceums;' finally, the 'National Lyceum,' to which, as to a great National Board for the management of subsidiary education, is intrusted the direction and control of the entire system. The 'Town Lyceums,' which also assume the designation of 'Branches of the American Lyceum,' are usually composed of the principal inhabitants of the town: the life subscription is twenty, the annual two, dollars; three-fourths of which are applied to the purchase of apparatus, books, tools, &c., for the use of the Town Lyceum, and the remaining one-fourth is forwarded to the County Lyceum, for the purpose of defraying the expenses of county libraries, apparatus, and collections too heavy for the Town Lyceums—of maps and agents for town and county surveys, statistical inquiries, &c. They hold meetings for lectures and essay discussions, in literature and science, at stated periods, and establish classes in various courses, under the superintendence of their lecturers, for the education of their junior members, and the greater improvement of the instruction pursued in schools.

"The 'County Lyceums' propose the same objects (though on a larger scale) as the Town Lyceums, promote the interests of Lyceums generally throughout the county, and co-operate with the State and National Lyceums in the same manner as the Town Lyceums do with them in all measures recommended for the advancement of national education and the general diffusion of knowledge. The members consist of delegates from the several Town Lyceums in the county, each Lyceum having the right of sending three. The County Lyceum holds semi-annual meetings, for the purpose of hearing reports or statements from the Town Lyceums, supporting discussions and pronouncing addresses, or reading papers upon any subject relative to the theory or practice of education. They procure, moreover, in proportion to the amount of their funds, a county library, apparatus, collection in natural history, mineralogy, models, &c.; appoint a supervisor, or civil engineer, to aid in surveys for town or county maps, &c., agents for statistical inquiries, &c. and finally carry into execution any other arrangements for the general or special objects of the Lyceum system throughout their jurisdiction. The formation of these collections is shared equally (as far as the labour is in question) by all. It is the result of the active and unceasing re search in which the Town Lyceums especially are engaged.

"Thousands of children, of not more than eight or ten years old, know now more of geology, mineralogy, botany, statistical facts, &c.—in fine, of what immediately concerns their daily interests and occupations—than was probably known thirty years ago by any five individuals in the United States. Indeed, so universally, and to such excellent profit, is this taste diffused, that in some sections of the country the majority of the school-houses are furnished with collections procured by the children themselves. Town, County, and State Lyceums are thus fitted out, at a trifling expense, with very excellent elementary museums; and a general deposit and distributing office for their more perfect and uniform supply is established by common co-operation at New York, under the direction of the National department of the Institution.

"The third class, immediately superior to the County Lyceums, are the 'State Lyceums.' They are composed of delegates from the County Lyceums, as the County Lyceums are of delegates from the Town. They hold annual meetings, as the counties semi-annual, to hear reports from the County Lyceums on the progress of education in every part of the State, to collect and combine facts of an useful character, to publish results and statements of former experiments, to suggest new ones, to confer and propose prizes and rewards,—in a word, to act in every particular as a sort of Provincial Board in aid of the National one, (as the National Lyceum may be called,) for the promotion of general education.

"The 'National Lyceum,' which forms the fourth and crowning department of the Institution, is composed of delegates from the State Lyceums. Where State Lyceums are not established, the National Lyceum invites delegates from the County or Town Lyceums, as the case may be, or, where they have not yet appeared, from the several classes of public teachers. The National Lyceum meets once a year, in May, to receive reports from all the State Lyceums, to discuss subjects connected with the general objects and interests of the Institution, especially the advancement of Lyceum and common school education, and in general to determine the best means which may be devised to ensure the general diffusion of useful knowledge. The minutes of their meetings state the subjects which have been discussed. To collect, consolidate, and perpetuate these advantages, 'corresponding' and 'recording' secretaries are appointed. The corresponding secretaries have each their particular department: to the first is assigned the department of 'Colleges, and their connexion with Common Schools;' to the second, that of 'books, apparatus, and branches of study;' to the third, 'legislative provisions and arrangements for schools, public institutions,' &c. &c. They are required during the year to collect details on each of these heads, to report thereon at the annual meeting, and to furnish copies and all accompanying documents relating thereto to the recording secretary. The recording secretary, on his side, has to digest and arrange these materials in a practical form; and to publish them, when approved, for the general benefit of the members and friends of the Institution. Nor are these aids confined to pupils: in addition, there are periodical meetings, in the counties, states, and finally at New York, of public teachers; one of the best means yet devised to keep instruction up to the existing standard of civilization. . . . .

"It is worth while inquiring whether any substitute, in the present state of things, can be devised by Mechanics' Institutions themselves, which, by bringing about a greater degree of union between them, shall materially add to the efficiency of this important branch of public education, and ultimately prepare it for a system analogous to, if not the same, as that adopted in America.

"A regularly graduated system, institution subordinate to institution, like that of the Lyceums, could only be carried into execution by the consent of all parties concerned. This would require a central meeting of delegates, with full powers to remodel, restrict, and enlarge, in one word, to establish. Even then, with our imperfect territorial divisions, it would be difficult to maintain it. It is not impracticable, but not easy.

"It does not however follow that, without attaining this, a much closer combination, and a better application of local advantages, might not be effected:

'1. *By Reports.*—These reports, to be efficient, should be drawn up as nearly as possible on the same model, presented at the same time, and, if deemed advisable, to the same body.

"The grounds for this are clear. The object of all such statements is, to facilitate comparison, and by extensive comparison to render our conclusions accurate. Unless we all take the same classification and periods, this is not easy. Addressed to one and the same body, they are easily collected, collated, preserved, digested, and circulated throughout the country.

"2. *Periodical Meetings.*—Though it might be impracticable to convene anything like a regular delegation, nothing exists to prevent members of these several bodies, with other promoters of public education, meeting at stated places and periods for the purpose of reading papers, receiving suggestions, proposing questions, offering and declaring prizes for essays on education, &c. This might gradually give rise to an annual 'Convention of Teachers,' which, in every country where it has yet been tried, has been productive of great utility.

"The second object, the applying to better purposes local advantages, will be materially assisted by the accomplishment of the first as soon as these several Institutions are sufficiently acquainted with each other: through the medium of the digest of the reports, it will not be difficult to diffuse any marked improvement, observable in any one, to all. By degrees, a certain number of these Institutions may form themselves into districts, for the purpose of engaging lecturers in common, &c. In like manner, arrangements may be made for the formation of local museums, local collections of models, local committees for statistical and other inquiries, and, finally, for the establishment of some central museum, to which the local museums may be invited to contribute duplicates. This suggestion has been already offered to the Dublin Society by the Parliamentary Committee, in their Report in 1836; which has further recommended not only that this contribution and interchange of specimens should be encouraged, but that lecturers should be provided by the society for the country Institutions whenever they might think necessary to apply for them, provided adequate security were given of a sufficient audience, and all travelling expenses to and from the capital paid by the local applicants."*

* These recommendations have, in a great degree, been lately followed by the Dublin Society.—*Parliamentary Papers.*

CHAPTER XII.

SCHOOLS.

The museums, lectures, and other facilities for obtaining instruction which a Mechanics' Institution affords, present great inducements for the establishment of a school, by aiding the master in pursuing his scheme of tuition, whilst, on the other hand, he might assist the institution by teaching its evening classes.

In large towns, where the Institution and the School are on an extensive scale, a general subdivision of labour necessarily takes place, and each teacher has a single task to perform, which his time is best employed in solely attending to. But in small towns and villages, where the number of pupils but ill recompenses the master, and where it is difficult to raise funds sufficient for establishing a Mechanics' Institution, the school building and the master might, with advantage to both School and Institution, be devoted to both purposes.

Philosophical apparatus, lectures, museum, and library, are all necessary to make a school what it should be. But they are so expensive and varied in their character as to be rarely within the reach of even schools for the wealthier classes of the community. What an advantage, then, for a school to be able to obtain benefits of so important a character merely by a well-considered arrangement!

Schools were originally attached to the London Mechanics' Institution; they have, however, been given up.

Two schools upon a superior and extended plan have been attached to the Liverpool Mechanics' Institution—the one for the sons of the more wealthy tradespeople, the other for mechanics and others of smaller means. As a year has not yet elapsed since their establishment, few facts can as yet be adduced concerning them. Masters of high qualifications have, however, been engaged; adequate salaries secured to them; and they have been performing the duties of their office for a short period.

The High School does not come within the scope of this work, but the prospectus of the Lower School will serve as a guide for similar establishments, and it is therefore inserted a length.

"*Lower School.*

"This School is designed for the sons of those whose means are too limited for the more expensive education of the High School; and the course of instruction which it offers is adapted, as far as possible, to the wants and expectations of the class of pupils for whom it is intended.

"It will be conducted on the same principle as the High School, that is, on the principle of each teacher confining himself to a particular department of instruction, and having his own room, and of the pupils passing from one teacher to another at the end of every hour. The masters peculiar to this school will be three in number, and their respective departments of instruction as follows:—

"A. First master, to teach reading, (including not only the orthography, pronunciation, and meaning of words, but explanations and examinations on the subject to which the reading-lessons may relate,) grammar, composition, the properties and uses of various objects of nature or art, (which objects are to be exhibited to the class,) the history and processes of the most useful mechanical or chemical arts, and the elements of natural history.

"B. G. Second and third masters, to teach writing, arithmetic mental and notational, mensuration, geometry, geography, astronomy, and the use of the globes; and, by means of dictation exercises, to train the pupil to accurate spelling and punctuation; to superintend, also, the writing of those descriptive or narrative compositions which the first master may prescribe to the more advanced pupils.

"To the constant instructions of the above masters will be added the occasional services of a drawing master, a French master, and the philosophical master of the High School.

"TERMS:

	Per Annum.	If paid Quarterly. Per Quarter.	
For Sons of Members	£1 15 0	0 10 0	in advance.
For Others . . .	2 5 0	0 12 6	

Two shillings and sixpence per quarter will be required in addition, for the use of books, slates, and writing-books, including copy-books and exercise-books; but drawing-books, boards, and pencils, will be charged separately, according to the consumption.

"The hours of this school are from half-past eight to half-past eleven in the morning, and from half-past one to half-past four in the afternoon, except on Saturday, when there will be, as in the High School, a general examination of the pupils, open to the parents and friends of the pupils, in the morning, and a holiday in the afternoon.

"The vacations will be, six weeks at Midsummer, two weeks at Christmas, and three days at Easter.

"The discipline of this school will be maintained, as far as possible, by the same means as in the High School, that is, by the public expression of approbation or censure on the day of general examination, and by expulsion in cases of obstinate misconduct. But, as an additional encouragement to exertion and good conduct, it is provided that three boys, on the recommendation of the two principal masters, subject to the approval of the Board, shall annually be selected out of this school, who shall be admitted into the High School, at the reduced charge of two guineas per annum, the choice being restricted to such boys as have remained in the Lower School three successive years.

"Any pupil who has regularly attended the three first classes in the Lower School shall have the privilege of attending, in the High School, any master he may wish, whether he remains a pupil in the Lower School or not, on paying the following fees to such masters as he attends:—

To the English Master . . .	£2	0	0	per Annum.
,, Mathematical Master .	2	0	0	,,
,, Philosophical Master .	2	0	0	,,
,, French Master . . .	2	0	0	,,
,, Writing Master . . .	2	0	0	,,
,, Classical Master . . .	4	0	0	,,
,, Drawing Master . . .	4	0	0	,,
	£18	0	0	

"The masters of the Lower School will be expected to attend the weekly council of the masters on Friday evening, for the purpose of conferring with them on the best means of promoting the general success of the whole establishment, and the common object of their united labours."

"*Evening Schools, and Lectures.*

"The evening classes and lectures at the New Mechanics' Institution will be continued, as formerly, but with some additions and modifications which will render them more extensively useful.

"The school for writing, arithmetic, and elementary mathematics will be open, as usual, from seven to nine, on Monday, Tuesday, Thursday, and Friday evenings, under the following masters:—Mr. Elliott, Mr. Gerard, and Mr. H. Carpenter.

"The schools for drawing will also be open on the same evenings, and at the same hours, and the following are the several departments for which instruction is provided:—

Mechanical Drawing	by Mr. . . . . . .
Architectural Drawing	by Mr. Cooper.
Landscape Drawing and Perspective .	by Mr. Pugh.
Figure Drawing and Modelling . .	by Mr. Seddon.
Ornamental Painting and Drawing .	by Mr. Bishop.

"A school for navigation and nautical astronomy will be open from seven to nine on Tuesday and Friday evenings, conducted by the mathematical master of the High School.

"Terms, one guinea per annum, paid in advance.

"A school for French will also be open to members of the institution, on Tuesday and Friday evenings, at the same hours, conducted by the master of the High French School.

"Lessons on geography, mechanics, and the mechanical arts will be given every Monday and Thursday evening, by the masters of the Lower Day-school.

"Classes for natural philosophy and chemistry also will meet every Monday and Thursday evening, under the philosophical master of the High School and Mr. John Wilson.

"A small additional fee will be required from the pupils in these classes.

"Public lectures on various branches of useful knowledge will continue to be delivered every Wednesday and Saturday evening by eminent lecturers from different parts of the kingdom."

"*Gymnastics.*

"The play-ground of each school will be furnished with proper apparatus for gymnastic exercises; and a master will be in attendance on Saturday afternoon to instruct therein, without any additional charge, any of the pupils who may wish for such instruction."

"*Normal School.*

"As it is the wish of the directors to render this institution as extensively useful as possible, they propose to make it, not merely a school of instruction for the youth of Liverpool, but a Normal school for the improvement of education in other places. For this purpose they propose to permit young men of respectable character and talents, who wish to become schoolmasters, to attend the school, and act as assistant masters; so that, while they are useful in instructing others, they may themselves be learning the most approved methods of tuition. When such teachers are able to afford material assistance, small salaries may be allowed them, while they are waiting for more important situations elsewhere.

"The number of pupils attending the Evening School are 456; High School, 201; Lower School, 276."

The annexed Table, indicative of the hours and scheme of instruction in the schools of this institution, may be found useful:—

SCHOOLS OF THE LIVERPOOL MECHANICS' INSTITUTION.

SYSTEM OF EDUCATION FOR THE LOWER SCHOOL.

MASTERS.

- **A** *First Master.*—Reading, Spelling, Grammar, Composition, Lessons on Objects, Mechanical Arts, Natural History.
- **B** *Second Master.*—Arithmetic, Geometry, Geography, Astronomy, and the Use of the Globes.
- **G** *Writing Master.*
- **D** *Drawing Master*, from the High School.
- **F** *French Master*, or his Assistant, from the High School.
- **M** One of the *Mathematical Masters*, from the High School.
- **P** *Philosophical Master*, from the High School.

HOURS.	FIRST CLASS.	SECOND CLASS.	THIRD CLASS.	FOURTH CLASS.
8½—9½	Mental Arithmetic, Lessons on Form. **B**	Writing. **G**	Reading. **A**	8—9. French. **F**
9½—10½	Reading. **A**	Arithmetic, 3 days. Mensuration, or Geometry, 2 days. **B**	Writing. **G**	9—10. Navigation and Nautical Astronomy. **M**
10½—11½	Writing. **G**	Reading, Spelling, and Grammar. **A**	Arithmetic, 3 days. Mensuration, or Geometry, 2 days. **B**	10—11. Elements of Natural Philosophy, or Chemistry as applied to the Arts. **P**
1½—2½	Geography. **B**	Writing from Dictation, 3 days. **G** Drawing, 2 days. **D**	Lessons on the Mechanical Arts, 3 days. **A** Natural History, 2 days.	In the Afternoon this Class is incorporated with the Third.
2½—3½	Lessons on Objects of Nature or Art. **A**	Geography. **B**	Descriptive or Narrative Composition, founded on the previous lesson, 3 days. **G** Drawing, 2 days. **D**	
3½—4½	Writing on the Slate, as an Exercise in Spelling, 3 days. **G** Drawing, 2 days. **D**	Lessons on the Mechanical Arts, or Readings in Natural History. **A**	Geography, 2 days. Elements of Astronomy, and the Use of the Globes, 3 days. **B**	

TERMS.—For Sons of Members, £1 15*s.* per Annum; for others, £2. 5*s.* payable in advance. Two shillings and sixpence per quarter will be required in addition, for the use of books, slates, and writing-books, including copy-books and exercise-books; but drawing-books, boards, and pencils, will be charged separately, according to the consumption.

Any Pupil who has regularly attended the three first Classes in the Lower School, shall have the privilege of attending, in the High School, any Master he may wish, whether he remains a Pupil in the Lower School or not, on paying the following Fees to such Masters as he attends:—To the *English Master*, £2; *Mathematical Master*, £2; *Philosophical Master*, £2; *French Master*, £2; *Writing Master*, £2; *Classical Master*, £4; *Drawing Master*, £4.

EVENING SCHOOLS, CLASSES, AND LECTURES.

Writing and Arithmetic .... *Mechanical Drawing* .... *Landscape Drawing and Perspective* .... *Ornamental Drawing and Painting* .... *Figure Drawing and Modelling*	On Monday, Tuesday, Thursday, and Friday Evenings, from Seven to Nine o'clock.
Architectural Drawing .... *Navigation and Nautical Astronomy* .... **French*,—by the French Master of the High School **F**	On Tuesday and Friday Evenings, from Seven to Nine o'clock.
Mechanics and Mechanical Arts*,—by the First Master of the Lower Day School **A .... **Geography*,—by the Second Master of the Lower Day School **B** **Natural Philosophy and Chemistry*	On Monday and Thursday Evenings, from Seven to Nine o'clock.

* A small additional Fee will be required from those Pupils who shall enter any of the Classes marked thus *.

TABLE showing the Number of HOURS each MASTER is employed.

	High School.	Lower School.	Evening School.	Total.
M	28	5	4	37
P	28	5	4	37
F	33	5	4	42
D	15	6	—	21
A	—	33	4	37
B	—	33	4	37
G	—	27	—	27

PUBLIC LECTURE EVERY WEDNESDAY AND SATURDAY EVENING, AT HALF-PAST SEVEN O'CLOCK.

***LIVERPOOL MECHANICS' INSTITUTION*, 1837.** **ANNUAL SUBSCRIPTION, ONE GUINEA.** **JOHN S. RADCLIFF, *Secretary*.**

Such is the character of a great experiment which is now making in one of the first towns in the empire. Of its success, if properly conducted, there can be little doubt. But there is another part of the population, to whom it is desirable to extend some of these advantages, namely, those engaged in agricultural pursuits; and in this class, not only the peasant, but his employer also, the farmer, is included. Persons conversing with farmers upon the necessity of giving some education to the agricultural labourer, which would elevate his character, and render him more capable of securing to himself an independence, are often met with the objection that there are no schools in which the children of the farmers themselves can learn as much as it is proposed to teach the children of the labourers. Nor are there any. If Central Institutions in each county were to be formed for the supply of books and lecturers to the rural districts, schools for farmers might be advantageously attached to them, so that both the schools and institutions should receive mutual advantage from the alliance. There are few, if any, occupations which require so much and such varied scientific knowledge as farming; and perhaps there are none in which, generally speaking, those engaged in them have so few means of obtaining it. The national benefits which would arise from farmers being educated in a superior manner are such as to defy calculation.*

* Vide an Article on "County Agricultural Colleges," third volume of the publications of the Central Society of Education.

The instruction of adult females has been hitherto unprovided for. In Mechanics' Institutions, women, if not excluded, have at least been wholly lost sight of. There appears, however, no good reason why one-half of the working-classes, in whose moral and intellectual elevation the other half have the deepest interest, should be overlooked. A happy and well-ordered home, valuable in every situation of life, is especially so to the working man of all ranks; whose increased skill and knowledge, and his cultivated tastes, are likely only to be sources of disappointment, if the companion of his home and the mother of his children is deficient in the habits and knowledge befitting her sex, and essential to the due performance of her duties. The absence of a systematic provision for female instruction is a fertile source of improvidence and domestic unhappiness. The difficulties, whatever they may be, in the way of introducing female education into Mechanics' Institutions, are those of detail merely, and may be obviated by judicious superintendence. In the Manchester Lyceums female members are admitted, upon the same footing as those of the other sex, to all the privileges of the institution excepting the reading-rooms. They vote for officers, and have evening classes especially appropriated to their instruction in singing, sewing, knitting, &c., and elementary knowledge, under the management of a numerous committee of ladies. It is desirable, of course, as far as circumstances allow, to keep the male and female classes distinct; and this is easily done by means of separate entrances, and by varying the hours and evenings of attendance.

CHAPTER XIII.

MEANS OF FOUNDING, AND RULES.

The means of founding a Mechanics' Institution or Reading-room will necessarily vary with the circumstances of each particular place; but the following course has in many instances been found useful:—

Let the persons most desirous of forming the institution consult those manufacturers or tradesmen who employ the greatest number of men, and endeavour to obtain their support, and their signatures to a requisition for a general meeting of the workmen, to consider the proposition.

It would be highly advantageous if the clergymen of the district, and any dissenting ministers officiating there, would sign the requisition, and actively support the project.

At the meeting resolutions may be proposed:

1. Affirming the expediency of having the proposed institution.
2. Constituting such of the persons then pre-

sent as should subscribe 5*l.* life members, and 2*s.* 6*d.* ordinary members for a stated period.

3. Naming a Provisional Committee, of whom two-thirds should be mechanics, to prepare rules, suggest officers, select rooms, and report generally on the means of effecting the object.
4. Adjourning for one month, to receive the report.

Upon the temper and discretion of the Provisional Committee, their eschewing of all ostentation, all rivalries with other institutions, and all personal or party motives, the ultimate success of the project must, in a great measure, depend.

A personal canvass among the workmen themselves, to induce them to join the institution, though somewhat laborious, would probably be useful.

The Rules by which it is conceived that Mechanics' Institutions should be guided are deductions from the preceding observations. Those of the London Mechanics' Institution having been for the most part adopted throughout the country, they have been taken as the groundwork of the following Rules, which, it will be observed, are intended for an institution comparatively numerous and opulent: many of them may be dispensed with; and they can be easily adapted to smaller Bodies, for whom, in their present state, they would be cumbrously minute. Thus the number of officers may be much diminished. The duties of secretary may be performed by a member of the Managing Committee; that of librarian by a committee of members, who would take the labour of attendance in rotation. The office of treasurer may be dispensed with, drafts being signed by the chairman of the day, and countersigned by the acting secretary.

APPENDIX I.

RULES

FOR

MECHANICS' INSTITUTIONS.

SECTION I.

The Objects of the Institution are,

1st.—The instruction of the Members in the principles of the useful and ornamental Arts, and in the various other branches of Useful Knowledge, to the exclusion of controversial divinity, party politics, and all subjects of local controversy;

2ndly.—The rational amusement of the Members and the cultivation of their tastes.

Means.

1. The voluntary association of Members and the payment of a small annual or quarterly sum, in advance, by each.

2. Donations of Money, Books, Specimens, Implements, and Apparatus.

3. A Library of Reference, a Circulating Library, and a Reading-Room.

4. A Museum of Machines, Models, Minerals, and specimens of Natural History.

5. Lectures on Natural and Experimental Philosophy, Practical Mechanics, Astronomy, Chemistry, Natural History, Literature, and the Useful and Ornamental Arts, particularly those which have reference to the immediate neighbourhood.

6. Classes.

7. An Experimental Workshop and Laboratory.

8. Exhibitions of Works of Art.

9. Evening Meetings for social intercourse.

Section II.

Constitution of the Society.

1. The Institution shall consist of Members who have been admitted, and who have paid to the Secretary their subscriptions, and of those who shall be hereafter admitted in conformity with the Rules and Orders.

2. The Institution shall elect, by ballot,

A President,
Vice Presidents,
A Treasurer, and
Committee-men ;

who together shall form a Committee of Managers, by whom the Institution shall be governed.

3. There shall also be elected   Auditors of the Accounts.

4. All these Officers must be Members of the Institution of six months' standing at least.

Section III.

Admission and Contribution of Members.

1. Candidates for admission shall be recommended by two Members of six months' standing, in the following manner:—

> "*We, the undersigned Members of the Mechanics' Institution, from our personal knowledge of of do hereby recommend him as a fit person to become a Member of the Mechanics' Institution.*"*

The recommendation is to be delivered to the Secretary by one of the Members signing it, in order that it may be filed. The Candidate is to be presented to the Secretary, and, on being admitted, must sign the following declaration:—

> "*I, do hereby promise to observe and keep all the Rules and Orders of the Mechanics' Institution.*"

2. Every Member must contribute ten shillings yearly, by quarterly payments in advance.

3. The quarter-days shall be the 1st of January, April, July, and December.

* Blank forms will be furnished by the Secretary, on the application of Members.

4. Members omitting to renew their subscriptions within fourteen days after they become due, will cease to be Members; but they may, at any time afterwards, resume their standings as Members, on the payment of their arrears.

5. Persons proposed as Members, after the expiration of the half-quarter, may be admitted on paying a half-quarter's subscription.

6. Every Member, on paying his subscription, shall receive from the Secretary a ticket, which will entitle him to all the privileges and advantages of the Institution for the period for which he has paid.

7. No Member will be admitted, either to the rooms or to any General or other Meeting of the Institution, unless he produces his ticket if required.

8. The tickets of Members are personal, and not transferable; and any Member lending his ticket for the purpose of introducing a person not a Member to any room of the Institution, or to any of its Meetings, shall, upon proof being given to the Committee of Managers, be fined two shillings and sixpence, and shall not himself be again admitted until he has paid his fine.

9. Any officer or servant shall detain the ticket of any Member which may be presented to him by a person who is not a Member.

10. No Member can either ballot for officers, or vote at any Meeting, unless he has been a Member six months.

SECTION IV.

Committee of Managers.

1. The Committee of Managers shall have the care and superintendence of the Institution, and the custody of its property.

2. The Committee shall meet every

3. No business shall be transacted in the Committee unless of its Members are present.

4. The Committee of Managers shall cause to be kept fair and accurate minutes of their transactions, and of all receipts and payments on account of the Institution.

5. The Committee of Managers, in conjunction with the Treasurer, shall appoint a Banker to the Institution.

6. The Committee shall cause the accounts of the Institution to be made up twice in every year; namely, to the 30th of June and 31st of December, and shall lay them, together with the minute-books, books of account, and all orders, bills, receipts, and every other document and voucher relative thereto, before the auditors, previously to the General Meetings in the months of April and October; and they shall further give such information and explanation as the auditors may require, to enable them thoroughly to investigate and state the accounts.

7. The Committee shall cause each half-yearly audit, with the books of account, documents, and vouchers, to remain open for the inspection of every Member of the Institution, from seven to half-past nine o'clock

every evening, for twenty-one days after the General Meetings in April and October, at which the said audit has been reported.

8. The Committee shall employ so much of the income of the Institution as may be necessary, in payment of rent and taxes, salaries, wages, repairs, current and incidental expenses, and in the purchase of books, models, apparatus, specimens, instruments, and whatever else may be requisite for the use of the Members of the Institution; but they are strictly forbidden to borrow any sum or sums of money without the consent of a General Meeting specially convened for the purpose.

9. The Committee shall engage Lecturers, and shall cause to be given Courses of Lectures on Natural and Experimental Philosophy, Practical Mechanics, Astronomy, Chemistry, Natural History, Literature, and the Arts, Useful and Ornamental, taking into particular consideration the occupations and peculiarities of the neighbourhood.

10. The Committee shall engage competent persons as Teachers in the Classes and Schools of the Institution.

11. The Committee shall engage a Secretary, and such servants as they may think necessary for the purposes of the Institution.

12. The Committee shall take security from two sufficient sureties on behalf of the Secretary, and from all servants through whose hands any money belonging to the Institution may pass, or in whose care or custody any property of the Institution may be deposited.

13. The Secretary, Teachers, and Servants of the Institution, appointed by the Committee, may be dismissed by them without assigning any cause.

14. No Member of the Committee shall be permitted to supply the Institution with anything from which he can, either directly or indirectly, derive pecuniary profit, or take any office of emolument, except that of Lecturer.

15. The Committee, at every Meeting, shall receive from the Secretary a report of all the money which he may have received since their last Meeting; and the Bankers' pass-book, showing that the same has been placed to the account of the Treasurer, shall be laid on the table of the Committee at every Meeting.

16. The President, or two Vice-Presidents, or three Committee-men, may at any time, by a written requisition signed by them, call a Special Meeting of the Committee.

17. The Committee of Managers shall have the power of forming themselves into Sub-Committees, whose decision, however, shall not be considered as final until confirmed by the General Committee.

18. The Sub-Committees shall keep minutes of their transactions, in the order in which they are brought before them.

19. The President shall take the chair at all Meetings at which he is present; in his absence, one of the Vice-Presidents shall take the chair; in their absence, the Committee shall appoint a Chairman for the occasion.

20. All questions in the Committee shall be decided by a show of hands.

21. The Chairman may always vote; and if the votes are equal, he shall have a second or casting vote.

22. The Committee shall have the power of expelling any Member for misconduct: the person so expelled shall have a right of appeal to the first Quarterly General Meeting of the Institution thereafter; but, when once expelled from the Institution, and not reinstated on appeal to the General Meeting, he shall never afterwards be admitted.

Section V.

Trustees, Treasurer, Banker, and Auditors.

1. The property of the Institution shall be vested, for the use and benefit of the Members, in Trustees, who shall be appointed by the Members in General Meetings assembled.

2. When the office of a Trustee becomes vacant, it shall be filled up at the first following Quarterly General Meeting of the Institution.

3. The account of the Institution with its Bankers shall be kept in the name of the Treasurer.

4. A general Cash-Book of the Treasurer's receipts and payments shall be kept, and shall be laid upon the table of the Committee of Managers at every weekly Meeting.

5. The Treasurer shall make up his accounts twice every year; namely, to the 30th of June and 31st of December, and shall lay each half-year's account before

the Committee of Managers at their third Meeting in July and January.

6. No payments on account of the Institution shall be made unless by order of the Committee of Managers, and by drafts on the Bankers of the Institution, drawn by the Treasurer and certified by the Chairman of the day and the Secretary; and the Bankers shall be directed not to pay any draft on account of the Institution unless so drawn and certified.

7. All money received on account of the Institution shall be paid into the hands of the Bankers of the Institution, in the name of the Treasurer.

8. The Auditors shall meet on the first Wednesday in August and in February, and shall be summoned by the Secretary, for the purposes before directed. [See Sect. IV., 6.]

9. Should the Secretary omit to summon the Auditors as above directed, they shall meet without summons in the months of August and February, and shall demand from the Committee that all books and documents be delivered to them forthwith, to enable them to make a full, clear, and precise statement of the Accounts of the Institution.

10. The Auditors shall make and sign a statement of each half-year's accounts of the Institution; and, with such observations as they think necessary, shall lay the same before the next ensuing General Meeting of the Institution.

Section VI.

Nomination and Election of Officers.

1. Every Officer of the Institution shall be elected by ballot.

2. The President, the Vice-Presidents, the Treasurer, and Auditors shall be annually elected on the Friday preceding the Quarterly General Meeting, in the month of October.

3. The Committee-men shall also be elected for one year; one half of them shall go out of office on the 1st of April and 1st of October in each year, and the vacancies thus occasioned shall be filled up on the Friday preceding the Quarterly General Meeting in those months.

4. Any member of six months' standing may put another member, duly qualified, in nomination for any office of the Institution.

5. The member making a nomination must deliver it to the Secretary in writing, at least twenty-one days before the day of election.

6. A list of the members nominated, and the office for which each of them has been nominated, shall be exhibited in the hall of the Institution, at least fourteen days before the day of election.

7. No name shall be inserted in the list, unless the person named shall have given his consent to take the office for which he is nominated.

8. The circumstance of a person having served an office in the Institution shall not disqualify him from

being elected immediately to another office, or again to the one he before held.

9. Balloting lists shall be printed, and ready for delivery to the members, ten days previous to the election.

10. On the Fridays preceding the Quarterly General Meetings in April and October in each year, the President, or one of the Vice-Presidents, or one of the Committee-men, shall take the chair in the Theatre, where the ballot shall commence at six in the evening, and shall close at half-past nine o'clock.

11. Every member who votes, having presented to the Secretary his ticket for examination, shall deliver his balloting-list, folded up, to the Chairman, who shall in his presence put it into the balloting-glass.

12. Three persons present, not members of the Committee, shall be appointed Scrutineers by the Meeting.

13. As soon as the balloting is closed, the Scruti neers shall add up the number of votes, and report the same, in writing, to the Chairman, who shall announce the result to the members assembled.

14. If the votes for two or more candidates are equal, lots shall be prepared by the Scrutineers, and drawn by the Chairman.

15. At the following General Meeting the Secretary shall read the list of Officers elected for the ensuing year.

16. When a vacancy in the Committee occurs, the place shall be filled up by the member who stood next to those elected on the Scrutineers' list, at the ballot, by which the retiring Member came into office.

Section VII.

General Meetings.

1. There shall be four General Meetings of the Institution in every year, which shall be held on the first day in January, April, July, and October. Notice of the days and hours of meeting shall be exhibited in the hall of the Institution.

2. At every General Meeting business shall commence at eight o'clock in the evening precisely, and no new motion shall be made after ten o'clock.

3. No General Meeting shall continue after eleven o'clock, unless the Chairman shall be of opinion that the business is likely to be terminated in a short time; but if the business cannot be got through, the meeting may adjourn.

4. No new business, other than the ordinary business of the Quarterly General Meeting, shall be entered upon at any adjourned Quarterly Meeting.

5. All voting at General Meetings shall be, in the first instance, by show of hands.

6. If, upon a show of hands, it shall appear to the Chairman, or any three Members, doubtful on which side the majority is, he or they may demand a division; but if any doubt shall still remain, the Chairman shall appoint Tellers, whose certificates shall be conclusive.

7. At the request of Members of the Institution, at any time, the Committee may call a Special

General Meeting; but, on their declining so to do, the Requisitionists may themselves call the Meeting, by public notice to the Members, on giving one week's notice of their intention to the Committee.

8. The following shall be the order of business observed at each Quarterly General Meeting:—

I. The Secretary shall read the Minutes of the last General Meeting.

II. A report from the Committee shall be read, containing the following particulars:

a. The balance of money in hand at the time of closing the last Report.

b. The total amount and the particulars of money received since that time.

c. The total amount and the particulars of money expended since that time.

d. The balance remaining in hand.

e. The total amount and the particulars of all debts due from the Institution at the time of closing the last Report.

f. The total amount and the particulars of the expenses since that time, stating whether such expenses are paid or unpaid.

g. The amounts of debts due from the Institution at the time of closing the Report.

h. All Donations and the names of the Donors.

i. The number of Members at the time of closing the last Report; and how many of them had then paid in advance, and up to what time.

k. The number of new Members since the closing of the last Report; and for what period they have subscribed.

l. The number of persons who have ceased to pay their subscriptions.

m. The total number of Members; and how many of them have paid beyond the expiring quarter, and to what time.

n. [In the January Report]. The number and subjects of all Lectures given in the Institution during the preceding year, and the attendance upon each.

o. The Classes open during the year, the subjects taught in them, and the attendance upon each.

p. The additions to the Library, Museums, and Collections during the year.

q. All other matters which the Committee of Managers may be desirous to communicate.

III. The Secretary shall read propositions for altering the Rules; and the Meeting shall discuss, adopt, or reject all such propositions.

IV. The Meeting shall also attend to any suggestions from Members relating to the Institution.

V. At the Quarterly General Meetings, in April and October, the Report of the Auditors shall be made immediately after the Committee's Report.

9. The Rules of the Institution can be altered only by General Meetings.

10. Every proposition for altering the Rules must be in writing; and, being signed by at least Members of six months' standing, must be delivered to the Secretary at least one calendar month before the day on which the next Quarterly General Meeting will be held: it must be immediately copied by him, and exhibited in the Hall of the Institution.

11. Every proposition for altering the Rules which shall be carried at any Quarterly General Meeting, shall be copied by the Secretary and exhibited in the Hall of the Institution until the next Quarterly General Meeting, when, if again carried, it shall be incorporated with the Rules.

12. No resolution for breaking up the Institution, or alienating any part of its property, shall be passed, unless it be consented to at two Quarterly General Meetings, by at least nine-tenths of the Members present.

Section VIII.

Library.

1. The Library shall consist of two branches,—a Library of Reference, and a Library of Circulation. Books of religious controversy or party politics shall be excluded.

2. The Committee shall have the power of purchas-

ing and exchanging books, and of establishing such regulations as they may deem necessary for affording to the Members the freest use thereof, consistent with the safety of the books, and the general convenience of the Members.

3. The Committee shall be empowered to sell and exchange duplicates and other works which do not appear to be wanted, and purchase other works in their room. They shall also exhibit a list of such publications as are wanted for completing any courses of study in the reading-room, and print them in their annual Reports, in order that persons desirous of presenting works to the Institution may be made acquainted with those which would be of the greatest service.

4. A book shall be kept in the rooms, in which any Member of the Institution may enter, for the consideration of the Committee, any books, apparatus, &c. which he may consider proper to be procured.

Section IX.

Reading-Room.

1. The room shall be open for the accommodation of the Members every day, from nine o'clock in the morning till ten at night.

2. No Member shall be entitled to enter the reading-room without producing his card, if required.

3. Catalogues of the books contained in the library shall be placed in the reading-room; and, in order to

afford increased facility of reference, the catalogues shall be arranged both alphabetically and scientifically.

4. If any Member shall take a book out of the house, which he has received to be used in the reading-room, he shall pay a fine of threepence per day for such book; and if he keeps it more than seven days, sixpence per day.

5. No Member shall be allowed to write in any of the books belonging to the library, or to deface or injure them; and every Member shall be responsible for whatever damage any volume may sustain while in his possession, or for its loss, if not returned agreeably to the fourth regulation.

6. Perfect silence must be preserved in the reading-room.

7. No Member is allowed to partake of refreshments in the reading-room.

8. A book shall be provided wherein Members may enter suggestions relative to the conduct and management of the reading-room; and also the names of any books which they may desire to have procured. The suggestion must be signed by the Member who makes it, and the book shall be laid before the Committee at each meeting.

Section X.

Circulating Library.

1. The Library shall be open for delivering out and receiving books on Monday in every week.

2. Every Member shall, if required, produce his admission ticket on taking out a book.

3. No Member shall have more than one volume at a time, unless the plates belonging to any work are in a separate volume, in which case they may be taken out with the work; but the whole must be returned at the expiration of the time allowed for one volume.

4. Two weeks are allowed for reading an octavo or smaller volume; and three weeks for a quarto or a folio volume, including the days of delivery and return.

5. If a book be not returned on the day appointed, the Member shall pay a fine of one penny for every day the book shall be detained; and, if kept above seven days, threepence a day; and, if not returned within fourteen days after the day fixed for its return, application shall be made to the Member for the same, and, if not then returned, the Member shall pay the value thereof, or of the set of books to which it belongs.

6. A Member lending a book to any person not being a Member of the Institution, or of his own family dwelling under his roof, shall pay a fine of two shillings.

7. If a book be written in or otherwise damaged, the Member in whose hands the book was at the time shall pay the value of the book, or replace the same, at the discretion of the Committee.

8. All fines must be paid to the librarian within one week after being incurred; and, in default thereof, the names of the Members incurring the same shall be exhibited in the reading-room of the Institution, and, after the lapse of one month, they shall cease to be Members thereof.

9. None of the books marked in the catalogue as books of reference shall be circulated.

10. Proper registers shall be kept of the books taken out of the library.

11. A Member, on returning a book, shall not take the same out again until it have remained one clear day in the library, nor then, if it is wanted by any other Member.

12. No new works shall be circulated until after they have remained in the library one month.

13. For the purpose of enabling the Committee to ascertain the state of the library, and the condition of the books therein, the circulation of books shall cease for one week in the year: viz. from the second to the third Wednesday in March. All books must be returned into the library on or before the first of the above days; and any Member detaining a book shall be fined sixpence for every day it is so detained.

15. Numbers of periodical works shall not be circulated until the next succeeding number shall have appeared.

Section XI.

Lectures and Classes.

1. The Courses of Lectures shall be under the direction of the Committee, who shall give public notice thereof in the Theatre and Hall of the Institution.

2. The President, one of the Vice Presidents, or one of the Committee-men, shall preside at every Lecture; and a place shall be set apart for him.

3. Members may have the privilege of taking out transferable tickets for admission to the Lectures. Transferable tickets, for the quarter, at ;—for single Lectures, at each.

4. Members of distant Institutions, similar in their objects to the Mechanics' Institution, may, during a visit to , be admitted, by the Committee, to attend the Lectures.

5. The Committee may engage Teachers for the Classes of the Institution.

6. Every Member desirous of entering any of the Classes shall give notice thereof, in writing, to the Secretary.

7. Each Class shall keep minutes and make a report of its proceedings, and of the attendance of Members, to be submitted by the Committee to the General Meeting.

8. All Members who have followed the regular Classes of the Institution for the space of two years, may, if they think fit, submit to an examination by Examiners appointed by the Committee, who are authorised to give the following Certificate to all whom they may find to have duly profited by their studies :—

——— MECHANICS' INSTITUTION.

" *We certify that attended the Classes of , taught in this Institution during the Sessions 18— and 18—; that he was examined by the persons duly appointed for that purpose, and being found to possess a* *competent knowledge of the subjects taught in these several Classes, was, at a General Meeting of the Members, presented with this Certificate.*

Dated

____________ *Secretary.*

__________ *President.*

__________ } *Examiners.*
____

Section XII.

Sons and Apprentices of Members.

1. Sons and Apprentices of Members, between the ages of twelve and eighteen years, may be admitted to attend the Lectures or Classes, on payment of shillings a quarter in advance for the Lectures, and the like sum for the Classes; and, on being recommended by the parent or master, in the following terms:—

"*I, the undersigned Member of the Mechanics' Institution, do hereby recommend of being my to attend .*"

2. Upon receiving the above form, properly filled up, and the sum of money directed to be paid, the Secretary shall issue a Ticket of Admission to the person applying for it.

3. The Tickets of Sons and Apprentices of Members are subjected to the same restrictions as those of the Members.

4. The female relations and friends of Members may be admitted to attend the Lectures, and to have the use of the Circulating Library, on being proposed in the same form as the Sons and Apprentices of Members, and on the payment of   shillings per quarter in advance. Their Tickets to be subject to the same restrictions as those of the Members.

Section XIII.

Honorary Members.

1. Any person having gratuitously given to the Institution, at the request of the Committee, a Course o. not less than six Lectures; or a sum of not less than ten pounds in money; or books, specimens, implements, models, apparatus, labour, or other service, to the value of fifteen pounds: or who shall have continued a subscribing Member fifteen years, shall be admitted an Honorary Member, subject to all the regulations of the Institution, and enjoying all its privileges.

2. The Committee shall be empowered to admit, without donation, persons not resident at   as Honorary and Corresponding Members; who shall be entitled to speak at General Meetings, as well as to all other privileges of membership, excepting the privileges of sitting on the Committee of Management, and of voting in the affairs of the Institution, which they shall not be entitled to unless they be also subscribing Members.

APPENDIX II.

CATALOGUE OF BOOKS.

Note.—The Committee are well aware that the following List is necessarily far from perfect either in the selection or classification. Many valuable Works, especially those relating to the Useful Arts, have no doubt been omitted by inadvertence; and it is possible that some Works have been recommended which might with propriety have been omitted. Those, however, who have attempted a similar task will be the most likely to look with indulgence upon the defects of this List.—The prices marked are chiefly taken from the Catalogue of Mr. Dowding, in Newgate Street.

MORAL AND POLITICAL PHILOSOPHY—METAPHYSICS—LAW.

Analogy of Natural and Revealed Religion. Bishop Butler; 2*s*. 6*d*.

Aristotle's Ethics and Politics, translated by Gillies; 2 vols. 8vo. 1*l*. 1*s*.

Bacon's Essays; 5*s*. 6*d*. Sharpe

Bentham (Jeremy) on Morals and Legislation; 2 vols. 8vo. 1*l*. 1*s*.

Bentham's Book of Fallacies; 12*s*. Hunt

Bishop Butler's Works; 2 vols. 8vo. 15*s*. Payne

Blackstone's Commentaries; last edition, with Notes

Brown's Lectures on the Philosophy of the Human Mind; 1 vol. 8vo. 16*s*. Longman

Brougham (Lord) on Natural Theology

Cobbett's Advice to Young Men; 12mo. 1829, 5*s*.

Coombe on the Constitution of Man; 1*s*. 6*d*.

Edgeworth on Practical Education; 3 vols. 12mo. 4*s*. 6*d*. Baldwin

Epictetus' Morals, translation

Feltham's (Owen) Resolves; 2*s*. 1677

Gambier on the Study of Moral Evidence; 1 vol. 8vo.

Kames' (Lord) Sketches of the History of Man; 3 vols. 8vo. 12*s*. Cadell

Knox's Essays; 3 vols. 12mo. 7*s*. Mawman

Locke on Education and the Conduct of the Understanding

Locke on Human Understanding; 1 vol. 8vo. 10*s*. 1828

Marcus Aurelius' Commentaries, translation; 1774

Mill's Analysis of the Human Mind; 2 vols. 8vo. boards, 14*s*.

Montagu's (Basil) Selections from the Works of Taylor, Latimer, Hall, Milton, Barrow, South, Brown, Fuller, and Bacon; 12mo. 5*s*. 1834

Montesquieu on the Spirit of Laws; 2 vols. 12mo. 8*s*. 1793

Novum Organum, Familiar Account of, Library of Useful Knowledge; 1*s*.

Paley's Moral Philosophy and Natural Theology, Lord Brougham's and Sir C. Bell's edition; 3 vols.

Pliny's Letters by Melmoth; 1810. 12*s*.

Reid's Inquiry into the Human Mind; 8vo. 5*s*. Cadell

Rochefoucault's Maxims, and Lord Bacon's Elegant Sentences; 24mo. 2*s*. 1830

Stewart's (Dugald) Human Mind; 2 vols. 8vo. 1*l*. 4*s*.
Tomlin's Law Dictionary; 2 vols. 4to. 1*l*. 8*s*. 1835
Whateley's Logic; 8vo. 12*s*. 1831
Whateley's Rhetoric; 12*s*. 1832
Xenophon's Memorable Sayings of Socrates, translation; 2*s*. 6*d*. 1747

HISTORY.

Adam's Roman Antiquities; 8vo. 5*s*. 6*d*. Cadell
Addison's Dialogues on the Usefulness of the Ancient Medals; 1745
Aikin's Queen Elizabeth; 2 vols. 8vo. 1*l*. 4*s*. 1826
Annual Register (Dodsley); 21*l*.
Arrian's History of Alexander's Expedition, by Rooke; 2 vols. 8vo. 1814, 1*l*. 1*s*. Walker
Burnet's History of His own Time; 4 vols. 8vo. 2*l*. 2*s*.
Ditto of the Reformation; 6 vols. 1*l*. 10*s*.
Botta's History of Italy under Napoleon, translation; 2 vols. 8vo. 5*s*. 6*d*.
British Costume (Library of Entertaining Knowledge); 1 vol. 4*s*. 6*d*.
Cæsar's Commentaries, Duncan's translation; 2*l*. 5*s*.
Clarendon's History of the Rebellion; 6 vols. 8vo.
Chambers' (R.) History of the Scotch Rebellions; 5 vols. 18mo. 1*l*. 5*s*.
Church, History of the (Library of Useful Knowledge); 13*s*. 6*d*.
Criminal Trials, Jardine's (Library of Entertaining Knowledge); 2 vols. 12mo. 9*s*.

Defoe's History of the Plague; 5*s*. Murray

Egyptian Antiquities; 2 vols. 12mo. 1832 (Library of Entertaining Knowledge); 9*s*.

Fosbroke's Encyclopædia of Antiquities; 2 vols. 4to. 2*l*. 5*s*.

England, Picture History of; 2 vols. 10*s*.

France, History of, (Library of Useful Knowledge), Part I.; 9*s*.

Gibbon's Decline and Fall of the Roman Empire; 1 vol. 8vo. Bungay Edition; 16*s*.

Godwin's Commonwealth; 4 vols. 8vo. 2*l*. 15*s*. Colburn

Greece, History of (Library of Useful Knowledge); 5*s*.

Ditto Lardner's Cyclopædia

Historical Parallels; 2 vols. 12mo. 9*s*. 1831, (Library of Entertaining Knowledge)

Hallam's Constitutional History of Great Britain; 3 vols. 8vo. 1*l*. 16*s*. Murray

Hallam's Middle Ages; 3 vols. 8vo. 1*l*. 18*s*. Murray

Haase, Ancient Greeks

History of Ireland, in Lardner's Cyclopædia

History of Scotland, Lardner's Cyclopædia; 2 vols. 12*s*.

Herodotus, translated by Laurent; 2 vols. 8vo. 1*l*. 4*s*. Longman

History of Switzerland, (in Library of Useful Knowledge)

Hooke's Roman History; 6 vols. 8vo. 1*l*. 8*s*.

Hume and Smollett's History of England; 8 vols. 8vo. 2*l*. 16*s*. Hatchard

James's Naval History; 6 vols. 8vo. 3*l*. 8*s*. Harding

James II., by Fox; 4to. 6*s*. 6*d*.

Livy, translated by Baker; 6 vols. 8vo. 1*l.* 11*s.* 6*d.* Cadell

Lingard's History of England, new edition; 13 vols. 2*l.* 10*s.*

Mackintosh's History of England (Lardner's Cyclopædia)

Mignet's French Revolution; 2 vols. 8vo., 1826, 1*l.* 5*s.* Hunt

Mill's British India; 6 vols. 8vo. 2*l.* 2*s.* Baldwin

Miller's History of the English Government

Mosheim's Ecclesiastical History; 6 vols. 8vo. 1*l.* 16*s.*

Napier's History of the Peninsular War; 4 vols. 8vo. 3*l.* Boone

Neale's History of the Puritans; 3 vols. 8vo. 1*l.* 1*s.*

Paris and its Historical Scenes (Library of Entertaining Knowledge); 2 vols. 12mo. 9*s.* 1831

Peru, History of the Conquest of; 12mo., 1831

Pompeii (Library of Entertaining Knowledge); 2 vols. 12mo. 9*s.*, 1831

Antiquities of Greece; 2 vols. 8vo. 18*s.*, 1838

Rollin's Ancient History; 12 vols. 18mo. 2*l.* 8*s.* Rivington

Robertson's Works; Bungay edition

Sallust, Gordon's translation

Secret Societies; 1 vol. 12mo., 4*s.* 6*d.* (Library of Entertaining Knowledge)

Sismondi's History of the Italian Republics; 12mo. (Lardner's Cyclopædia)

Spain and Portugal, History of (Library of Useful Knowledge); 7*s.*

Sully's Memoirs; 5 vols. 12mo. 12*s.*, 1812

Thierry's Conquest of England by the Normans; 3 vols. 8vo. 12*s.* 6*d.* Whittaker

Turner (Sharon) History of England during the reign of the Anglo-Saxons; 3 vols. 8vo. 1*l.* 18*s.*

Thucydides, translated by Hobbes; 3 vols. 8vo., 2*l.* Longman

Tacitus; Murphy's or Gordon's

Xenophon; Jones's edition

BIOGRAPHY.

Alexander the Great, Williams's Life of; 5*s.* Murray

Autobiography; 22 vols. 12mo., 1828

Biographia Britannica; 7 vols. folio. 4*l.* 10*s.*

British Admirals, Lives of; 8 vols. 8vo. 1*l.* 16*s.* 1813. Campbell

British Painters, Cunningham's Lives of, &c.; 6 vols. 12mo., 1823

British Physicians, Lives of; 12mo., 1830

Burns, Lockhart's Life of

Catherine II., Life of; 2 vols. 8vo., 1800

Cellini (Benvenuto), Life of, by Roscoe; 2 vols. 8vo. 12*s.* 6*d.* 1823

Chalmers' Biographical Dictionary; 32 vols. 8vo. 15*l.* 18*s.* Whittaker

Charlemagne, Life of; 8vo., 1833

Cromwell (Oliver), Russell's Life of

Charles XII. of Sweden, Voltaire's Life of; 5*s.* 6*d.* 1815

Columbus, Washington Irving's Life of

Cuvier, Lee's Memoirs of; 8vo. 12*s.* Longman

Davy, (Sir H.) Life of; Paris's and John Davy's

Distinguished Men of Modern Times (Library of Entertaining Knowledge); 4 vols. 12mo. 18*s.*

Edgeworth, Life of; 7*s.* Hunter

Franklin (Benj.), Life and Writings of, by his Grandson; 6 vols. 8vo. 2*l.* 15*s.* 1818

Gallery of Portraits; 7 vols. 7*l.* 7*s.*

Gustavus Adolphus, King of Sweden, Harte's History of; 2 vols. 8vo. 1*l.* 1*s.* 1807

Hampden (John) and Pym, Lives of, (Lardner's Cyclopædia)

Hutton (W.), Life of, by Himself

Johnson, Boswell's Life of; 5 vols. 12mo. 1*l.* 10*s.* 1824. Murray

Leo X., Roscoe's Life of; 4 vols. 8vo. 2*l.* 8*s.* Cadell

Lives of Eminent Persons (Library of Useful Knowledge); 8vo. 10*s.*

Lives of British Statesmen; 12mo., 1831 (Lardner's Cyclopædia)

Lives of the most Eminent Foreign Statesmen; 1830

Lives of Haydn and Mozart

Lives of Eminent Lawyers (Roscoe's); 12mo., 1830

Lorenzo de Medici, Roscoe's Life of; 2 vols. 8vo. 1*l.* 4*s.* Cadell

Michael Angelo, Duppa's Life of; royal 8vo. 15*s.* Longman

Napoleon, Bourrienne's Memoirs of; 2 vols. 8vo. 1*l.* 8*s.*

———, Lockhart's

———, Scott's; 9 vols. 8vo. 2*l.* 2*s.* 1827

Nelson, Southey's Life of; 12mo. 1824

Newton (Sir I.), Brewster's Life of; 2 vols. 12mo. 9*s.* 1832

Oberlin, (John F.), Memoirs of; 12mo. 1834

Owen's Life of Owen

Owen's Life of Baxter

Peter the Great, Life of, by Voltaire; 1832

Philip of Macedon; Leland; 2 vols. 18*s.*

Philip II. and Philip III., Watson's Lives of; 5 vols. 8vo. 2*l.* 10*s.*

Pursuit of Knowledge under Difficulties (Library of Entertaining Knowledge); 2 vols. 12mo. 9*s.*

Pilkington's Dictionary of Painters; 2 vols. 8vo. 18*s.* 1829

Plutarch, translated by Langhorne; 6 vols. 8vo. 1*l.* 8*s.* Longman

Sir W. Raleigh, Tytler's Life of; 12mo. 1833

Russell, Lady Rachael, Life of; 1 vol.

Russell, Life of William, Lord; 1 vol.

Scottish Worthies, Tytler's Lives of; 3 vols. 12mo. 1833

Washington, Life of

Wesley, Southey's Life of

Xenophon's Education of Cyrus

POLITICAL ECONOMY.

Ansell's Treatise on Friendly Societies (Library of Useful Knowledge); 1 vol. 8vo. 5*s.* 1835

Babbage on the Economy of Machinery and Manufactures; 12mo. 1832. 4*s.* 6*d.* Knight

Commerce (Library of Useful Knowledge); 2*s.* 6*d.*

Dupin on the Commercial Power of Great Britain; 2 vols. 8vo. 1*l.* 4*s.* Knight

Guizot on Civilization, Mrs. Beckwith's translation

Hopkins's (John) Notions on Political Economy
Jones's (Rev. R.) Essay on the Distribution of Wealth; 8vo. 7*s*. 6*d*. Murray
Malthus on Population; 2 vols. 8vo. Murray
Marcet's (Mrs.) Conversations on Political Economy
Mill's Elements of Political Economy; 8vo. 1821, 8*s*.
M'Culloch on Wages and the Labouring Classes; 12mo. 1826
———'s Political Economy; 16*s*. Longman
———'s Dictionary of Commerce; 8vo. 2*l*. 2*s*. 1837
———'s Statistical Account of the British Empire; 2 vols. 8vo. 2*l*. 2*s*. 1839
Martineau's Illustrations of Political Economy; 23 vols. 2*l*. 2*s*. 1835
——— Illustrations of Poor Laws; 4 vols. 4*s*.
Money Matters, Easy Lessons on
Ricardo on Political Economy; 8vo. 9*s*.
Rights of Industry; 1*s*. 3*d*. 1832. C. Knight
Results of Machinery; 12mo. 1*s*. 3*d*. 1832. C. Knight
Smith's Wealth of Nations, by M'Culloch; 4 vols. 8vo. 1828. 2*l*. 12*s*. 6*d*. Longman
Whateley's Lectures on Political Economy

EDUCATION.

Ascham's (Roger) Schoolmaster
Arithmetic for Young Children; 1*s*. 6*d*. Knight
Austin's Translation of Cousin's Report on the State of Public Instruction in Prussia; 12mo. 1834

Barbauld's Evenings at Home; 4 vols. 18mo. 10*s.* Baldwin

Central Society of Education, Publications of; 5*s.* 6*d.* each volume. Taylor and Walton

Combe's Physiology, as applied to Education; 8vo. 1837

Journal of Education of the Society for Diffusion of Useful Knowledge; 10 vols. 8vo.

The Schoolmaster; 2 vols. 12mo. 12*s.* C. Knight

VOYAGES AND TRAVELS—MANNERS AND CUSTOMS OF NATIONS.

Anson's Voyage round the World; 12mo. 5*s.* 6*d.* Rivington

Barrow's Travels in China and the Cape of Good Hope; 4to. 1*l.*

Bruce's Life and Travels; 7 vols. 8vo., Plates 4to. 3*l.* 10*s.*

Brydone's Tour through Sicily and Malta; 2 vols. 8vo. 1774

Canada, Backwoods of (Library of Entertaining Knowledge); 4*s.* 6*d.*

Carmichael's Domestic Manners, &c. in the West Indies; 2 vols. 12mo. 1834

Clapperton's last Expedition to Africa; 2 vols. 8vo. 1830

Clarke's Travels; 13 vols. 8vo. 6*l.* 16*s.* 6*d.* 1816

Carver's Travels in North America; 1779

Cook's Voyages; 7 vols. 12mo. 1*l.* 15*s.* Sherwood

Conder's Modern Traveller

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APPENDIX III.

OUTLINES OF LECTURES.

CONTENTS OF FIRST COURSE.

POLITICAL PHILOSOPHY.

Note.—One smaller course of Lectures may be conveniently formed of the six first, the 16th, 20th, 24th, 25th, 26th, 27th, and 28th; in all, thirteen "Lectures on the Philosophy of Governments." Another may be formed of the fifteen last Lectures "On the Principles of National Policy."

PART I.

LECTURE I.

Introductory exposition of a scheme of the sciences as divisible into—1. Those which treat of the relations of abstract ideas, being mathematics (comprehending geometry, arithmetic, and algebra) and logic; 2. Those which treat of the properties of matter, being the various branches of natural philosophy; and 3. Those which treat of the qualities of mind, including the two great branches of psychology or intellectual philosophy, and ethics, or the philosophy of morals—The science of politics, the subject of the present lectures, is a subdivision of ethics—Its objects, uses, and vast importance—Distinction between politics and political economy—Refutation of the opinion that political subjects are not fit for discussion among the great body of the people—One consideration, never to be forgotten is, that such discussion cannot be prevented—But even if it could it ought not—Importance of the aid which may be derived to the work of good government from the instruction of the people in political science; that is, in the science of the rights and duties both of subject and ruler.

LECTURE II.

Discussion on the foundations or origin of civil government—The original contract or compact—No foundation for this theory in fact, proved by the history of all the governments of which we know anything—No foundation for it, nor any traces to be seen of it in the earliest stages of society and of government—Mr. Locke's deduction of it considered—The opposite doctrine of the patriarchal origin of government as maintained by Sir Robert Filmer and his followers—Locke's facts and historical theory groundless, but his practical conclusions correct, and safe in their consequences; Filmer's facts correct, but his conclusions false, and dangerous in their consequences—Although the earliest form of government was undoubtedly that of a single chief, and the first chief was the head of a family, there is not thereby established for all time coming, and for all circumstances, either any divine right of lineal succession for the ruler, or any duty of passive obedience for the subject—The question of what form of government is the best is at all times simply a question of expediency—So also is the question of changing one form of government for another in any particular country——Statement of the manifest convenience that there is in having some system of government—The inconvenience that there always is in a change of government, as such. The hazard there always is in attempting a change—The question is to be resolved by weighing against that inconvenience and hazard the chances of success and the benefits to be reasonably expected from success—Whenever the latter considerations clearly and greatly preponderate, the attempt ought to be made—Authority of Paley and others in support of this doctrine—Consideration of the opinion which rests the foundation of government on prescription—Statement of the true amount of the advantage which a government derives from having been long established—Still this is an advantage merely, and nothing more—It gives no claim of right to the obedience of the subject contrary to the principle of comparative advantage to the whole—The right of property has also been grounded upon prescription—This, however, like the right of government, is derived wholly from the consideration of its expediency—So is the mode in which property is to be held, and the extent to which the rights of property are to be exercised—General conclusion, 1. that through the whole system of society, expediency, or a regard to what is for the general benefit of the community, is the only governing principle, and the foundation of all rights; and 2. that this is also the safest foundation for the peace and good order of the community.

LECTURE III.

The doctrine of resistance—The people have not a right to resist their government in all, but only in certain circumstances—Explanation of what these circumstances are—The evils actually suffered must be so great that it is better for the people even to risk a civil struggle than to continue to bear them, and the chances of success in the enterprise must be decidedly greater than those of failure—The account of the doctrine thus given fortified by references to the writings of Paley and Blackstone, who have, however, stated it less cautiously—Sketch of the history of the political parties which in this country have sprung out of the opposite opinions, or inclinations of opinion, upon the right of resistance—The controversy to which it gave rise at the time of the Settlement of 1688—The Whigs and Tories—Modern modifications of parties—General spirit of the two parties—Great evils of the abuse of party in promoting misgovernment and excluding the people from all influence.

LECTURE IV.

The different forms of government—Necessity of a supreme power in every state—Explanation of the proper meaning of the expression, *supreme power* in the state—Its division into three branches, the legislative, the executive, and the judicial—The legislative branch, however, may be said to comprehend the other two—The various ways of establishing, distributing, and exercising the supreme power distinguish one form of government from another—Plain and simple test of the merits of any constitution, viz. Does it secure to the people the best laws at the smallest expense both of money and of subjection?—It does not, however, follow that any one form is to be accounted the best for every nation and in all circumstances—The circumstances of each country always to be regarded—Two great divisions of the whole subject—1. The frame or structure of the government, that is, the means by which it exists and is maintained—2. The offices or duties which it performs to the community, that is, the use which it is of, and the benefits with which it repays the allegiance and support of the people—The three great divisions under which the various forms of government may be classed—Monarchy, Aristocracy, Democracy—These forms often mixed with one another—The mixture, however, sometimes no more than apparent—Manner in which one form may degenerate, and often does, into another.

PART II.

LECTURE V.

The MONARCHICAL form of government—The most ancient in the world, having begun with the authority exercised by a father over his family, or by its hereditary head over a tribe—It may also, however, have happened that a tribe on a particular occasion would select for its head or leader the individual deemed best qualified to discharge the duties of that post—Prevalence of the monarchical or chieftain form of government in all rude states of society—The chief, however, in these cases frequently elective—Indeed, it is quite impossible that in early periods the kingly power ever could have been hereditary according to any fixed rule of succession—As far as the evidence of history goes we know that it never was so—The complete establishment of the hereditary principle is a refinement of a comparatively advanced stage of society—Examination of the monarchical form of government in its purity—Turkey—Detailed view of the system of government there established—Oppression suffered by different classes—In the smaller despotisms of the East the state of things is still worse—Main sources of the evils of a despotic form of government—The misery, and also the universal corruption, which are its consequences—Its destructive action upon the whole edifice of national prosperity—The stationary condition of society in the East.

LECTURE VI.

Alleged advantages of the pure and absolute monarchical form—In how far it is favourable to unity of design and promptitude of deliberation—The disadvantages with which this kind of promptitude is attended—The superiority of an absolute government in regard to promptitude of action—The occasional appointment of a dictator by the Romans in the times of the republic—Comparison of the advantages of absolute and popular governments in war and in negociations—The want of stability of absolute governments—Polish of manners and the fine arts often flourish under the monarchical form of government—Even this admission, however, ought to be made with much qualification—Estimate of the value of that refinement of manners which is sometimes to be found in a despotic monarchy—Dangers of admitting any part of the practice or spirit of despotism into free governments—The welfare of the whole body of the people, and not that of either the rulers or of any fraction of the people, the only consideration to be looked to in reforming a bad government.

LECTURE VII.

Examination in detail of the government of Russia, in its constitution and its effects—Sketch of Russian history, in illustration of the little security despotism gives to the throne, beside the little happiness it allows to the people—Examination of the force and real value of the checks by which the power of the Czar in Russia has been said to be controlled in certain directions—In all such governments the principal check upon the excesses of arbitrary power must be the fear of popular resistance—The Russian autocrat is also in some degree controlled by the power of the public opinion of Europe—In foreign policy Russia has pursued a scheme of continual aggrandizement—Always at war somewhere, and always gaining something at a peace.

LECTURE VIII.

Review of the origin and nature of the Feudal System, as introductory to an examination of the constitutional monarchies of Europe—This examination necessary, because all the monarchies of Europe originated in the Feudal System—It was equally the origin of modern aristocratic governments — Conquest of the Roman Empire of the West by the Northern Barbarians—Condition of the ancient German nations—The Scythians and Huns—The new monarchies established in France, Germany, Italy, Britain, &c.—Distribution of the conquered lands by the several leaders of the invading barbarians, to be held by their followers on condition of military service—The amount or degree of the right of property thus acquired by the latter is matter of dispute —Meaning of the term Feud—Subinfeudation—Allodial lands.

LECTURE IX.

Duties of the Vassal—Allegiance—Services—Commutation for escuage—Late introduction of the right to alienate the feud—In course of time feuds became hereditary—Origin of Relief—Heriots—Fines—Aids—Wardship—Marriage—Other feudal incidents—Division of the inhabitants into freemen and serfs or slaves—Origin of manors—Villeins—Decay and final disappearance of villenage—Consequences of the feudal relation between lord and vassal to the structure of government and society—Limited power of the crown—Exorbitant domination of the barons—Disturbed state of society by warlike practices, rights, and habits—Oppressed and degraded state of the bulk of the people—Origin and early constitution of the legislative, administrative, and judicial powers in the feudal monarchies.

LECTURE X.

The tendency of the feudal system to obstruct the progress of civilization—The ferocious manners and dispositions of its founders—The distinction of ranks, and all the other arrangements of society under the feudal system, regulated with a reference to the profession of war—Origin of privileged classes, and of an hereditary nobility—Degrading effects of the feudal distinction of ranks—The tyranny of the nobles in the feudal times—They became, in some kingdoms, the dominant power in the state—The distinction of nobility gradually came to be conferred unaccompanied by a grant of land—Unfortunate impressions which the feudal system has left upon men's habits and modes of thinking in all the countries in which it once flourished—1. General prevalence of tyranny and subserviency through society—2. Superiority of landowners to all other classes—3. Peaceful pursuits discouraged—4. Preference of eldest sons—5. Vanity maintained by titles and names—6. Tendency of submissive habits to promote civilization—7. Idleness tends to introduce refinement—8. Crusades or Pilgrimages produce similar effects—Origin of Chivalry—9. Veneration for antiquity and dislike of innovation—Much of the system still in actual force among ourselves in the right of primogeniture and other particulars—The causes which led to the decline of the feudal system in England and other countries—Resumption of grants by the crown —Encroachments on the barons—Rise of the towns.

LECTURE XI.

The principles of constitutional monarchy—General history of the growth of limited monarchies—Review of circumstances which have prevented the establishment in Europe of forms of government similar to the absolute monarchies of the East—Six great causes of the distinction enumerated—1. Influence of Aristocracy—2. No despotic power ever exerted in a single hand—3. The rise and privileges of the towns—4. No power of taxing exerted to any considerable extent, but the crown was supported by lands—5. Judicial establishments—6. Progress of knowledge and improvement, chiefly from the invention of printing—Retrospect of the progress made by the crown in the different countries of Europe (where its emancipation from the power of the nobles has been effected) in encroaching upon the rights of the people—Circumstances to be noted in the rise of monarchical influence—1. Attraction of the nobility to the court, and alliance with it—2. Disuse of popular assemblies which had been generally established —3. Introduction of regular troops or standing armies in the room of feudal military services—4. Influence of the clergy in favour of the crown—Examination of Mont-

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APPENDIX III.

OUTLINES OF LECTURES.

CONTENTS OF FIRST COURSE.

POLITICAL PHILOSOPHY.

Note.—One smaller course of Lectures may be conveniently formed of the six first, the 16th, 20th, 24th, 25th, 26th, 27th, and 28th; in all, thirteen "Lectures on the Philosophy of Governments." Another may be formed of the fifteen last Lectures "On the Principles of National Policy."

PART I.

LECTURE I.

Introductory exposition of a scheme of the sciences as divisible into—1. Those which treat of the relations of abstract ideas, being mathematics (comprehending geometry, arithmetic, and algebra) and logic; 2. Those which treat of the properties of matter, being the various branches of natural philosophy; and 3. Those which treat of the qualities of mind, including the two great branches of psychology or intellectual philosophy, and ethics, or the philosophy of morals—The science of politics, the subject of the present lectures, is a subdivision of ethics—Its objects, uses, and vast importance—Distinction between politics and political economy—Refutation of the opinion that political subjects are not fit for discussion among the great body of the people—One consideration, never to be forgotten is, that such discussion cannot be prevented—But even if it could it ought not—Importance of the aid which may be derived to the work of good government from the instruction of the people in political science; that is, in the science of the rights and duties both of subject and ruler.

LECTURE II.

Discussion on the foundations or origin of civil government—The original contract or compact—No foundation for this theory in fact, proved by the history of all the governments of which we know anything—No foundation for it, nor any traces to be seen of it in the earliest stages of society and of government—Mr. Locke's deduction of it considered—The opposite doctrine of the patriarchal origin of government as maintained by Sir Robert Filmer and his followers—Locke's facts and historical theory groundless, but his practical conclusions correct, and safe in their consequences; Filmer's facts correct, but his conclusions false, and dangerous in their consequences—Although the earliest form of government was undoubtedly that of a single chief, and the first chief was the head of a family, there is not thereby established for all time coming, and for all circumstances, either any divine right of lineal succession for the ruler, or any duty of passive obedience for the subject—The question of what form of government is the best is at all times simply a question of expediency—So also is the question of changing one form of government for another in any particular country——Statement of the manifest convenience that there is in having some system of government—The inconvenience that there always is in a change of government, as such. The hazard there always is in attempting a change—The question is to be resolved by weighing against that inconvenience and hazard the chances of success and the benefits to be reasonably expected from success—Whenever the latter considerations clearly and greatly preponderate, the attempt ought to be made—Authority of Paley and others in support of this doctrine—Consideration of the opinion which rests the foundation of government on prescription—Statement of the true amount of the advantage which a government derives from having been long established—Still this is an advantage merely, and nothing more—It gives no claim of right to the obedience of the subject contrary to the principle of comparative advantage to the whole—The right of property has also been grounded upon prescription—This, however, like the right of government, is derived wholly from the consideration of its expediency—So is the mode in which property is to be held, and the extent to which the rights of property are to be exercised—General conclusion, 1. that through the whole system of society, expediency, or a regard to what is for the general benefit of the community, is the only governing principle, and the foundation of all rights; and 2. that this is also the safest foundation for the peace and good order of the community.

LECTURE III.

The doctrine of resistance—The people have not a right to resist their government in all, but only in certain circumstances—Explanation of what these circumstances are—The evils actually suffered must be so great that it is better for the people even to risk a civil struggle than to continue to bear them, and the chances of success in the enterprise must be decidedly greater than those of failure—The account of the doctrine thus given fortified by references to the writings of Paley and Blackstone, who have, however, stated it less cautiously—Sketch of the history of the political parties which in this country have sprung out of the opposite opinions, or inclinations of opinion, upon the right of resistance—The controversy to which it gave rise at the time of the Settlement of 1688—The Whigs and Tories—Modern modifications of parties—General spirit of the two parties—Great evils of the abuse of party in promoting misgovernment and excluding the people from all influence.

LECTURE IV.

The different forms of government—Necessity of a supreme power in every state—Explanation of the proper meaning of the expression, *supreme power* in the state—Its division into three branches, the legislative, the executive, and the judicial—The legislative branch, however, may be said to comprehend the other two—The various ways of establishing, distributing, and exercising the supreme power distinguish one form of government from another—Plain and simple test of the merits of any constitution, viz. Does it secure to the people the best laws at the smallest expense both of money and of subjection?—It does not, however, follow that any one form is to be accounted the best for every nation and in all circumstances—The circumstances of each country always to be regarded—Two great divisions of the whole subject—1. The frame or structure of the government, that is, the means by which it exists and is maintained—2. The offices or duties which it performs to the community, that is, the use which it is of, and the benefits with which it repays the allegiance and support of the people—The three great divisions under which the various forms of government may be classed—Monarchy, Aristocracy, Democracy—These forms often mixed with one another—The mixture, however, sometimes no more than apparent—Manner in which one form may degenerate, and often does, into another.

PART II.

LECTURE V.

The MONARCHICAL form of government—The most ancient in the world, having begun with the authority exercised by a father over his family, or by its hereditary head over a tribe—It may also, however, have happened that a tribe on a particular occasion would select for its head or leader the individual deemed best qualified to discharge the duties of that post—Prevalence of the monarchical or chieftain form of government in all rude states of society—The chief, however, in these cases frequently elective—Indeed, it is quite impossible that in early periods the kingly power ever could have been hereditary according to any fixed rule of succession—As far as the evidence of history goes we know that it never was so—The complete establishment of the hereditary principle is a refinement of a comparatively advanced stage of society—Examination of the monarchical form of government in its purity—Turkey—Detailed view of the system of government there established—Oppression suffered by different classes—In the smaller despotisms of the East the state of things is still worse—Main sources of the evils of a despotic form of government—The misery, and also the universal corruption, which are its consequences—Its destructive action upon the whole edifice of national prosperity—The stationary condition of society in the East.

LECTURE VI.

Alleged advantages of the pure and absolute monarchical form—In how far it is favourable to unity of design and promptitude of deliberation—The disadvantages with which this kind of promptitude is attended—The superiority of an absolute government in regard to promptitude of action—The occasional appointment of a dictator by the Romans in the times of the republic—Comparison of the advantages of absolute and popular governments in war and in negociations—The want of stability of absolute governments—Polish of manners and the fine arts often flourish under the monarchical form of government—Even this admission, however, ought to be made with much qualification—Estimate of the value of that refinement of manners which is sometimes to be found in a despotic monarchy—Dangers of admitting any part of the practice or spirit of despotism into free governments—The welfare of the whole body of the people, and not that of either the rulers or of any fraction of the people, the only consideration to be looked to in reforming a bad government.

LECTURE VII.

Examination in detail of the government of Russia, in its constitution and its effects—Sketch of Russian history, in illustration of the little security despotism gives to the throne, beside the little happiness it allows to the people—Examination of the force and real value of the checks by which the power of the Czar in Russia has been said to be controlled in certain directions—In all such governments the principal check upon the excesses of arbitrary power must be the fear of popular resistance—The Russian autocrat is also in some degree controlled by the power of the public opinion of Europe—In foreign policy Russia has pursued a scheme of continual aggrandizement—Always at war somewhere, and always gaining something at a peace.

LECTURE VIII.

Review of the origin and nature of the Feudal System, as introductory to an examination of the constitutional monarchies of Europe—This examination necessary, because all the monarchies of Europe originated in the Feudal System—It was equally the origin of modern aristocratic governments — Conquest of the Roman Empire of the West by the Northern Barbarians—Condition of the ancient German nations—The Scythians and Huns—The new monarchies established in France, Germany, Italy, Britain, &c.—Distribution of the conquered lands by the several leaders of the invading barbarians, to be held by their followers on condition of military service—The amount or degree of the right of property thus acquired by the latter is matter of dispute —Meaning of the term Feud—Subinfeudation—Allodial lands.

LECTURE IX.

Duties of the Vassal—Allegiance—Services—Commutation for escuage—Late introduction of the right to alienate the feud—In course of time feuds became hereditary—Origin of Relief—Heriots—Fines—Aids—Wardship—Marriage—Other feudal incidents—Division of the inhabitants into freemen and serfs or slaves—Origin of manors—Villeins—Decay and final disappearance of villenage—Consequences of the feudal relation between lord and vassal to the structure of government and society—Limited power of the crown—Exorbitant domination of the barons—Disturbed state of society by warlike practices, rights, and habits—Oppressed and degraded state of the bulk of the people—Origin and early constitution of the legislative, administrative, and judicial powers in the feudal monarchies.

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The tendency of the feudal system to obstruct the progress of civilization—The ferocious manners and dispositions of its founders—The distinction of ranks, and all the other arrangements of society under the feudal system, regulated with a reference to the profession of war—Origin of privileged classes, and of an hereditary nobility—Degrading effects of the feudal distinction of ranks—The tyranny of the nobles in the feudal times—They became, in some kingdoms, the dominant power in the state—The distinction of nobility gradually came to be conferred unaccompanied by a grant of land—Unfortunate impressions which the feudal system has left upon men's habits and modes of thinking in all the countries in which it once flourished—1. General prevalence of tyranny and subserviency through society—2. Superiority of landowners to all other classes—3. Peaceful pursuits discouraged—4. Preference of eldest sons—5. Vanity maintained by titles and names—6. Tendency of submissive habits to promote civilization—7. Idleness tends to introduce refinement—8. Crusades or Pilgrimages produce similar effects—Origin of Chivalry—9. Veneration for antiquity and dislike of innovation—Much of the system still in actual force among ourselves in the right of primogeniture and other particulars—The causes which led to the decline of the feudal system in England and other countries—Resumption of grants by the crown—Encroachments on the barons—Rise of the towns.

LECTURE XI.

The principles of constitutional monarchy—General history of the growth of limited monarchies—Review of circumstances which have prevented the establishment in Europe of forms of government similar to the absolute monarchies of the East—Six great causes of the distinction enumerated—1. Influence of Aristocracy—2. No despotic power ever exerted in a single hand—3. The rise and privileges of the towns—4. No power of taxing exerted to any considerable extent, but the crown was supported by lands—5. Judicial establishments—6. Progress of knowledge and improvement, chiefly from the invention of printing—Retrospect of the progress made by the crown in the different countries of Europe (where its emancipation from the power of the nobles has been effected) in encroaching upon the rights of the people—Circumstances to be noted in the rise of monarchical influence—1. Attraction of the nobility to the court, and alliance with it—2. Disuse of popular assemblies which had been generally established—3. Introduction of regular troops or standing armies in the room of feudal military services—4. Influence of the clergy in favour of the crown—Examination of Montesquieu's three fundamental principles of the three kinds of government; namely, fear in a despotism; honour in a monarchy; and virtue in a republic, (under which term he comprehends aristocracy as well as democracy)—Fallacy of this celebrated doctrine—Montesquieu's work; its general character—Examination of the effects of the monarchical form of government, and of the degree in which it promotes or impedes the ends of all political association—1. The tendency of all monarchy to degenerate into despotism is always to be kept in view throughout this inquiry—Sacrifice of all interests to those of one—Alliance with the nobility only checks monarchy as to that body—3. Monarchical government becomes naturally a warlike power—4. Naturally extravagant in expenditure—5. Affects military power and state—6. Communicates the monarchical form to all subordinate institutions—7. Favours the unequal distribution of private property—8. Promotes the subserviency of all ranks to the court and upper classes—9. Greater unity and vigour of councils and less factious divisions—Advantages of an hereditary over an elective monarchy—Hereditary better than elective monarchy—Best form till the people are fit for self-government—Then a republican government is the best, unless where the long prevalence of mixed and limited monarchy has habituated the people and the institutions to that form.

LECTURE XII.

History of the rise and gradual formation of the old French monarchy, and detailed examination of its constitution.

LECTURE XIII.

History of the formation and constitution of the confederacy of sovereign princes forming the German empire—Federal government; the confederacies or leagues of the states of ancient Greece—Modern changes in the political state of Germany—The Confederation of the Rhine—The constitution of the present Diet—Advantages and inconveniences of such a combination or union of independent sovereignties as formed the old German empire—Origin of the science of public or international law.

LECTURE XIV.

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LECTURE XV.

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PART III.

LECTURE XVI.

The Aristocratic form of Government—This, in most instances, both of ancient and modern times, combined with the Democratic form — Both forms agree in the main feature of having no single chief, and entrusting power to portions of, or the whole of, the people—They therefore differ from each other only in the degree to which the people are admitted to the government of themselves or excluded from it—This difference comprehends the other difference of the manner in which the admission or exclusion of the people at large is effected—The distinguishing feature of ARISTOCRACY is the vesting of supreme power in a certain portion of the community, from entering into which the rest of the state is prevented—A pure aristocracy is where this privileged class holds its rights by hereditary title alone — This has seldom existed: chiefly in some of the small Italian states — Even in most of these it was mingled with some infusion of the democratic principle — Aristocracy would still be the proper term for a government which vested the supreme power in a certain privileged hereditary order, although from time to time, and by certain merits, as services or wealth, access to this order was allowed to the rest of the community, provided this access were difficult, and the new members of the order bore no proportion to the old hereditary body—In proportion as it is pure or approaches to purity, the Aristocratic form becomes the worst of all kinds of government—Failing most in the great end of all government—1. This failure is chiefly owing to its vesting power in irresponsible persons, because a number of hereditary rulers or lawgivers feel hardly any check of individual responsibility—2. It has all the worst evils of a monarchy, namely, the risk of virtues and capacity not being hereditary, without the redeeming quality which countervails the defect in a monarchy, namely, its preventing constant struggles for supreme power and allaying the turbulence of faction—3. It promotes faction, and gives free scope to every kind of selfish propensity, sacrificing the good of the many to the interests of the few—4. It encourages dissoluteness of manners — 5. It vexes, humbles, and annoys the body of the people far more than monarchy, because the tyranny of one person, removed above us and out of our view, is far lighter than that of many, more nearly on our own level and always coming in contact with us—There is hardly any advantage to be set against these great evils, unless it be the encouragement afforded to refinement in the arts and in manners—The like advantage is by no means incompatible with either a monarchy or a republic.

LECTURE XVII.

Constitution and history of the Governments of Venice — Genoa — Lucca, and San Marino—Tuscany—Points of resemblance and of difference in those States —Illustration, from their history, of the general principles before laid down.

LECTURE XVIII.

Mixture of aristocracy in Governments of other kinds—There may be such a predominance of the aristocratic principle that the Government is properly an aristocracy, although a king may be at its head—Instance of Venice and other Italian aristocracies, which had sovereigns at their head with little power, under the name of Doges and Gonfalonieres—Those sovereigns being elective does not make them wear less of a monarchical appearance—Only an appearance; for they had no more real power than if they had been the ministers or officers of the nobles—Hungary is an instance of this—Its constitution and history—Its peculiar connexion with Austria—Poland is another instance, where, however, the king was elective—Great evils of an elective monarchy illustrated by the Polish history—Both in Hungary and Poland the crown had very considerable powers—Consequently these governments come nearer a mixed monarchy and aristocracy than a pure aristocracy like the Italian states.

LECTURE XIX.

Aristocratic principle in other countries—At different times it has prevailed so as to make the monarchical scheme only the apparent and not the real constitution—Example of this in Sweden—Thraldom and impotence of the Crown, and power of the Nobility and Senate—Bad consequences as to domestic government—Still worse as to foreign dependence, through Russian intrigue, which it introduced—Subjection to Russia would soon have become almost as great as in Poland—This influence destroyed and monarchy restored in 1772 by the revolution which Gustavus III. effected—Similar evils of aristocracy in Denmark—Remedied by the Revolution of 1787—Aristocratic principle in England—It forms a very prominent feature in the Constitution—Modifies the Government still more than the Democratic principle does—Its history from the feudal times—Its consequences to the interests of the country—Encouragement of faction—Corruption of the upper classes—Subserviency of the other orders—Misgovernment by the scramble for power and for profit out of the public purse to which the Aristocratic principle affords scope—Principles of policy, from the Restoration to the American War, little attended to, except at and immediately after the Revolution of 1688—For a century parties were united or divided by personal questions connected with the mere scramble for place and profit—Improved feelings and checks to the Aristocratic principle since the American War, and especially since the French Revolution—Crown in the hands of the Aristocratic leaders, that is, a few great families, chiefly owing to the Borough system — Important change effected in 1831-2 by the Reformers—Principle of progressive improvement then established — General conclusion of the Aristocratic principle—Inaccuracy of considering Oligarchy as a separate form of Government—It is hardly even an abuse of the Aristocratic form—It is the natural and inevitable consequence of that form—If a nobility is invested with supreme or nearly supreme power, and is a numerous body, a portion of it must rule for the whole, and this is Oligarchy —If the nobility is so confined in numbers that all can exercise the supreme power, this is an Oligarchy also— An Aristocracy is, in every view, not only a failure to secure the only end of all Government, the promotion of public good at the least possible expense of capital and of liberty, but its very nature makes it the antagonist of this end—In order that Aristocracy may prevail, that object must be defeated.

PART IV.

LECTURE XX.

The Democratic principle—This, in its pure state, implies the exercise of supreme power by the people at large, or by those whom the people at large choose from time to time as rulers—If any right not derived from the people exists, as of hereditary chiefs, or hereditary judges, or hereditary lawgivers, or persons enjoying any power in any way independent of the people, the purity of the Democratic principle is, *pro tanto*, violated —Advantages of the Democratic principle—1. The interests and wishes of all are more likely to be consulted —2. Universal publicity to all the proceedings of Government—3. Strict responsibility of all the servants of the State—4. General promotion of independent spirit —5. Arming the Government with vigour by making the people feel an interest in its proceedings, whether of finance or of war—6. Prevention of faction by making opposition to the Government an offence against the country—7. Cheapness of the national establishments—8. Universal access to the honours and emoluments of the public service—9. Command of all men's talents for the service of the State.—Disadvantages of the Democratic principle—1. Want of vigour and unity in public operations, especially of negociation and war—2. Want of secrecy—3. Shifts which these two defects render necessary, by conferring dictatorial powers occasionally, and by occasional secret debates

—4. Tendency to turbulence and civil war—5. Proneness, first to go to war and then to make prematurely a peace when the pressure is felt: this, however, is often exaggerated, because general discussion of public interests is always favourable to peace—6. The same remark applicable to injustice committed on individuals under the influence of temporary odium or of demagogues—General reflections—No people are fitted for a Republican Government who are not sufficiently improved to be capable of self-government—Republics in ancient times always failed from beginning at the wrong end, and being established among people in a rude state—Two consequences—1. Anarchy ascribed erroneously to the Republican form from inattention to this particular—2. Same remark applicable to the other objection, that a military usurper naturally arises out of a republic, inasmuch as an improved people will not be prone to war or allow a successful general to have the means of enslaving them.

LECTURE XXI.

Few instances till 1775 of the purely democratic principle being established throughout any system of polity—Privileged orders in the ancient republics—Athens—Sparta—Thebes—Greek Colonies in Asia Minor—Rome—Carthage; of which last little is known—Singular anomalies in the Roman Government—It had more of the democratic principle than any of the modern republics before 1775—Athens approached still nearer to it—Italian republics were aristocratic rather than democratic—Dutch United Provinces had something of monarchy and still more of aristocracy in their constitution, but far more of democracy than the Italian republics.

LECTURE XXII.

Republic of the United States of America—Its origin and history—Noble conduct of the Americans in throwing off the yoke—Impolicy and injustice of England—Popular delusion on the subject—Same could not now be repeated—Obstinacy of the king and the court—Subserviency of the parliament—Advantages of colonies in an early stage of commerce—Advantages of separation afterwards—Advantages retained by the mother-country, especially if the separation be effected in a kindly manner—Purely Republican constitution of the United States—Its benefits—Its drawbacks—Vast preponderance of the former—This great experiment has entirely answered because made at the right time—Doubtful if it could have succeeded had not the long war united the people and formed them to habits of self-government—Circumstances which distinguish the people in this country from the Americans, and render a republican government both unsuited to our condition, and of difficult attainment, notwithstanding the similarity of character, habits, and laws with those of America—1. Power and wealth of the aristocracy—2. Institutions of a monarchical form generally prevalent—3. Influence of the clergy, and their devotion to monarchy encouraged by the episcopal constitution—4. Large standing army—5. Great crown patronage—6. Especially large colonial possessions—7. General habits of love and respect towards the sovereign—8. Generally prevailing opinion of monarchy being favourable to our interests and suited to our circumstances — General remark— Some of these circumstances are of a nature to be changed by time and events, and above all by the conduct of the Government — The two last are of this description, and if changed may easily change also the others—All good men should rather wish for the improvement of the monarchy so as to supersede the necessity of a change and make our present constitution be generally preferred, by making it really preferable— Evils of resistance and radical change.

LECTURE XXIII.

French Republic from 1792 to 1800—Chief cause of its failure was the people being unprepared for it— Chief cause of its excesses was the republicans being almost everywhere, except in Paris and one or two large towns, the minority, and being obliged to make up for their weakness by concert, vigour, and intimidation— The invasion of France in 1792, next to the misconduct of the court and the weakness of the king, was the main proximate cause of the republicans being successful, both at home and abroad—The refusal of all reforms, together with the abuses in church and state increasing as the people's knowledge increased, instead of being corrected in time, was the main remote cause of the revolution—Mixed monarchical constitution of 1791 —

Republican constitution of 1792—Vigour of administration in the Revolutionary Committees owing to their being despotisms that wielded the whole power of the state, having the whole resources of both terror and patriotism, without any of the obstructions under which all single despots labour — Directorial government and Councils, 1795—Occasional acts of violence and tyranny —Revolution of 18 Fructidor (Sept. 14, 1797)—Buonaparte's return and usurpation—First consulship—Extinction of the republican government and foundation of an absolute monarchy—General reflections—Consequences of the times of terror in making all men agree to support almost any government rather than run the risk of their recurrence—This sustained Buonaparte in his unpopular wars, his arbitrary proceedings, and even his conscription—Dread of these times of terror, and also of war and conscription, gave power to the restored government, notwithstanding its weakness and vices—Nothing but infatuation touching the constitution, and above all, the press, could have countervailed that feeling and overthrown even Charles X.—History of the French Revolution affords no exception to the general principles already laid down upon republics.

PART V.

LECTURE XXIV.

Mixed forms of government—These have already been incidentally treated of—The structure and functions of our own constitution require further consideration — Compared to the study of Human Anatomy, while the study of foreign constitutions resembles that of Comparative Anatomy—1. As light is thrown upon Human anatomy by studying Comparative, so is light thrown upon the structure and functions of our own constitution by studying those of foreign governments—2. As the study of the Comparative Anatomy of the body, independent of this advantage, leads to the pleasures of scientific contemplation, so does studying the Comparative Anatomy of governments lead to the improvement and the pleasures of political science—3. As Comparative Physical Anatomy enlarges our views of the animal nature and economy, so the Comparative Political Anatomy enlarges our knowledge of human nature—4. As the lessons drawn from Comparative Physical Anatomy impart new views of the dispensation under which the universe is formed, so does Comparative Political Anatomy improve our knowledge of the moral government of the world—Advantages of minutely studying our own form of government, and its practical working as well as its theory—1. As an interesting subject of contemplation —2. As leading to a better knowledge of our duties—3. As giving a better knowledge of our rights—4. As showing how its benefits may best be preserved and its imperfections removed—5. As affording the best security both against the abuses of administration, the encroachments of power, the frauds of party, and the delusions of demagogues and other interested persons—Sources of Constitutional Information—Foundation of all is the positive Law, written and unwritten—This comprehends also the law of Parliament, which is parcel of the law of the land—It comprehends also the Common Law of the constitution, which is not to be found either in statutes or in the orders of either house—Although the institutions of the country are the groundwork of all constitutional knowledge, they are not enough for understanding any government—This remark is peculiarly applicable to the mixed government of this country—History, and especially parliamentary history, is the school in which such knowledge must be acquired, or at least finished—The history of the reign of James I., when the struggle for liberty began; of Charles I. and the Commonwealth, when it was continued; of the Restoration, when it was nearly suspended; and of the Revolution, 1688, when it was resumed and advanced to success, must be minutely and attentively studied—After that the progress of reform since the American Revolution, and the experiments on free government tried there and in France, must be considered.

LECTURE XXV.

The powers, checks, and functions of the three estates in this country—The history of these—Aristocratic government of the feudal times—Gradual rise of the crown and the commons in league against, and upon the ruins of, the Baronial power—Arbitrary and uncertain government of those times—Constant violation and renewal of Magna Charta—Frequent absolute despotism of the Plantagenets and the Tudors—Part borne by the Law and the Church in these struggles—Despotism of Henry VIII. and Elizabeth — Religious matters mixed up with civil in those times, and exerting great influence upon the affairs of the government—Effects of the Reformation favourable to liberty, although its great promoters, Henry VIII. and Elizabeth, felt the checks which it was providing at home, and only were impatient for its assistance in throwing off the foreign yoke of Rome and the heavier thraldom of Priests—Struggles of freedom under James I.—Charles I.—Lord Coke—Selden.

LECTURE XXVI.

Commonwealth — Pym — Hampden — Falkland — Great progress of liberty during the Civil War and under Cromwell—Reaction and fear of renewed turbulence and civil contention rendered it easy and safe for Charles II. to govern arbitrarily — Had he been less indolent and less necessitous through his dissolute manners, he might have seriously injured the cause of freedom—James II.'s bigotry of incalculable advantage to liberty—Justification of the patriots in seeking foreign assistance against a tyrant—History and nature of the Revolution—Extraordinary fact of such a change being brought about with the deliberation of an ordinary legal proceeding, and almost according to the established forms of the constitution—Lord Somers's great merits.

LECTURE XXVII.

The balance of the powers in our constitution is not chimerical—Its practical operation is not only not impossible, but what constantly occurs in almost every community where more than one interest or power are joined in action—Two bodies combining to elect an office-bearer, by one having the veto on the other, is an example of practical check often seen and easily worked—One body acting by its majority where parties are nearly balanced, is another—In all such cases the person, or the plan, which neither would choose if uncontrolled, is preferred—This secures, 1. A greater deliberation in choosing—2. A better selection—3. A greater cordiality in co-operating with the party chosen or executing the measure adopted—Thus, too, the three powers control the movement of the state by each deflecting it towards itself, as two forces acting angularly make a body move in a diagonal direction—Same remark applicable to the parties and their influence in each House—Opposition governing the country as well as ministry—Advantages and abuse of party—The great benefit is that the government always has a party kept together and disciplined by place and pay, and that the people require a counterpoise of the like kind, having nothing to give—Evils of party—1. Its giving government extreme power, by the superaddition of the party power to the government power—2. Its excluding so many men from the direct service of the state—3. Its subjecting many persons to the influence of a few, who will often consult only their own interest—Sacred duty of all men in a free country to form their own opinions, thinking for themselves, and not allowing themselves to be dictated to by the government or by the leaders of parties.

LECTURE XXVIII.

Checks to the crown and the legislature, by—1. Influence of public meetings—2. The press—3. Associations—1. The abuse of public meetings when held too numerously for discussion and for the safety of the peace—Great bodies apt to follow sudden impulses and approve the strongest counsels—2. Uses and abuses of the press—Anonymous and irresponsible writing—3. Associations must always be open and not secret—They combine both the advantages of meetings and of the press.

PART VI.

LECTURE XXIX.

Connexion with the preceding lectures—The structure of government being considered, its functions remain to be examined—These, with the institutions of society, hitherto only mentioned incidentally—The great duty of all government is to afford protection to the people—This is the original design of civil society—In proportion as the people are protected with the least expense to themselves, this end is attained—Expense of protection is twofold, cost in money and cost in abandonment of natural liberty—Government approaches to perfection, that is, attains the ends of its institution, in proportion as it affords full protection to the people at the smallest cost in money and liberty—Protection consists of two branches—1. Security from domestic wrongdoers, or preservation of civil rights—2. Security from foreign enemies—Hence the two great duties of government are the administration of justice and the national defence—I. Judicial establishments comprehend, 1. Preparatory procedure, or police—Police comprehends the measures and the means necessary for preserving the peace of the country—2. Final criminal procedure—3. Civil procedure—Principles regulating these—1. All police service should be in the hands of persons chosen by the qualified persons in each district, and officered by persons whom the government appoints, but irremoveable except for offences proved—Except in great towns, the police service should be performed by the citizens in rotation—Substitutes should be allowed, as in the militia—All police inquiry or judicial police should be in the hands of magistrates appointed by the executive government, and irremoveable except for offences proved—The pay of police service should be levied on the district; the pay of judicial police should be levied from the community at large—2. Judges should be appointed by the executive government, and for life, or only removeable for offences proved—They should be paid by salary, and not by any emoluments derived from any proceedings over the number or costs of which they have any power— They should have no patronage whatever—They should have no seats in the legislature—They should be incapable of holding any other offices or receiving any dignity or power whatever from the executive—They should be incapable of promotion as judges—II. The army must depend upon the measures of defence required—It should be the lowest which the state of foreign relations and the condition of other countries renders possible—Officers and petty officers should be maintained in peace sufficient to provide for the numbers which the exigency of a war may require—The home defence should be intrusted to a militia chosen by rotation, so as to arm all the community in succession—The colonial defence to regulars voluntarily enlisted—No additional troops of any kind should be provided for police purposes, or with a view to quell revolts — This service in every well-governed country may always be confided to the civil power.

LECTURE XXX.

I. Judicial systems of different countries—Ancient judicatures of Greece—Of Rome—Modern—Those of France—Vast number of judges and low salaries a great evil—Germany—Holland—Italy—Portugal and Spain—Eastern nations—Feudal judicatures—Hereditary jurisdiction of those times—England—Scotland—Sale of judicial places in France — Bribing and canvassing of judges in foreign countries—American judicial system.

LECTURE XXXI.

Judicial system of England and Scotland in the present day—Origin of trial by jury—Of division of equity and law—Advantages and defects of the existing system.

LECTURE XXXII.

II. Military policy of the European powers—History of standing armies—Militia of Germany—Systems of Russia—Austria—Prussia—Minor States of Germany—Switzerland—Italy—Spain and Portugal—Sweden—Denmark—Holland—France—England.

LECTURE XXXIII.

General views connected with military policy—Foreign or international policy—Origin and progress of the law of nations—Balance of power—Federal policy and balance of power as known among the states of Greece—Doctrine of, in modern times—Its uses and abuses—The chief benefit has been encouraging defensive leagues and the provident and cautious policy of combining to check aggression—This has often prevented conquest and sometimes war—The chief evil has been the encouragement of a meddling spirit and giving pretexts for war—Severe wars have sometimes been caused by it.

LECTURE XXXIV.

When a Government has well provided for police, justice, and defence, it has no other absolutely imperative duty—Almost all that remains may be left to the interests and exertions of individuals—More harm than good has in all countries been done, and at all times, by government overstepping its proper bounds and interfering with industry—This interference is in almost all circumstances particularly prejudicial—1. It often interferes with natural rights—2. It forces or seduces capital and labour into unprofitable channels—3. It expends the national resources unprofitably—4. It is liable to abuse from partiality and corruption—Though there are some few things which government should interfere in, if the balance were struck, the effects of interference would be found far less beneficial than the very interference has proved hurtful—Illustrations from the history of the Mercantile System and the effects of Bounties, Duties, and Companies—Leading maxim—A government is always the least accurate, least judicious, and most corruptible farmer, trader, and manufacturer—Next to a government, this character applies most to a Joint Stock Company—Joint Stock Companies with privileges bad in proportion to the extent of them—Such companies with monopoly, nuisances.

LECTURE XXXV.

Some things in which Government may safely interfere—Some which the public good requires that it should take charge of—1. Public works are highly expedient and often necessary, but no individual can undertake them—Joint Stock Companies may often perform them—Of this kind are roads, docks, and canals—Harbours and quays may be formed by government, but also by companies—2. Hospitals are of the same class, but these are very liable to be abused, both in the kind of institution and in the administration—Foundling hospitals a nuisance in every case—So are all establishments for supporting the poor as of right, unless these be taken by way of escape or transition from a still worse system—

Tendency of all bad plans of this kind to stimulate population by encouraging improvident marriages, and to relax the industrious, thrifty, and provident habits of the working classes—Houses of refuge for sick and hurt, or for orphans, or for aged and other impotent poor, not liable to the like censure—3. Establishments for public instruction are of the class adapted to Government management—But care must be taken to exclude abuse and oppression—The principle which suits the supply to the demand has not its usual free scope here, because the want of instruction produces an ignorance of, or indifference to, its advantages—Care must especially be taken, in forming a National System of Education, to leave it free—This freedom implies two particulars: first, that no test, or anything in the nature of an exclusive principle, shall be allowed; secondly, that the Government shall not interfere in directing anything but the elements of education, and not in dictating the opinions taught—4. Religious establishments—Arguments for these—1. Supplying spiritual instruction to the poor.—2. Preventing splitting into innumerable sects—3. Checking the growth of fanaticism, which arises from competition—4. Preventing the injury to religion and morals which must arise from the teacher being dependent on his flock, afraid to offend them, cramped in teaching them, and induced to follow their humours—Arguments against such establishments, and for the voluntary principle—1. This want may be supplied, like others, by individual exertion, and by charity where that fails—2. The variety of opinions is wholesome, indicating as it does the freedom of inquiry and general pursuit of truth—3. Enthusiasm and fanaticism will cure themselves if left alone, because truth must prevail, and truth is never found in extremes either of thinking or feeling—4. The improved sense and knowledge of the people will effectually check the disposition to reject unpalatable doctrine, and an honest teacher will be preferred to an unfaithful and time-serving one—5. Quietism and indolence the effects of endowment—6. Perversion of an endowed church to support a party in the state—7. Difficulty of having an establishment without oppression and intolerance to sects—8. Necessary consequence of an establishment that whoever dissents has to pay for his own church and the endowed one too, unless there are public funds possessed by the former, and even then the sectaries pay indirectly—General conclusion, that if there is to be an establishment, it must very carefully be kept from all privileges which are not absolutely necessary to its existence, and be carefully watched in practice.

LECTURE XXXVI.

Proceedings of different governments in regard to public works and national institutions—Establishments for education in Germany—Switzerland—Holland—Belgium—France—America—Spain and Portugal—Northern kingdoms—Italy.

LECTURE XXXVII.

Religious establishments in different countries—Influence of the Catholic religion in former times—Great difference in this respect now—Rise of the monastic institutions — Some benefit conferred by them on literature, science, and education in the earlier ages—Prodigious benefits of the Reformation.

LECTURE XXXVIII.

Same subject continued—Established Church in Italy—Germany—France—Holland—Northern countries—Eastern despotism — Voluntary church in America—England—Scotland—Ireland.

LECTURE XXXIX.

Manner of supporting institutions for education and religion—Endowments for teachers of learning must be small that they may depend on their labours—Moderate endowments for religious teachers—History of tithes—Injurious to Agriculture—Injurious to religion and peace — Stipendiary system — Illustrations from Scotland — America — Ireland — English universities —Irish—Scotch—French.

LECTURE XL.

Cases of Government interfering with the employment of capital and labour—These comprise the history of the greatest errors committed by Government, where the intention was good—They have also led to the other and worse class of political errors—The greatest of these are conquest and war where the motive is bad—History of the Mercantile System—Its fundamental principle erroneous, though naturally arising from the representatives of wealth or medium of exchange being mistaken for wealth—That principle is, that the multiplication of the precious metals is the increase of national wealth—The encouragement of exportation, and discouragement of importation, became hence the main object of those political economists—This doctrine of the balance of trade illustrated and its absurdity proved —1. No benefit whatever arises from having more gold and silver in any country than is required for performing the exchanges of that country—2. No possibility exists of obtaining, unless by forcible means, for any country a greater amount of those metals than the natural demands of its circulation require, and its resources enable it to procure—3. But more may be accumulated in any country than the wants of its commerce require by rejecting the helps of paper circulation—Effects of the errors of the Mercantile System in producing bad legislation, and both fettering human liberty, and making industry and capital less productive than they naturally would be—Bad laws arising from this system still in existence after the erroneous theory has been abandoned.

LECTURE XLI.

Encouragement and forcing of trade in particular branches, the great error of the Mercantile System, illustrated by the grants made of exclusive privileges—These are chiefly of two kinds, the restraints imposed on foreigners by corporations, and the monopolies given to trading bodies—The former are of ancient date, and have proceeded not only from false views of economical science, but from the wish to favour the towns as a politic measure of the Crown against the Aristocracy—The latter always have proceeded from erroneous views of political economy—Illustrations of the errors thus committed by the history of trading companies in England, Holland, and France—General inference—Joint Stock Companies hurtful wherever they are not necessary to carry on some public work beyond the reach of individuals—Even then liable to great abuse, and require much guard and control—Monopoly ought never on any account to be given to them.

LECTURE XLII.

Errors respecting Population adopted by the professors of the Mercantile System—Policy of rulers for increasing their power at home and extending their dominions, acted generally in the same direction in order to facilitate the raising of armies—Means employed to stimulate population—The true principle of population first stated by Townsend in his Spanish Travels—First systematically unfolded by Mr. Malthus—His doctrine usually adopted—Popular errors propagated respecting it—Gross injustice done to that eminent philosopher—Operation of the Poor Laws upon population—Doctrine respecting a provision for the poor—It must on no account be one which any person can reckon upon as his right, else it will encourage idleness and profligacy, and give rise to improvident marriages—Public charities, in proportion as they approach to such a provision, are hurtful—Some bear more particularly than others on population—Foundling Hospitals the worst, and now regarded in the light of public nuisances—Encourage child-murder, to prevent which they were instituted—Necessary operation of such institutions in thus stimulating population and producing crime — Other establishments for supporting children tend to stimulate population, though less hurtful to public morals—Illustration of the subjects of Population and Charity from the history of the English Poor Laws.

LECTURE XLIII.

History of the Mercantile System concluded—Its arguments refuted and its doctrines abandoned above half a century ago—Great merits of the French Economists, and of Adam Smith in this country—The French Economical system went into the other extreme—Merits of Quesnay and Mirabeau (the Elder) lessened by their exaggerations and by their obscure style—Outline of that system—Its errors in theory—The error of supposing all Labour Unproductive except agricultural—They who maintain that agriculture alone adds to wealth forget that the manufacturer who makes a machine of wood or iron gives it more value, as much as the farmer who converts one ear of wheat into twenty—They also forget that the two processes are conducted precisely alike, namely, by man calling to his aid the powers of nature and properties of matter—Illustration of this argument by comparing the distilling with the growing of grain—A. Smith and others draw the line between Productive and Unproductive Labour at a different part of the scale—Their error in holding that the labour of the manufacturer differs in kind from that of the soldier, ruler, and judge—Both kinds are productive, and the only difference is that one is bestowed on particular portions of stock and the other on the whole—In society it is impossible to say who clothes, or feeds, or defends the community, the division of labour distributing these functions among the whole—Consequent errors of the dispute respecting Productive and Unproductive Labour—Practical errors of the Economical System far less hurtful than those of the Mercantile—Chief one is that of holding that all taxes should be abandoned except the Contribution Fonciere or land-tax—Errors of this—1. The repartition or distribution is by no means possible to the extent required—2. If it were, the variety of modes of collecting is to be preferred as lightening the pressure of its incidence.

LECTURE XLIV.

The practical errors of the Mercantile System are far greater—All the legislation of the world has been infected by them—Restraints upon commerce are injurious because—1. Contrary to liberty—2. Force capital and labour into channels necessarily less profitable, otherwise no force would be required to make them be chosen—3. Abuses of every kind fostered by such regulations as these restraints require — 4. Their machinery always must be expensive — Where force has not been used inducements have been held out—These are liable to all the same objections except the first. They are also liable to this in addition, that they operate by a greater outlay of the national capital in bounties and other instruments of encouragement—Mercantile System and its consequences illustrated by the history of the Corn Laws.

LECTURE XLV.

The general conclusion from the whole is against the interference of Government with industry and capital—This principle almost universally acknowledged by both speculative and practical politicians, but very little acted on—Illustrations of this from the fetters still left everywhere on trade, and the miserable result of these in stunting the commerce of the countries best fitted by nature to be each other's customers—Some instances of beneficial interference—1. The public authority must make and preserve the Coin of the country—Principles which regulate the Circulating Medium—Course of Foreign Exchange—Expense of a merely metallic circulation—Use and abuse of Paper Currency—As long as it is payable on demand, and thus convertible into specie, it never can be superabundant—Effects of a currency not thus convertible in raising the Market price above the Mint price of the precious metals—Exportation of gold thus occasioned—All prices fluctuate in consequence of the depreciation—Illustration from the history of the English Bank stoppage in 1797, and down to the resumption of cash payments in 1819—2. Public works must often be carried on by Government, as roads, canals, buildings—In wealthy countries this can be done by means of Joint Stock Companies—3. Foreign settlements, and the emigration connected with their establishment and support, most frequently a work of the Government—Use of Colonies in the infancy of trade and manufactures—They greatly encourage these, and eventually promote domestic agriculture also—If one country, or set of countries, founded colonies and suffered all others to trade freely with them, only paying a reasonable sum to defray the cost incurred by the establishment of the colonies, it would be unnecessary and inexpedient in others to pursue a like plan—This too would be more beneficial to the colonies themselves and their parent states — It would be most profitable to the former, and would best and most cheaply preserve the dominion of the latter—The policy of all nations that have founded colonies has been different; they have not merely reimbursed their original outlay, but monopolized the whole colonial trade—Hence other nations, which would not naturally have founded colonies, have been drawn into doing so as the only means of extending their commerce—After a colony has grown to a certain size, its separation becomes inevitable—To this event nations should look forward, and so govern as to lay the foundations of an amicable intercourse when the colonial independence is established—Circumstances of laws, language, and institutions, which tend to secure a preference to the Mother Country in trade with its

Colonies after these become independent—In the more advanced stages of commercial, manufacturing, and agricultural industry, colonies become unnecessary, and a state may trust to the ordinary principles of dealing for a sufficient share of trade with the independent settlement—This free intercourse is much more profitable to both; and the mother country saves the expense of government and defence, as well as avoids the constitutional evils resulting from great patronage.

APPENDIX III.—*Continued.*

MECHANICS.

Note.—The references in the following syllabus of Lectures have been principally confined to the two volumes of "Natural Philosophy," published by the Society, and to Webster's "Elements of Physics," as these works are within the means of every Lecturer. But no one who has the opportunity ought to omit consulting many other works, such as Young's "Lectures;" Herschel's "Introduction to the Study of Natural Philosophy;" Arnott's "Physics;" Whewell's, Prout's, and Bell's "Bridgewater Treatises;" Whewell's "First Principles of Mechanics;" Moseley's "Applications of Mechanics to the Arts;" Gregory's "Mechanics;" Robison's "Mechanical Philosophy," &c. &c.; and many others, the titles of which will be found in Appendix, &c.

LECTURE I.

INTRODUCTORY.

1. The science of Mechanics or Mechanical Philosophy has for its object the laws of the equilibrium and motion of matter, and their practical applications.

Mechanical Philosophy may be considered as co-extensive with Physics, that is, as concerned with the laws of all the sensible changes to which matter is subject, and of all the mutual actions which are going on around us. It is, however, generally limited to the laws of the state of rest and of motion of bodies subject to external forces.

2. The term law is the rule which expresses the phenomena or facts of the particular case.

That forces having a particular relation to the arms of a lever will balance or be at rest—that all bodies falling from the same height will acquire the same velocity—are laws of mechanics; that fluids transmit a pressure equally in all directions is a law of hydrostatics; that light, in passing through certain media, is separated into seven primary colours, is a law of optics; that the periods of the revolutions of the planets have a certain fixed and invariable relation to the diameter of their orbits, is a law of physical astronomy.

See Whewell's *Bridgewater Treatise*, pp. 7 and 301.

3. The bodies around us are supposed to be composed of matter, every portion of which possesses extension and impenetrability.

The notions of extension or space, and of impenetrability, are among our earliest mental conceptions; they appear to arise from the consciousness of efforts exerted and resisted.

4. The idea of motion is suggested to us on all sides, and is invariably associated with that of force as the cause producing and modifying motion.

See Webster's *Elements of Physics*, Arts. 4—6.

5. Matter exists in the three states of solid, liquid, and gaseous, according to the relations of the internal forces by which the elementary particles are acted on; the two latter states are generally included under the term fluid.

At present we have to deal with matter in its solid state, and with the relation of the external forces to which it is subject; the change of state as due to heat belonging to another department of physics.

6. Body or matter, being that which is extended, may be conceived divisible without limit, the instruments of division being mathematical points or lines; but it is not really divisible beyond certain ultimate molecules or atoms.

In the manufacture of gilt wire for the purpose of embroidery, in the propagation of scents, in the solution of metals in acids, and in the generation of plants and animalculæ, we have evidence of a division of matter of incredible minuteness.

See Prout's *Bridgewater Treatise*, p. 24.

The hypothesis that matter consists of ultimate particles or atoms, which are infinitely hard and indivisible, rests on mathematical evidence, and on the researches of modern chemists.

See Thompson's *Chemistry*.
Turner's *Chemistry*.

7. The elementary particles or ultimate atoms of solid bodies are kept together by attraction; this attraction betwixt the particles of the same substance being termed cohesion, and betwixt the particles of different substances adhesion.

The particles of a piece of granite or glass, or of a drop of water, are said to cohere together, but a drop of water is said to adhere to a piece of glass or other substance.

This attraction or influence of the forces of cohesion and of adhesion takes place only at insensible distances, and must be carefully distinguished from that general attraction which takes place at all distances, and which is called the attraction of gravitation, and is referred to the force of gravity.

These forces are called molecular forces; to them are referred the phenomena of crystallization and of the various states of matter; the evidence on which these hypotheses rest is mathematical of the highest kind; and is in the present aspect of science most intimately connected with the theories of light and capillary attraction

Hardness, toughness malleability, ductility, and other properties of solid bodies, may be considered as modifications of the force of cohesion.

8. All bodies, if unsustained, descend in straight lines towards the surface of the earth, and the force which must be exerted to sustain them is called their weight.

This weight, or the pressure which any body exerts upon that which supports it, may be referred to the force of gravity acting on each elementary particle, and urging it in a direction perpendicular to the surface of still water.

All bodies do not fall at the same rate in air, because of its resistance, but in vacuo every body would fall $16\frac{1}{10}$ feet the first second, twice that distance the next second, and so on. The whole space described from the commencement of the motion is as the square of the time.

The general laws of gravity are derived by calculation from observations on the pendulum and motions of the heavenly bodies. See *Physics*, Chap. V.

The laws may be verified by Attwood's machine.
See *NAT. PHIL. Mech.*, Treat. I. Art. 37.

9. Statical force or pressure is measured by weight.

Weight is a universal and invariable property of matter, and the evidence of the influence of gravity pervading everywhere. In consequence of this universality and invariability it may serve as a standard of reference, and a measure of force. Without such a common standard no true comparison could be established betwixt different forces.

The unit of weight used for civil and commercial purposes is the measure of forces in mechanical science.

10. The advantages resulting to the individual and to the nation from a widely-extended culture of mechanical science are great.

The ruin in which many ingenious men have been involved would have been entirely avoided by the knowledge of a few simple principles. The absurd schemes for perpetual motion would never have been projected.

The study of mechanical philosophy has all the charms of an exact science, added to the interest which must be derived from observing the practical applications of the laws in the dominion and control of matter.

England, moreover, being peculiarly a manufacturing country, must look to the improvements in its machinery for the continuance of its prosperity.

The advantages resulting from machinery and manufactures may be referred to the following sources:—The addition to human power; the economy of human time; the conversion of substances apparently common and worthless into valuable products.

See Babbage on *Economy of Machinery and Manufactures*, Chap. I.
See *Results of Machinery*.

Article 8. An air-pump is necessary to show the falling of all bodies with equal velocities in vacuo; and air-pumps are usually provided with an apparatus termed a guinea and feather apparatus for this experiment. The expensive part of this apparatus is the tall glass tube, which costs from 5*s*. to 50*s*. The other part for allowing the light and heavy substance to fall at the same instant, costs from 10*s*. 6*d*. to 32*s*. 6*d*.; but this may be effected by much more simple means, as for instance, by a piece of wire passing through the arm of the jar and carrying a small stage.

Mr. Attwood's machine, in its simplest form, consists of two equal weights connected by a string and hung over a light wheel a vertical rod, on which feet and inches are marked, and to which a movable stand may be fixed by a screw at different heights; a common Dutch clock, or simple seconds pendulum, to mark the time. The method of using this apparatus is fully described in the Treatise on Mechanics, Article 37. A small light apparatus may be had for 3*l.* 3*s.*, but one completely fitted up, with friction wheels, will cost from 13*l.* to 20*l.*

LECTURE II.

GENERAL PRINCIPLES OF EQUILIBRIUM.

11. WHEN a body is at rest, the forces to which it is subject are in equilibrium with each other.

A body acted on by a single force could not be at rest, but would move in the direction of that force's action. A body suspended by a string is at rest because its weight is counteracted by the point of support. There may be no fixed point or immoveable support against which the body is supported, as when a body floats in a fluid; but here the weight of the body is counteracted by particular pressures, so that the body is supported or at rest because all the forces are in equilibrium with each other.

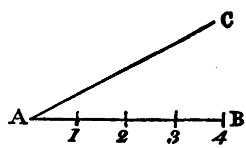
12. Action and reaction are equal and opposite.

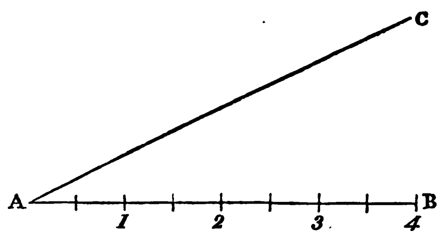
The pressure produced by a hand against any obstacle, or the action, must be counterbalanced by an equal force in the opposite direction, which is termed the reaction.

It is convenient to distinguish between these two forces.

13. Forces may be represented in magnitude and direction by lines.

Force is measured by weight (Art. 9), but we require to know the direction of a force as well as its magnitude. If a portion of line be supposed to represent a force which is measured by 1 lb., then a line double the length would represent a force which would be measured by 2 lbs., and so on. The length of the portion of line representing the unit of force is immaterial, provided the same length is added for every unit.





Suppose that there are two forces of 6 lbs. each applied in the different directions, as A B and A C to the point A. These may be represented either as in Fig. 1 or Fig. 2, the lines in the latter being double those in the former, but then the units of length, the *assumed* representation of the unit of force, is also double in the latter case.

14. A force may be applied or conceived to be applied at any point of its direction.

In pulling at a rod, or by a rope, the force exerted is the same at whatever distance from the obstacle it is exerted. Thus, if a weight be suspended by a string, the force with which the string is stretched is the same at every point.

The above is included in the general principle of the transmission of force, which is an important physical principle. By this, any forces in the same plane, whose directions are not parallel, may be transferred to some point of their direction and made to act at a point.

15. Two or more forces acting at the same point may be compounded into a single force, and this single force is termed the resultant.

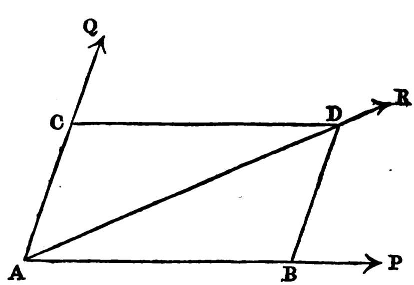
If two forces acting at the same point be equal in magnitude and opposite in direction, they counteract each other, or their resultant is nothing. But generally the effect produced by several forces acting at a point may be produced by a single force. Thus a boat, drawn along by several forces applied to ropes having different directions, might be drawn along by a single force applied to a rope having some particular direction.

When several forces act on a body at rest we may conceive any one of these forces as counteracting or being in equilibrium with all the rest. This force would be equal in magnitude and opposite in direction to the resultant of the other forces.

16. One force may be resolved into several forces acting at the same point.

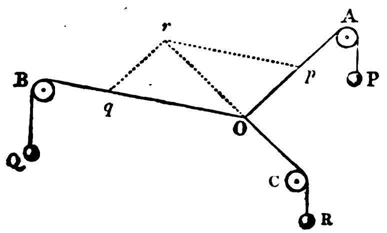
This is the converse of the preceding proposition. Thus it appears that several forces may be compounded into one resultant, or one force may be resolved into several components.

17. If two forces acting on a point be represented in magnitude and direction by two lines, their resultant will be represented in magnitude and direction by the diagonal of the parallelogram of which the sides represent the component forces.



This is the rule by which forces may be compounded or resolved. Let A B, A C, represent in magnitude the two forces P and Q applied at the point A; then, completing the parallelogram, the diagonal A D will represent in magnitude and direction their resultant R. Conversely, let A D represent in magnitude any force R; then, drawing any two lines, A P, A Q, and from D drawing lines parallel to them, the parts A B, A C, represent the component forces P Q, into which R has been resolved.

18. The preceding laws of the composition and resolution of forces may be verified and illustrated in a simple manner.



Let O be a point to which three strings are attached, and let these strings pass over small wheels, A, B, C, fixed against a vertical board, as represented in the figure. To the end of these strings let weights, P, Q, R, be attached. Then we shall have three forces, P, Q, R, applied at the point O, in the direction of these strings. Let P, Q be considered the component forces, and R the resultant force. Then O C will be in the direction of the diagonal of the parallelogram, of which O A, O B, are the sides; let O *p* represent in magnitude the force P; and on the same scale O*q* represent the force Q; then, completing parallelogram O *r*, will represent in magnitude the force R.

See *Mech.*, Treat. I., Arts. 9—11.

The action of the wind on the sails of a vessel, by which the resistance of the water is overcome; of the bird's wings on the air; of the rower; and of the swimmer; furnish instances of the composition and resolution of forces.

19. If three forces, represented in direction and magnitude by the three sides of a triangle, taken in order, act on a point, they will keep it at rest.

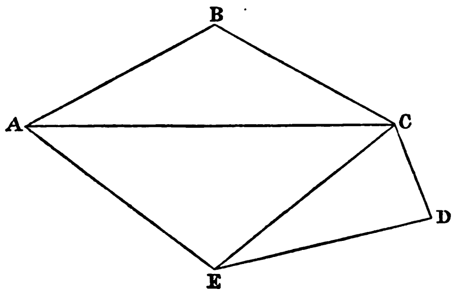
In the preceding proposition (Art. 18) there are three forces, P, Q, R, represented by the three lines, O *p*, O *q*, O *r*. Now *p r* may represent O *q*, being parallel and equal to it. The three forces then represented by O *p*, *p r*, *r* O, the sides of a triangle taken in order, applied to the point O, keep it at rest.

Also the third side of any triangle whose other two sides thus represent two forces, represents a force equivalent to the other two.

20. If any number of forces represented in magnitude and direction by the sides of a polygon, taken in order, act at the same time upon a body at rest, they will keep it at rest.

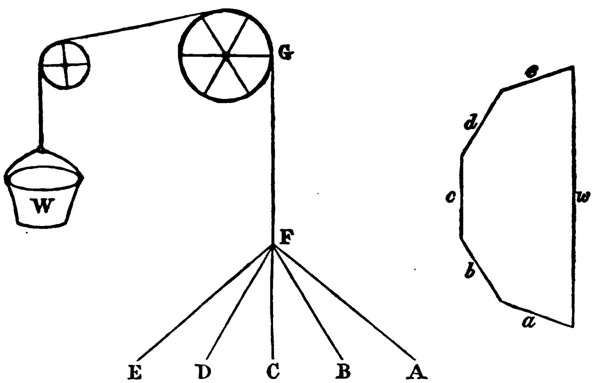
Let AB, BC, CD, DE, EA, represent the forces.

Then by Art. 19, AB, BC, are equivalent to CA; CA, AE, to EC; and EC, CD, to DE. But a point acted on by forces EC, CD, DE, will be at rest; hence a point acted on by the forces represented by the sides of a polygon taken in order will also be at rest.



Instances of the application of several forces which would be represented by the sides of a polygon are common, as where several men pull simultaneously to raise the weight or monkey in pile-driving, and to raise the basket of coals in unloading colliers.

Suppose that five men, whose pulls are exerted at A, B, C, D, E, the ends of ropes uniting at F in a common point, raise a weight W by the rope F G passing over wheels. Let any line as *w* be drawn parallel to F G, representing the force exerted by the weight W in magnitude and direction. Then if, on the same scale, lines *a*, *b*, *c*, *d*, *e*, be drawn parallel to AF, BF, CF, DF, EF, these will form a polygon.



21. Parallel forces have a resultant equal to their sum or difference, according as their directions are the same or different.

The forces hitherto spoken of are oblique forces, that is, forces whose directions are inclined to each other.

When two forces are parallel, equal, and act in opposite directions, there is no single resultant. Such forces are said to constitute a *couple*, and their tendency is to twist a body about some axis. The magnetic forces to which two ends of a needle are subject are parallel, equal, and opposite in direction; the needle consequently turns about its centre.

See *Physics*, Arts. 22, 288.

The forces of gravity are parallel forces, and the centre of gravity is the point of application of the resultant of these forces.

See *Mech.*, Treat. I., Arts. 40—45.
Physics, Arts. 46—49.

22. The centre of parallel forces is the point of application of the resultant of all the parallel forces to which the body is subject.

This point possesses some remarkable properties, which are fully treated in mathematical treatises on mechanical philosophy.

See Whewell's *Mechanics*.
Gregory's *Mechanics*.

Articles 13, &c. The lecturer will find a large black board, on which he can draw the diagrams of a suitable size, extremely convenient for illustrating this and the following articles.

Articles 17—20. Forces may be made to act in any direction by strings passing across wheels fixed to a vertical board and fastened together at one end, and having weights at the other end. The laws of the equilibrium of any forces in the same plane may thus be verified at an exceedingly small cost.

LECTURE III.

SIMPLE MACHINES, OR MECHANICAL POWERS.

23. Any instrument or contrivance designed for the modification of force, as for the transfer of force exerted at one point to another point, or for causing a force which acts in one direction and in one manner at one point to act in a different direction and a different manner at another point, is a machine.

The simple machines or mechanical powers are six in number—the lever, the wheel and axle, the pulley, the inclined plane, the wedge, and the screw. These are the elements of all machines, however complicated.

See *Mech.*, Treat. II., Arts. 1—6.

In treating of machines, two terms are introduced to distinguish between the forces applied, namely, the power, and weight or resistance. The term power is applied to that force whose action or direction is to be changed and modified by the machine; the term weight or resistance to the obstacle which is to be overcome, or the work to be done. See *Physics*, Art. 24.

The road is a sort of machine; also the coach, the cart, the ship, the barge, the locomotive engine and railway.

THE LEVER

24. A lever, in its simplest form, is a beam or rod, sustained at one point against an immoveable obstacle, termed the fulcrum, and having forces applied at two other points.

There are three kinds of levers according to the relative positions of these three points.

Any solid body, having a fixed axle about which it is capable of moving, may be considered as a lever.

Mech., Treat. II., Art. 7.

25. A lever is said to be of the first kind when the power and the weight are on opposite sides of the fulcrum.

The following are examples of a lever of the first kind:—A poker, employed to lift the coals; the bar of the grate being the fulcrum, the force exerted by the hand the power, and the coals lifted the weight or resistance. A handspike, a crowbar, a claw-hammer for drawing nails; the point against which the head of the hammer rests being the fulcrum.

Common scissors, pincers, forceps, snuffers, are double levers of this kind; the hinge or pin being the fulcrum, and the force applied by the fingers the power.

The scale-beam of a common balance is a lever, with equal arms. When these arms are unequal, the balance is false. If the counterpoise to the same weight be ascertained at each end of a false balance, the sum of the two counterpoises will be more than twice the weight.

Bent lever-balance, carriage-wheel.

See *Mech.*, Treat. II., Arts. 47, 48.

26. A lever is said to be of the second kind when the power is on the same side of the fulcrum as the weight, but further from the fulcrum; that is, the weight between the point of application of the power and the fulcrum.

The following are examples :—

The common wheelbarrow: the axis of the wheel is the fulcrum, and the load carried, or the weight, between it and the handle, the point of application of the power.

The oar: the water against the blade of the oar is the fulcrum, and the resistance of the water to the boat the weight.

A stock-knife, and a chaff-knife.

A handspike, when the end is lifted up in order to raise a weight.

A pole, on which two persons carry a load, as the pole of a sedan-chair: each person is a fulcrum to the other. The bar, by which two horses draw a plough.

A pair of nut-crackers is a double lever of this kind.

27. A lever is said to be of the third kind when the

power is on the same side of the fulcrum as the weight, but nearer to the fulcrum; that is, when the power is between the fulcrum and the weight.

The following are examples:—

The common fire-tongs: the pivot is the fulcrum, the force exerted by the fingers the power, and the force with which the substance is grasped the weight or resistance.

In a pair of shears, for shearing sheep, the fulcrum is at the centre of the elastic spring, at the back. In the treadle of the common turning-lathe, the end resting on the ground is the fulcrum, the force exerted by the foot the power.

In opening or shutting a gate, the hand pushing near the hinge, there is the same relation of forces as in a lever of this kind.

The limbs of animals furnish many instances of the application of this kind of lever.

See *Animal Mechanics*, Chap. VI.

28. By levers of the first and second kind the force of an agent is increased; that is, the resistance overcome, or the weight raised, is greater than the power, or applied force; by a lever of the third kind the resistance overcome, or the weight raised, is less than the force exerted.

Levers of the first and second kind are sometimes called *gaining* levers; those of the third kind, *losing* levers; these terms are correct, as applied to the magnitude of the force which is transmitted.

29. A lever will be at rest when the forces applied to it, that is, the power and the weight, are to each other inversely as the lengths of the perpendiculars, or the directions of the forces.

When the lever is a straight rod, and the forces act in a direction perpendicular to it, the arms of the lever will be at once seen to have this proportion to the power and the weight.

Mech., Treat. II., Arts 13—25.

When several levers are employed, so as to constitute a compound lever, a similar relation will exist between the power and the weight when there is equilibrium.

The common weighing machine, used on turnpike-roads, furnishes an instructive example of the combination of levers.

Mech., Treat. II., Arts. 26—31.

30. In the application of every combination of lever, the space through which the power moves is as many times *greater* or *less* than the space through which the weight moves as the power is *less* or *greater* than the weight.

Thus the product of the power into the space through which it moves is equal to the product of the weight into the space through which it moves. In drawing a nail with a claw-hammer, a hand which could not exert a direct force of more than fifty pounds may exert at the nail a force of a ton. In this case the hand will have moved through *thirty-two* times the space the nail has moved through. This is generally stated as follows:—What is gained in force is lost in velocity, or conversely.

The power of an agent is the product of the force the agent can exert into the space through which it can be exerted; no power consequently is created by a system of levers, or by any mechanical contrivance whatever.

See *Physics*, Art. 26.

31. The lever, in its various combinations, is a most common element of complex machinery.

The common balance, the steelyard, the weighing-machine, and the printing press, are instructive examples of its application.

Mech., Treat. II., Chap. V.

A good balance must have the three following properties:—1st. It must rest in an horizontal position when unloaded. This is insured by the arms being straight, and in every respect similar. 2nd. It must have great sensibility; that is, a small weight in either scale should make the beam move sensibly from the horizontal position. The sensibility is improved by increasing the length of the arms, by diminishing the distance between the point of suspension and the centre of gravity of the balance; and as the weights with which the balance is loaded are less. 3rd. It must possess great stability; that is, when disturbed return quickly to a state of rest. This is improved by lengthening the arms of the balance, and increasing the distance between the point of suspension and the centre of gravity of the balance. Thus the lengthening of the arms increases both the sensibility and the stability.

Mech., Treat. II., Arts. 32—42.

The Stanhope printing-press furnishes a good illustration of the great force which may be obtained by the intervention of a series of bent levers; the types are pressed to the paper with an enormous pressure.

THE WHEEL AND AXLE.

32. The wheel and axle consists of a wheel having a cylinder or axle passing through its centre. The power is applied to the circumference of the wheel, and the weight to the circumference of this cylinder, or of the axle; and, when there is equilibrium, the power is to the weight as the radius of the axle to the radius of the wheel.

This machine, which is a modification of the lever, furnishes a means of applying forces through a great space continually in the same direction. The radii of the axle and wheel, to the extremities of which the weight and power are applied, may be considered as constituting a lever of the first kind.

If the power act not at the circumference of the wheel, but at the extremity of a handspike or bar inserted into the wheel, the distance of that extremity from the centre is to be taken as the radius of the wheel.

The windlass, the capstan, the tread-wheel, for rendering animal power available, the fuzee of watches, the crank with two axles, are modifications of the wheel and axle adapted to particular circumstances.
Mech., Treat. II., Arts. 49—60.

The combinations of wheel-work so useful in mechanics are generally referable to the wheel and axle, though the wheels and axles have frequently a different axis of motion. The motion is communicated by belts or straps passing over the circumferences of both, or by teeth cut in the surfaces and working into each other. When straps or belts are employed, the communication of motion is by the friction of the surfaces. This method has peculiar advantages in some manufactures, as the belt or strap can slip round on any sudden impediment occurring to the motion of any part of the machinery.

The most usual method of transmitting motion is by toothed wheels. It is usual to call a smaller wheel, acted on by a large one, a pinion, and its teeth the leaves of the pinion. Sometimes the smaller wheel is a cylinder, in which the top and bottom are formed by circular plates, or boards, connected by staves inserted at equal distances along their circumferences, serving as teeth; this is called a lantern. There are many modifications of shape and number to which particular names are assigned. *Mech.*, Treat. II., Art. 70.

Toothed wheels are frequently used for changing the direction of the motion, and are called crown, or bevilled wheels. The universal joint is used for a similar purpose. Toothed wheels are employed not only for modifying motion, by increasing and diminishing velocity, but for producing motions, that shall recur with great precision, and have given ratios to one another. In clock-work, for example, one wheel may be required to turn several hundred times while another turns once.

33. The number of teeth in each of two wheels should be prime to each other, so that the same teeth may not be in action each revolution.

This is effected by the hunting cog, as it is technically called; the inequalities of wear arising from inequalities of form and material will thus compensate each other. *Mech.*, Treat. II., Art. 38.

34. The teeth of wheels should be of a shape such hat each tooth of the driving wheel may press in a direction perpendicular to the radius of the wheel which is driven, and that the line which is perpendicular to both teeth at the point of contact may pass continually through the same point of the line which joins the centres of the wheels.

Teeth are commonly made with the lower part in a straight line in the direction of the radius, and the upper a portion of an epicycloid. An equable motion is thus secured.

See *Mech.*, Treat. II. Art. 67.
Camus *On the Teeth of Wheels.*

See Young's *Nat. Phil.*, Lect. XV.
Willis *On the Teeth of Wheels; Transactions of the Institution of Civil Engineers*, Vol. II.

Articles 24—26. For the illustrations of the lever nothing is requisite but a straight rod pierced with holes; the rod may be hung on a pin inserted into a vertical board through one of those holes, and forces applied (by weights attached to strings across wheels) in any required direction. Bent levers, having their arms inclined at any angle, may be made by two such rods fastened together by a common thumb-screw. Any combination of levers may be made in a similar manner.

Article 31. A stick of deal, with the blade of a penknife stuck transversely through it, the edges resting on two pieces of thermometer-tube, will furnish the beam of a balance of simple construction, with which the properties of the balance may be illustrated. In all cases in which accuracy is required, the body to be weighed should be put in one scale and counterpoised; then being taken away, its place should be filled by such weights as will exactly balance the counterpoise.

Article 32. The illustrations of the wheel and axle would require wheels of different diameters, made to stick on a cylinder, or axis, and having weights attached to strings at their circumference; or one wheel, with grooves or projections of different diameters, would be sufficient.

LECTURE IV.

MECHANICAL POWERS.—Continued.

THE INCLINED PLANE.

35. When a body is sustained on an inclined plane the power is to the weight as the height to the length, if the force act parallel to the plane, and as the height to the base, if the force act parallel to the horizon.

The uses of the inclined plane in loading and unloading heavy carts, in ship building, in ascending heights with burdens, are well known. In laying out roads through a country the great object is to have the inclinations as uniform and small as possible.

The velocity acquired by a body in descending an inclined plane is the same as would be acquired in falling the same height.

36. The angle of inclination of a plane upon which a body will just rest, the force of gravity being balanced by the resistance of friction, is called the limiting angle of resistance.

By experiments on the motion of bodies down inclined planes, the effect of friction is most accurately ascertained. *Mech.*, Treat. III., Chap. i.

37. Two bodies connected by a string placed on two inclined planes, whose ends abut against each other, and whose bases are on the same horizontal line, will balance if their weights be as the length of the planes.

Inclined planes of this nature are often employed in the mining districts: a heavy train of carriages descending one inclined plane will draw a similar train up another; the force requisite to put them in motion is that just exceeding the resistance of friction. *Mech.*, Treat. II., Art. 95.

THE WEDGE.

38. The wedge will be at rest, the resistance being perpendicular to the side, when the power is to the weight as the back to the side of the wedge.

The wedge may be considered as two inclined planes placed base to base.

All piercing and cutting instruments, as nails, needles, stakes, knives, teeth of animals, are to be referred to the wedge.

A saw is a series of wedges.

The common wedge is generally employed in cleaving substances. It is used, for raising great weights a small height, in ship-building, and in the centres of bridges.

The power applied to the wedge is impact; and the application of the wedge shows the great value of this kind of force, viz. pressure of short duration: the pressure which used to be obtained by driving small wedges in squeezing the oil from substances, to make oil-cakes, is almost incredible; this method is now, however, superseded by the Hydro-Mechanical or Bramah press.

The wedge is used to tighten the ropes in building scaffolds, to join timbers by wedge-shaped mortises. The stones composing the arch of a large bridge are truncated wedges.

THE SCREW.

39. In the screw, the power is to the weight as the distance between two contiguous threads to the circumference of the circle which the power describes.

The screw may be considered as generated by wrapping an inclined plane round a cylinder, the base of the inclined plane being equal to the circumference of the cylinder. The distance between any two contiguous threads is the height of the plane. The spiral thread, which is thus generated, may be on the convex or concave side of the cylinder, and the screw is accordingly either an internal or an external screw.

The screw was generally used for compressing bodies; but the friction between the surfaces of the internal and external screw is a great impediment to its use, and it is now almost entirely superseded when great pressures are required by the Hydro-Mechanical or Bramah press.

A screw, heavily loaded, and allowed to descend by its gravity, acquires momentum, which may be employed for the purposes of coining, or where a great instantaneous pressure is required.

A screw may be employed to act on the cogs of a wheel, and move it continuously in the same direction; it is then called a perpetual, or endless screw.

The screw with two threads, or Hunter screw, is an ingenious and useful combination for producing great pressure by a small power.

The micrometer screw, so essential in astronomical observations for measuring very minute distances, is a most valuable adaptation of the screw.

Mech., Treat. II., Arts. 99—102.

40. In the inclined plane, the wedge, and the screw, whatever is gained in force is lost in time, so that no increase in power can be obtained by any of the combinations.

THE PULLEY.

41. By the simple pulley a force may be made to act in any direction without sensible diminution.

The pulley differs from all the other simple machines in this, that the modification which the force undergoes is in direction, and not in magnitude.

A force may, by virtue of the tension and inextensibility, be transmitted from one end of a rope to another, without diminution; the rope, being passed round pulleys, may have its direction changed in any conceivable manner, and the force will still be transmitted from one end of the rope to the other without sensible diminution. We may conceive a rope passing round fixed points, or through rings, so as to have its direction changed in the same manner; but then the force, owing to the rigidity of the rope, will not be transmitted without great diminution.

The frame, in which the wheel turns, is called the sheave, or block. Peculiar advantages of this frame.

But though, by a single pulley, the magnitude of a force undergoes no modification, by a system of pulleys a force may be modified in any manner.

In every system of pulleys one general principle obtains, viz. that the tension of the string must be the same throughout its whole length.

Mech., Treat. II., Arts. 71—73.

42. In the system consisting of one fixed and one moveable pulley the power is half the weight.

This is commonly called the first system; the single moveable pulley is called a runner—it is most extensively used in the rigging of ships.

Mech., Treat. II., Art. 76.

43. In the other systems of pulleys the ratio of the power to the weight depends on the number of the strings and blocks, and their peculiar arrangement.

In the second system, that is, when the same string passes round every pulley, the weight is as many times the power as there are sheaves in the lower block. This is the system in most general use. Practical advantages have led to the adoption of peculiar arrangement of the pulleys. The two most celebrated are, Smeaton's Tack, and White's Pulley. In the former, the directions of the power and weight nearly coincide; in the latter, the diameter of the wheels have such a relation that all move with the same velocity.

Mech., Treat. II., Arts. 77—80.

In the third system, each string is attached to the weight. This, though a powerful combination, is practically useless.

There are other combinations called Spanish Bartons, each possessing its peculiar advantages.

Mech., Treat. II., Art. 82.

44. In every system of pulleys the product of the power into the space through which it moves is equal to the product of the weight into the space through which it moves.

This may be verified at once by measuring the quantity by which one portion of the rope is shortened and the other lengthened. Thus what is gained in force is lost in time or in velocity.

45. Every machine, however complex, is compounded of some of the simple machines, and the product of the power into the space through which it is exerted is always equal to the product of the weight into the space through which it is exerted.

The advantage of every machine, or the ratio of the weight to the power, is known at once by measuring the spaces through which they move in the same time. The above conditions will not be exactly verified in practice, since, owing to friction and rigidity of cordage, and other retarding forces, the power must be slightly greater than the above theoretical ratio. The above theoretical conditions being fulfilled, the systems of forces will always be at rest.

46. The force of friction depends on the roughness of the surfaces in contact, and the force with which they are pressed together.

There are two kinds of friction, as when one body glides over another, and when one body rolls over another. The former is much greater than the latter; one kind may be converted into the other; as when a block of stone is placed on rollers, wheels are fitted to the sledge, or the wheel of a carriage locked on descending a hill.

The amount of friction is estimated by the inclination which can be given to an inclined plane on which the body rests, so that it will just begin to move. This angle being ascertained under different circumstances, furnishes a comparison of the amount of friction in those cases. This angle is less in proportion as the surfaces are highly polished.

Mech., Treat. III.

The fiction is in all cases independent of the velocity, that is, it is the same in amount at whatever rate the surfaces move across each other.

See Gregory's *Mechanics.*

47. The stiffness of ropes, or rigidity of cordage, depends on the force with which the ropes are stretched, the diameter of the circle into which it is to be bent, and the section of the rope.

Mech., Treat. III., Chap. V.

Article 35. The relation of the power and the weight on the inclined plane according to the different directions in which the power acts may easily be illustrated; the power being applied by a string passing over a wheel fixed at various distances above or below the base of the inclined plane, so as to bring the string parallel to the base or to the plane.

Article 38. The relations of the power and weight on the wedge do not admit of being readily illustrated; the great effects of the wedge when driven by impact may be readily shown.

Article 39. The relation of the power and of the weight on the screw can only be shown by wooden models prepared for the purpose.

Articles 41—43. The various combinations of pulleys may be made by fixing wooden wheels in suitable positions against a vertical board. Small models of Smeaton's and White's Tacks may be had at about 10*s*. each.

LECTURE V.

LAWS OF MOTION.

48. THE motion or velocity of a body is said to be *uniform* when it passes over equal spaces in successively equal intervals of time, and *variable* when the spaces passed over in successive and equal portions of time are not the same.

The velocity of a body being measured by the space passed over in successive portions of time, is said to be accelerated, or retarded, according as these spaces are greater or less each succeeding portion of time.

FIRST LAW OF MOTION.

49. A body in motion, not acted on by any force, will move on in a straight line with a uniform velocity.

The proof of this law depends on experiment and observation. A body continues to move longer in proportion as the external resistances are removed. Thus we are led to the conviction that all retardation arises from the action of external causes; that consequently, if these were removed, a body in motion would continue in motion for ever. The strongest evidence for the truth of this law is derived from the predictions which mathematical calculation, based on the assumed truth of this law, enables us to make. *Physics*, Art. 5.

The first law of motion is sometimes termed the *law of inertia*, by which is meant simply to express the fact of a body continuing in the state, as to rest or motion, in which it happens to be.
Physics, Art. 27.

50. Motion at the earth's surface, and with the present laws of matter, cannot be perpetual.

In all mechanical combinations there is some resistance; and as the smallest perpetual subtraction, constantly repeated, would exhaust the largest quantity, the smallest perpetual resistance uncompensated would finally destroy any existing motion.
Physics, Art. 28.

SECOND LAW OF MOTION.

51. When any force acts on a body in motion the change of motion which it produces is in the direction and proportional to the magnitude of the force which acts.

Since a body cannot have at the same time a motion in more than one direction, it follows that if the circumstances are such that a body might move in more than one direction, these motions will be combined into one. The truth of this law is inferred from the facts that a body thrown up

by a person in motion returns to the hand; a stone let fall from the top of a tower falls at the base.
Physics, Art. 30.

This law may be verified by one experiment.

The proofs of the first and second law cannot be separated; the conviction of the truth of both is derived from the agreement of results of complicated mathematical investigations, founded on the supposed truth of laws with observed phenomena.

The paths of projectiles, that is, the course of a stone thrown into the air, furnishes evidence of the truth of this law. *Physics*, Art. 3, 5, 30.

52. The centrifugal force with which any body moving about a centre tends to recede from that centre, is the necessary consequence of these laws.

It being the law of matter in motion to continue to move in a straight line, unless acted on by some force, any body moving in a circle would, at any point, move on in the direction of the tangent, unless acted on by a force towards the centre. The bulging out of the earth in the regions of the equator, and the application of the governor to machinery, are striking illustrations of the above laws.

THIRD LAW OF MOTION.

53. When a force of the nature of pressure produces motion in any given mass, the velocity produced is proportional to the force.

The third law of motion differs from the other two in that it may be made the subject of direct experiment. The evidence is not in this case that of presumption of the highest possible order derived from calculations and observations, but of direct experiment. *Physics*, Art. 32.

54. The momentum, or quantity of motion which a body possesses, is measured by the product of the quantity of matter and the velocity of the body.

The term momentum is applied to the product of the velocity and quantity of matter: thus, a mass weighing 100 ounces, and moving with a velocity of one foot per second, and a mass of one ounce moving with a velocity of 100 feet per second, have the same momentum, or quantity of motion.

55. In the direct mutual action of bodies the momentum gained and lost in any time are equal.

If one body impinge on another the momentum gained by one is precisely the same as that lost by the other. Thus it appears, that there can be no destruction of momentum. Some amount of relative motion may be extinguished, but the absolute quantity of motion or momentum must continue the same so long as the present laws of motion remain unchanged. *Physics*, Art. 33.

56. The momentum generated is proportional to the pressure and the time of the continuance of the action.

The velocity generated by the hand turning a crank, or any large wheel, is small at first, but increases with the time that the action is continued; and we observe daily, that a small pressure continued for a long time will generate the same momentum as a great pressure continued for a short time.

Physics, Art. 34.

57. Time is requisite for the generation and destruction of velocity.

Not only is the velocity generated in a heavy mass proportional to the time (Art. 56), but the experiment of firing a bullet through a sheet of paper, of skaiting over thin ice, &c., show that a finite time is necessary for the generation of velocity; the particles of the sheet of paper in immediate contact with the ball are forced away, and there is not time for the motion to be communicated to the whole mass. *Physics*, Art. 34—37.

58. The effect produced by the destruction of the velocity of a body in motion is inversely as the time occupied in the destruction of that velocity.

The shock sustained when a body in motion is suddenly stopped is greater as the time during which the body is being stopped is less.

59. Impact is a pressure of short duration.

The proper introduction of the element time removes all difficulty in referring impact to the nature of pressure. When a hard body impinges on another, as a hammer on a nail, the velocity of the hammer, in consequence of the hardness of the surfaces, is destroyed almost instantaneously; the result is an immense pressure of short duration. Springs are affixed to carriages, that, by their yielding, time may be afforded for the destruction of the velocity on the conversion of the direction of the momentum by the obstacles in the road.

60. **In uniform accelerated motion the velocity generated is proportional to the time.**

The motion presenting itself most frequently to our attention is the accelerating force of gravity. This force, but for the resistance of the air, would generate the same velocity in all bodies in the same time. The motion of a body is said to be accelerated when it passes over a greater space in each succeeding portion of time than in the preceding, and it is said to be uniformly accelerated when the velocity added, that is, the increment of space passed over in each succeeding equal portion of time, is the same. Thus, in falling bodies, the velocity added in the space passed over in first second is $16\frac{1}{10}$ feet, the velocity added in the second second is also $16\frac{1}{10}$ feet, so that the whole space passed over in the second second is $32\frac{1}{5}$ feet.

Were the accelerating force to cease after the first second, the body would, by the first law of motion, describe in the second second the same space as it had done in the first second; that is, it would move on at the end of the first second with its then acquired velocity. *Mech.*, Treat. I., Art. 36—39.

61. The whole space described from the beginning of the motion is as the square of the time.

The space described by a body uniformly accelerated from rest is half that described in the same time with the last acquired velocity.

The preceding laws of uniformly-accelerated motion are satisfied in the motion of falling bodies; consequently, gravity is an uniformly-accelerating force.

Mech., Treat. I., Arts. 28—39.
Physics, Arts. 42—44.

Establishment of these laws by Attwood's machine.

Mech., Treat. I., Art. 37.

LECTURE VI.

PRACTICAL MECHANICS.

62. The term Practical Mechanics refers particularly to the application which may be made of the simple machines, together with the theoretical laws which have been laid down.

The force by which the machine is to be worked, which we have called the power, must have some origin.

63. The forces or powers which can be converted and adapted to our use, are various.

Animal power, and the power derived from the motion which already exists at the surface of the earth, or from the elasticity of fluids as developed by heat.

Gravity is not a source of power in the proper sense of the term, though it is frequently employed to put machinery in motion.

Electrical actions, as developed by chemical combination, may be regarded as sources of power of small amount.

64. The power of an animal is to be estimated by the following circumstances conjointly:—the force it can exert, the space through which it can exert that force, the facility with which it can repeat this effort, and the time during which it can continue its exertions.

The power of an animal is not to be measured by the weight it can support, since a post would on this standard be a better agent, or by the weight it can lift, which being a muscular effort, may be exceeded by a spring.

The difference between an animal and a post or spring consists in the animal being able to repeat the effort; a man, for instance, having lifted one weight from the ground, can stoop down and raise another.

In drawing, the immediate *cause* of the force is the weight of the animal, but the power by which this force can be repeatedly and continuously exerted is the strength of the animal.

The horse-power is generally estimated at 33,000 lbs. raised one foot high per minute: it is generally assumed that a horse can continue this exertion for eight hours per day. A man's power is about one-fifth of the horse's power.

The useful effect of an animal in drawing or carrying loads depends on the load carried, and on the speed with which it is carried.

Mech., Treat. I. Art. 57.

65. The *efficiency* of any force is the product of the force exerted, and the space through which it is exerted;

and the *duty* of any machine is the work done, estimated in a similar manner.

It is evident that the value of any mechanical agent and the work done do not depend on the pressure which may be exerted. The height to which weights are to be raised is as much to be considered as their magnitude.

The duty or work done by any machine is always equal to the efficiency of the moving force; it is not increased or diminished by any intermediate machinery, nor by any rate of working which does not diminish the pressure of the moving force. All that machinery can do is to increase the convenience of the application of the force, to modify the time in which it produces its effect, and determine the kind of work done. Thus, suppose 100 lbs. in weight at the height of 100 feet from the ground,—the efficiency of this weight in raising other weights is 100 × 100 or 10,000. By the intervention of machinery this weight might, in the absence of friction and other causes destroying motion, be employed to raise 1 lb. 10,000 feet high, or 10,000 lbs. 1 foot high. The more perfect machinery can be made the nearer will these limits be approached, but they can never be reached.

The duty of steam-engines is estimated by the number of pounds raised one foot high by a given quantity, as one pound or one bushel of coals.

The duty of other machines moved by animal power is estimated by the weight raised to a given height in a given time.

66. The existence of a "perpetual motion" is theoretically as well as practically impossible, so long as the laws of motion and natural forces, which now obtain at the surface of the earth, continue.

The search after a perpetual motion is a search after a machine which will create power, that is, one in which the work done or duty is greater than the efficiency of the agent. The force of an agent can be increased by the intervention of machinery, but its power cannot.

At the earth's surface everything is subject to gravity. Now the impossibility of a perpetual motion, in which gravity is the moving force, results from this —that the expenditure of power in raising a weight is precisely the same as the gain of power when that weight descends again.

With other forces and other laws of motion a perpetual motion might be possible, but such are not known to exist.

67. The fly-wheel is a reservoir of power, and a regulator of the motion of machinery.

The momentum generated in any body as a fly-wheel is proportional to the pressure exerted, and the time during which it is exerted. A very small pressure acting for a long time continuously, or a great pressure acting periodically, will generate momentum in a fly-wheel, which thus acts as the reservoir of the power exerted; this momentum may be employed to put machinery into motion, or to regulate machinery. The instances of its application are very numerous; and it is essential whenever a uniform motion is to be secured. The regulating effect of a fly-wheel is proportional to its mass into the square of its velocity.

The instances of the accumulation of power to be suddenly applied are numerous; among these, those furnished by the iron works, the coining presses, and the pile engine, are the most remarkable.—See Babbage's *Economy of Manufactures*, Chap. II.

LECTURE VII.

HYDROSTATICS.

HYDROSTATICS.—GENERAL PROPERTIES AND PRINCIPLES.

68. The particles of a fluid may be moved amongst each other without any sensible resistance.

Fluids are usually divided into liquids and gases; in the former the force of cohesion betwixt the particles is scarcely sensible, in the latter the particles mutually repel each other.

All fluids, liquids as well as gases, are porous, compressible, and elastic. The compressibility of water is proved by the experiments of Canton, Perkins, and Oersted.

69. A pressure exerted on any part of a fluid is transmitted in every direction.

The transmission of pressure is the characteristic property of fluids, by which they are distinguished from solids.

The hydro-mechanical, or Bramah press, furnishes the best practical illustration of the transmission of pressure in liquids; the use of the safety-valve in steam-engine boilers and the construction of bellows, furnish illustrations of its truth for elastic fluids or gases. *Physics*, Arts. 68—70.

70. The surface of a fluid at rest is perpendicular to the resultant of all the forces which act at any point of the surface.

These forces are gravity, centrifugal force, cohesion betwixt the particles of the liquid, and the adhesion of the particles near the sides of the containing vessel; to the resultant of all these any point of the surface is perpendicular.

71. The pressure at any point of the surface of a fluid at rest is the same.

For, did two pressures exist at two contiguous points, these pressures would be transmitted in every direction, and the equilibrium destroyed.

72. The surface of a fluid of small extent at rest is horizontal.

The surface of any large extent of water, as the ocean, is curved, or a level surface; the horizontality of any small extent of surface enables us to determine the levels of places; that is, their situation with respect to some standard, as the surface of the ocean. This operation is termed levelling.

The instrument employed for this purpose is termed a level. *NAT. PHIL.*, *Hydrostatics*, Chap. II.

73. Fluids rise to the same level throughout a system of communicating vessels.

The supply of towns with water furnishes an example, on a great scale, of the truth of this law, which may be readily illustrated by vessels of various shapes situated near and communicating with each other.

NAT. PHIL., *Hydrostatics*, Chap. II.

74. The pressure at any point in the interior of a vessel is proportional to the depth of the point below the surface of the fluid.

Each layer of particles is subject to gravity, and the pressure which any one of these exerts on that below it is transmitted, so that the pressure at any point, being the sum of these, is proportional to the depth.

75. The pressure on any surface immersed in a fluid is equal to the weight of a column of the fluid whose base is equal to the area of the surface pressed, and height equal to the depth of the centre of gravity of the surface below the surface of the fluid.

In illustration of this principle, we know, experimentally, that the pressure on equal portions of the bottoms of all vessels is the same, whatever the inclinations of the sides, provided that the fluid stands at the same height in all of them.

If vessels be provided whose lower orifices have the same area, but their sides very different inclinations, and these lower orifices be kept closed with a flat plate sustained by a weight attached to a string passing over a pulley, the same weight will be a counterpoise for the water in all the vessels so long as it stands at the same height in all.

The pressure, then, on the bottom of a vessel does not depend upon the quantity of the fluid the vessel contains, but upon the height at which the fluid stands in the vessel.

It also follows, from the law of the transmission of pressure in a fluid, that an exceedingly small quantity of water may be made to sustain a very great weight. This is shown to be the case in the hydrostatic bellows, and illustrated by the natural springs which spout forth from between water-tight strata of the earth.

NAT. PHIL., *Hydrostatics*, Chap. III.

76. The centre of pressure of a surface is the point in the surface at which a single force, being applied, will balance the pressure against the surface.

This single force is the resultant or sum of all the forces or fluid pressures to which the surface is subject. The position of this point may be determined in all cases by the aid of mathematics.

The knowledge of this point is of great importance in the construction of sluice gates, and large vessels to hold liquids, as vats. If the surface pressed be a parallelogram, the centre of pressure is two-thirds of the depth of the fluid from the surface. The staves of a barrel may be held by a single hoop placed at one-third from the bottom.

Webster's *Hydrostatics*, Chap. IV.

77. The lateral or horizontal pressures in any vessel containing a fluid destroy each other.

The pressures of a fluid against the side of a vessel cannot produce any motion in the vessel; but if the equilibrium of the forces be destroyed by removing a portion of the side, the opposite pressure, not being counteracted, may cause motion. This is the principle of Barker's mill, and similar reaction machines, and also of the ascent of a rocket.

78. When a body is immersed or floats in a fluid, it displaces as much of the fluid as is equal to the weight of the body; and the force with which it presses downwards, and the pressure of the fluid upwards are each equal to the weight of the body.

This upward pressure of a fluid on a body immersed in it with a force equal to the weight of the fluid displaced, was entirely overlooked in the early days of the science of hydrostatics, and gave rise to many curious theories about the gravitation of bodies. Cotes's *Hydrostatics*, Lect. I.

The methods of ascertaining the specific gravities of bodies furnish illustrations of the above law. It may be easily shown that when a solid is immersed in a fluid, the weight lost is to the whole weight of the body as the specific gravity of the fluid is to that of the solid. The instruments used for ascertaining specific gravities are the hydrostatic balance and the hydrometer, of which there are many various constructions.

If the upward and downward pressure be not in equilibrium, the bodies ascend or descend in the fluid, as in the ascent or descent of balloons. Fish have a peculiar faculty of altering the relation of these forces by increasing or diminishing their bulk.

79. When a solid body floats at rest in a fluid, its weight is equal to the weight of the fluid displaced and the centres of gravity of the body and of the fluid displaced are in the same vertical line.

The first condition of the equality of the forces is not sufficient to ensure the equilibrium. There is a point termed the metacentre, whose position must be ascertained before the stability of a floating body can be insured. The proper application of these principles, so as to ascertain this point, is of the greatest importance in ship-building.

Physics, Art. 84.

Article 69. This law may be verified experimentally by having a vessel with a number of equal orifices closed by pistons. This being filled with water, if a force be applied to one piston an equal force must be applied to all the rest, or they will start out wherever situated.

LECTURE VIII.

ELASTIC FLUIDS.—INSTRUMENTS.

80. THE elastic force of air at a given temperature is inversely as the space it occupies, or is proportional to its density.

The particles of the elastic fluids, as common air and the gases, exert a repulsive force, by which they have a tendency to recede and separate from each other unless restrained; and the pressure thus exerte against the sides of the containing vessel is their elastic force. They possess the property of transmission of pressure equally in all directions, and the preceding propositions as applicable to them as well as to liquids.

This law may be proved by inverting a tall cylindrical vessel over water or any liquid, and observing the force which is required to press it down; or by compressing an elastic fluid into the closed leg of a glass tube bent upwards by mercury poured into the other.

The air-pump, the air-vessel affixed to fire-engines and large pumps, the condenser, the air gun, the diving-bell, furnish familiar instances of the application of the above law.

The action of the air-pump depends entirely on the property possessed by air, of dilating when the pressure to which it is subject is diminished; and when the density is so far diminished that the elastic force is insufficient to raise the valves, the rarefaction can proceed no further.

The application of high pressure steam as a moving power, and the system of working steam expansively, furnish illustrations of this law.

81. All elastic fluids in free communication with each other, or separated by a porous substance, become diffused through each other.

If two vessels be filled, the one with hydrogen and the other with carbonic acid gas, which is 22 times heavier than hydrogen, and the vessel containing the hydrogen be set above the other, and an opening be made betwixt them, the hydrogen will descend and become diffused through the carbonic acid, and the carbonic acid will ascend and become diffused through the hydrogen, so that there will be both hydrogen and carbonic acid in every part of the two vessels.

The above and similar facts led Dalton to the hypothesis that the particles of each gas, though highly repulsive to those of its own kind, exert no sensible action on the particles of another kind, but that each gas is, as it were, a vacuum to the other—that the particles of one permeate and move through the interstices of the other as a spring of water through a bed of sand.

82. The pressure of an elastic fluid at any point in its interior is proportional to the depth of the point below the surface of the fluid, and is equal to the weight of the superincumbent column.

The same reasoning which applies to liquids (Art. 74) applies to fluids generally. The barometer furnishes a direct measure of this pressure in the case of the atmosphere; this is the only instance presented to us in which the pressure of an elastic fluid as due to its weight can be measured.

The atmosphere is generally spoken of as one fluid, whereas it is a mixture of several fluids; and there is good reason for the hypothesis that the several gases, whereof nitrogen, oxygen, and vapour of water are the most important, are in a state of mechanical admixture.

Physics, Arts. 92—101.

83. The pressure of the atmosphere at the surface of the earth is very nearly 15 lbs. on every square inch.

The weight of the column of mercury which balances the atmospheric column may be accurately ascertained. This varies with different states of the atmosphere, and these variations furnish some evidence as to the probable future state of the weather.

The syphon for drawing off liquids furnishes an instance of two columns of liquids of unequal length, and which cannot consequently be in equilibrium with the atmosphere.

The variations in the weight of the superincumbent column for different heights above the surface of the earth may be employed for the purpose of levelling.

The common pump furnishes an illustration of the above law. The history of this part of the discovery of Torricelli, and the previous explanation of the phenomena by Nature's horror of a vacuum, are most instructive and curious.

See Cotes's *Lectures on Hydrostatics.*

LECTURE IX.

MOTION OF FLUIDS.

84. Fluids are subject to the same laws of gravity as solid bodies, and a mass of fluids, descending vertically, has its motion accelerated, in the same manner as a solid; and the momentum acquired is the product of the mass and the velocity.

A liquid contained in a bent tube will oscillate according to the same laws as a pendulum. The bobs of pendulums are frequently vessels filled with mercury. Thus there is no difference between the motions of a solid and of a fluid, except so far as relates to the particles of the latter moving amongst each other.

85. The velocity of the particles of a fluid issuing from an orifice is that which would be acquired by a

heavy body falling through the vertical height of the surface of the fluid above the orifice.

The velocity of efflux, depending simply on the depth of the orifice below the surface, is the same for all liquids. The velocity will also be as the square root of the depth of the orifice below the surface. Thus, if in a tall vessel holes be pierced at the depths of 1, 4, 9, 16, &c. inches, the velocity of the issuing fluid will be as the numbers 1, 2, 3, 4, &c.

86. The stream of issuing fluid is contracted after leaving the orifice, and the actual discharge is about five-eighths of the theoretical discharge.

The motion of the particles, as they approach the orifice, is curious. They descend vertically till within a small distance, when the *vena contracta*, or contracted vein, commences. From this point the section of the stream is uniform.

The motion of the particles of the fluid may be rendered visible to the eye by mixing small pieces of sealing wax or other substances with the water.

The discharge from an orifice is greatly increased by the insertion of a small piece of pipe of different shapes, termed an *adjutage*, into the orifice. The *adjutage* producing the greatest effect consists of a portion of two cones united at their narrowest ends at the commencement of the *vena contracta*.

87. The motion of a liquid in long pipes, canals, and rivers, is accelerated according to the declivity and

depth of the channel, until the force of resistance, increasing with the velocity, becomes equal to the accelerating force, after which the velocity is uniform.

The motion of water in long pipes and open channels, as rivers, furnishes many important and interesting illustrations of the laws of fluids.

See Robison's *Mech. Phil.*, Vol. II.
Young's *Lectures*, XXIV. and XXVI.

88. When a wheel is put in motion by a stream of water striking against a float-board, the action of the water diminishes as the velocity of the wheel increases, till the accelerating force becoming equal to the retarding force, the motion of the wheel is uniform.

The undershot and breast-wheel are instances of methods by which power existing in nature is converted so as to do work for man. In the latter the force of gravity is also employed to generate momentum.

A machine driven by the impulse of a stream does the most work in a given time when the wheel moves with from one-third to one-half the velocity of the water. *Mech.*, Treat. I., Arts. 48, 49.

89. When the weight of the water is employed to give motion to machinery, as in the overshot water-wheel, the motion becomes uniform when the momentum of the water is equal to the resistance.

The construction of the buckets of the overshot wheel should be such as to retain the water to the lowest point, and then empty it at once.

There are other machines, as Barker's mill, called reaction machines, in which the motion is obtained by removing one of the pressures which preserve the equilibrium. The lateral or horizontal pressures destroy or counteract each other; if, however, one of these be removed, the other, not being counteracted, will produce motion. If an orifice be made near to the top of a tall vessel on one side only, the vessel will tumble over, from the pressure on the opposite side not being counterbalanced. The machine called Barker's mill depends on this principle.

In a sky-rocket, the pressure of the elastic fluid on one end of the chamber not being counteracted by the pressure at the other, drives the rocket in the direction of its length. Motion is also obtained on the same principle by high steam or gas rushing out of an orifice at the end of a bent arm.

90. If the momentum of a mass of fluid be suddenly destroyed, that is, its motion at once checked, the shock or pressure which the opposing body sustains is very great.

If water, flowing through a long inclined pipe, be stopped by turning a cock suddenly, there will be recoil through the whole mass, which may be sufficient to burst the pipe at any weak part, though at a considerable distance from the point at which the motion is checked. The sudden destruction in a fluid mass is subject to the same laws as in a solid (Art. 58). This principle is applied to raise water to great heights, and the machine for this purpose is termed the hydraulic ram.

See Webster's *Hydrostatics*, Chap. XI.

The effects of strong gales and rapid currents on objects which do not yield or bend is referable to the same laws.

LECTURE X.

CAPILLARY PHENOMENA.

91. WHEN a body is in contact with a liquid by which it can be wetted, the liquid rises against it and presents a concave surface; if the body is not wetted by the liquid, the liquid is depressed about it, and presents a convex surface.

Water in contact with clean glass rises above its general level, but if the glass be greasy the water sinks below the general level. Mercury in contact with gold rises, but in contact with glass sinks, and presents a convex surface upwards. Water maintains its level against a piece of well polished metal.

92. If a capillary glass tube, that is, a tube of which the internal diameter is less than one-tenth of an inch, be immersed in water, the rise of the water within the tube is inversely as the diameter of the tube.

If the tube be immersed in mercury, the depression of the mercury within the tube will follow the same law.

The elevation and depression of the liquid is entirely independent of the thickness of the tube, it depends in some measure on the nature of the liquid. Water ascends highest of all liquids.

The ascent or descent depends upon the form of the surface, according as it is concave or convex upwards; and the concavity or convexity of the surface depends upon the mutual relation of the forces of cohesion and adhesion.

93. The surface of a liquid in contact with a solid will be plane concave or convex, according as the attraction of the particles of the liquid for each other is equal to less or greater than twice the action of the solid on the liquid.

See Webster's *Hydrostatics*, Art. 218.

The adhesion of liquids to solids, the cohesion of the particles of a drop, and similar phenomena, prove the existence of these forces; and the proposition just stated, being fully followed out, furnishes a complete explanation of all the phenomena.

Physics, Art. 115, 116.

94. A drop of liquid placed in a cone with its axis horizontal, approaches or recedes from the summit according as the surfaces are concave or convex, that is, as the tube is or is not wetted by the liquid.

A drop of water placed in a conical tube runs towards the narrower end, but a drop of mercury runs towards the wider end.

95. Two substances immersed in a liquid, and within a capillary distance of each, and both or neither wetted by the liquid, will approach each other, and when one is wetted and the other is not wetted, will recede from each other.

Two small vessels of glass floating on water or mercury come iuto contact. But if a piece of ivory, which is wetted by the water, be placed near a piece of talc which is not wetted by water, the one will recede from the other. *Physics*, Art. 114.

96. The phenomena of absorption and filtration, and of the ascent of sap, are to be referred to the laws of capillary action.

Physics, Art. 118.

LECTURE XI.

OPTICS.

OPTICS.

97. Light, or the agent to whose action the phenomena of seeing are referred, is, like gravity, known to us only by its laws; of its nature we are wholly ignorant. These laws are experimental facts, and independent of any hypothesis respecting the nature of light.

Two opinions have been entertained respecting the nature of light. According to one, it consists of material particles projected from the luminous body with immense velocity in every direction. According to the other, it consists in the vibrations or undulations of an elastic medium. The truth of either hypothesis is to be ascertained by the explanation which it affords of the phenomena.

The theory of emission is quite inadequate to explain many of the phenomena.

Webster's *Physics*, Arts. 252—255.

98. Light is propagated in every direction from every visible point of luminous bodies.

The flame of a candle, the electric spark, or any source of light, is seen equally well in every direction.

99. All bodies which are not luminous in themselves are rendered visible by light, derived from some body luminous of itself.

Among the bodies luminous in themselves, or rather among the sources of natural light, we may enumerate the sun, the fixed stars, some animals, the flame of a candle, the electric spark. Those bodies which are not luminous of themselves shine with borrowed or reflected light, as the moon and most of the objects by which we are surrounded.

NAT. PHIL., *Optics*, Chap. I.

100. Light is propagated in straight lines in a uniform medium.

The air through which the light passes is far from having a uniform density; the light consequently suffers refraction, that is, is bent from its direct course. When light meets with a medium of any different density, as in its progress from air into glass, this refraction is at once apparent, the light not coming in the same direction. An object not before visible may be rendered visible by interposing a piece of glass between it and the eye. The direction of the light is changed on entering this medium.

NAT. PHIL., Optics, Chap. II.
Physics, Art. 190.

101. A ray of light may be considered as any line along the object which is visible, and a pencil of light several such lines.

If any opaque body be interposed between the eye and a luminous body, the smallest portion of light which can be stopped or allowed to pass is a ray. When light enters into a dark chamber through a very small hole, the fine line of dusty particles, by the illumination of which we are sensible of the light, is a ray; the course of the light may be rendered very distinct by powdering dust or flour on its course from a small bag.

NAT. PHIL., Vol. II., *Account of Newton's Optics.*
Physics, Art. 193.

102. Any pencil of light from the sun consists of parallel rays, but the light from artificial sources consists of divergent rays.

Parallel or divergent rays may be made to converge to a point, and this point is called their focus, and the light, after passing this point, is divergent.

103. When light is stopped by the interposition of any opaque substance, an umbra or shadow is formed.

Most substances, when reduced to plates or layers of inconsiderable thickness, are transparent, and others transmit light but faintly. When light is stopped a shadow is formed, whose external contour or periphery depends on that of the interposed body. *Physics*, Art. 194.

104. The image of the sun admitted through a hole of any shape, and received on a screen or wall exactly opposite the hole, is round.

This is the immediate consequence of the pencils of light from every point of the sun consisting of parallel rays. When the screen is inclined to the hole the image is elliptical, and when the sun is partially eclipsed the images are crescent shaped, or of a form corresponding to the visible portion of the sun. *Physics*, Art. 195.

105. The intensity of any light received on a screen is inversely as the square of the distance of that screen from the source of light.

The intensity of light may be measured by removing one of two sources of light until the illumination which they produce appears equal, or until two shadows appear equally dark. The latter mode is found the most convenient in practice. It is found that one candle, at the distance of one foot, is of the same intensity as four candles at the distance of two feet; thus each candle at the distance of two feet gives one-fourth the light which it gives at the distance of one foot.

Instruments for measuring the intensity of light are called photometers. Two different methods have been pursued, one of observing when two shadows are equally dark, the other when two surfaces are equally bright.

106. The transmission of light is not instantaneous, but occupies a finite time.

This was discovered by astronomers observing that the eclipses of Jupiter's satellites were sometimes sooner and sometimes later as the planet was nearer to or farther from the earth than they should have been, according to calculations made on the hypothesis of the transmission of light being instantaneous. It thus appears that light takes 16′ 26″ to traverse the diameter of the earth's orbit, or 8′ 13″ to come from the sun to the earth.

Physics, Art. 196.

The consequences of this fact in producing aberration or change in the apparent place of the fixed stars, owing to the motion of the earth in its orbit, and other conclusions and speculations which follow from it, are of a most interesting nature.

Physics, 196—198.

LECTURE XII.

ON THE REFLECTION OF LIGHT.

107. A pencil of light traverses a homogeneous medium, in a rectilinear direction with a uniform velocity; but, on meeting with different media, is divided into several parts, whereof each pursues a different path from the others, and is differently modified.

One part is regularly reflected, and pursues, after reflection, a path entirely exterior to the obstacle or new medium; another part is reflected regularly, that is, enters the medium and traverses it according to the laws of refraction; a third part is irregularly reflected or dispersed in all directions. It is this latter portion by which objects are visible. When the medium is crystallized the second portion is divided into two rays, or the light is doubly refracted. The portion which enters the medium undergoes a loss by what is termed absorption. This loss depends on the thickness and nature of the medium. A piece of glass absorbs according to its thickness; but, in opaque substances, the absorption takes place when the substance is exceedingly thin. When the surface on which the light falls is polished, almost the whole is regularly reflected.

Physics, Art. 199.

108. In regular reflection, at polished surfaces, the angles of incidence and reflection are equal.

The angle of incidence is the angle which the incident ray makes with the perpendicular to the surface at the point of incidence; and the angle of reflection, that which the reflected ray makes with the same perpendicular. The truth of this is evident from the use of plane mirrors, the formation of images by which, according to this law, is a fact familiar to all.

NAT. PHIL., *Optics*, Chap. V.

109. Light reflected at a polished surface may be considered as proceeding from a point termed the virtual focus, and situated at the same distance from the mirror as that of the incident rays, but on the opposite side.

Any image seen by reflection may be considered as thus situated with reference to the mirror and the original object. This virtual or imaginary object has a fixed and permanent position, which never changes, whatever be the position of the eye.

The objects in a plane mirror are erect as regards top and bottom, but inverted from left to right.

If the object advance towards, or recede from, a plane mirror by a certain quantity, the distance betwixt the image and the object is diminished and increased by double that quantity, since each moves in the same or in opposite directions.

NAT. PHIL., Optics, Chap. V.

110. The images of an object placed between two plane and parallel reflecting surfaces are infinite in number; and if the reflecting surfaces meet in an angle, the images are arranged on the circumference of a circle whose centre is in the point of junction of the surfaces.

The application of this principle is exhibited in the construction of the kaleidoscope.

111. When reflection takes place at a curve surface, each indefinitely small portion of the surface may be considered as a plane mirror reflecting the rays of the object.

The only curved surfaces in general use are spherical surfaces. These are employed in lighthouses and in many other cases when the direction of the pencil is to be changed and its nature modified; as when a divergent pencil is to be rendered convergent or parallel.

Concave and convex spherical mirrors may also be used for the production of images differing in magnitude from the original object, as in reflecting telescopes.

Parallel rays falling on a convex mirror diverge after reflection from the point bisecting the radius, and on a concave mirror converge to the point bisecting the radius.

NAT. PHIL., *Optics*, Chaps. V. and VI.
Physics, Arts. 204—206.
NAT. PHIL., Vol. II., *Optical Instruments.*

LECTURE XIII.

ON THE REFRACTION OF LIGHT.

112. When a ray of light is incident on the surface of a transparent medium, a portion thereof is reflected, another portion is dispersed in all directions, and renders the surface visible, and another portion enters the medium, undergoing a total change of direction from that of the incident ray, which change is called refraction.

Light on passing from one medium to another of very different density is bent abruptly. Some change in the direction of the ray takes place at every change of density, as in the passage from one stratum of the atmosphere to another.

A piece of metal or other substance placed at the bottom of a vessel, and concealed from the eye by the edge, may be brought into sight by pouring water into the vessel. Here the change is abrupt, but in the atmospheric refraction it is exceedingly gradual.

NAT. PHIL., *Optics*, Chap. II.

113. The sine of the angle of incidence bears a constant ratio to the sine of the angle of refraction for the same medium.

The angle of incidence is the angle which the incident ray makes with the perpendicular to the surface at the point of incidence, and the angle of refraction is the angle which the refracted ray makes with the same perpendicular. These two angles are on opposite sides of the perpendicular. When the light passes from a rarer into a denser medium, the angle of refraction is less than the angle of incidence. This law has been subjected to a rigorous examination by Fresnel, who found that the results calculated upon it, and given by his experiments, agreed to six places of decimals. The value of this ratio for different substances is called the index of refraction for that substance.

NAT. PHIL., *Optics*, Chap. II.
Physics, Art. 208.

114. A ray of light incident perpendicularly on a transparent medium, bounded by plane and parallel surfaces, undergoes no refraction, and parallel rays incident obliquely thereon emerge parallel.

The rays are bent by the same quantity in opposite directions at the two surfaces, so that the direction of emergence is parallel to that of incidence.

115. A ray of light can always pass from a rarer into a denser medium, but it cannot pass from a denser into

a rarer medium when the angle of incidence in the denser medium exceeds a certain value.

This limiting angle of incidence in the denser medium is termed the critical angle: it is of such a value that the angle of emergence into the rarer medium is a right angle; for any greater value than this the ray cannot emerge, but is reflected within the medium. An eye may be so situated, with respect to the surface of water and a substance within it, that the latter may be invisible. An eye within water sees all external objects as through a circular aperture; it sees also objects within the water by reflection at the surface. The preceding principle is the basis of the camera lucida; the rays of light are incident and emergent in directions perpendicular to two surfaces of the prism, and suffer total reflection within the prism at the other two surfaces. *Physics*, Arts. 209 and 215.

116. Rays of light traversing a medium of variable density have their directions changed continuously, so that their path is curvilinear.

The light of all the heavenly bodies reaches us having described a curve whose concavity is downwards; consequently they appear more elevated than they in reality are.

The images of objects formed in the air, the elevation of coasts, called by the sailors *looming*, and the mirage in Egypt, are instructive illustrations of the preceding law.

NAT. PHIL., Vol. I., *Optics*, Chap. XVIII.
Physics, Art. 210.

117. Rays of light incident on a spherical surface of small extent, the radiant point being on the axis of the surface, are refracted and converge to a point termed a focus.

The refraction of light by spherical surfaces is shown by use of lenses of which there are seven different kinds.

NAT. PHIL., Vol. I., *Optics*, Chap. III.

The seven different kinds of lenses may be referred to two distinct classes, convex lenses or lenses of convergence, and concave lenses or lenses of divergence.

The ordinary optical instruments, as the camera obscura, the simple microscope, the compound microscope, the astronomical telescope, the common terrestrial or erecting telescopes, the solar microscope, and the magic lantern, consist simply of a combination of lenses adapted to each particular case.

NAT. PHIL., Vol. II., *Optical Instruments.*
Physics, Art. 218.

118. The eye is an optical instrument for the formation of an image, in obedience to the preceding laws of refraction.

The human eye is nearly a sphere, with a slight projection in front. It consists of four membranes—the sclerotic, the cornea, the choroid, and the retina; of two fluids, the aqueous and the vitreous; and of the crystalline lens.

The cornea fills up a circular orifice in the front of the sclerotic membrane, fitting in like a watch-glass. The eye is divided into two chambers by the crystalline lens; the smaller or anterior containing the aqueous, the posterior the vitreous humour.

A ray of light, being refracted by the different membranes and fluids of the eye, but principally by the crystalline lens, reaches the retina, on which the image of the external object is depicted. This image is inverted, as may be seen in the eye of any animal recently killed on scraping off a portion of the posterior surface so as to render it transparent.

There are many most interesting inquiries connected with vision; as single vision with two eyes, duration of the impressions on the retina, squinting, accommodation of the eye to different distances, long-sightedness, short-sightedness, and cataract.

NAT. PHIL., *Optics*, Chap. XVII.
Physics, Arts., 232—236.

LECTURE XIV.

CONSTITUTION OF LIGHT.

119. The white light of the sun, or other luminous bodies, consists of seven simple elementary colours.

These colours are exhibited whenever light suffers refraction, but they are best shown by receiving on a screen a ray of light after it has passed through a prism. The image on the screen is termed the spectrum, and the colours are red, orange, yellow, green, blue, indigo, violet.

Every constituent portion of white light has a different refrangibility; the violet has the greatest and the red refrangibility. The other rays have intermediate refrangibilities.

These seven primary colours undergo no farther separation however refracted.

NAT. PHIL., Vol. II., *Account of Newton's Optics*, Chap. ii.
Physics, Art. 219.

120. The solar spectrum consists of an infinite number of coloured circular images overlaying each other.

The image of the sun is always round (Art. 104), and each of the images formed by the component rays is subject to the same law.

Physics, Art. 221.

121. Each colour of the spectrum is a simple colour, and undergoes no change, however refracted.

Any portion of the spectrum, as the extreme violet, being selected, and alone allowed to fall upon a prism and refracted, will be always violet; and the colour of any object viewed by this light, that is, on which this light is allowed to fall, will be violet; plants, trees, &c. will all appear violet. The same is the case with any other colour. Any one may be made the subject of experiment by placing a screen with a hole in it opposite that portion on which we wish to experiment.

NAT. PHIL., Vol. II., *Account of Newton's Optics.*

122. The elementary colours may be recompounded, or white light may be reproduced by causing the different rays to meet in a point.

If the light from the first prism be received on a second in an inverted position, that is, the base of the first being uppermost, the base of the second must be lowest, each ray will be bent back to its original path, and the emergent light will be white, the colours will have been recompounded.

Also, if the spectrum be received on a concave spherical mirror in the focus will be a white image, beyond the focus the spectrum again, but in an inverted position; or it may be received on a converging lens with the same result. Thus it is the condition of white light that all the colours should meet in a point.

White light may also be compounded mechanically. If a circular card be taken, and the different colours of the spectrum be painted upon it, in order, in spaces included between radii, and the card be made to revolve rapidly, it will appear to the eye as white. Here the different colours produce in the mind, through the impression on the eye, sensations of the successive colours almost simultaneous. Thus it appears that the sensation of white light is but the simultaneous succession of the sensations of all the colours.

Physics, Arts. 221—225.

123. White light incident on any surface obliquely, so as to undergo refraction, is decompounded.

The separation of colours is not always apparent, since they frequently become recompounded, or partially so. If the surfaces bounding the medium are parallel, the recomposition is nearly complete; the extreme rays will not be recompounded, but the colours will seldom be visible. The colour of the image produced by lenses is the source of the greatest difficulties in the construction of telescopes. But in the union of a lens of crown and flint glass the colours in the centre of the image may be recompounded without destroying all the refractions; many ingenious combinations having been adopted which should be achromatic.

NAT. PHIL., *Optics*, Chap. X.
Physics, Arts. 225, 228, 229.

124. The rainbow is produced by the light of the sun undergoing two refractions and one reflection at the drops of rain.

The rainbow furnishes one of the most beautiful illustrations of the laws of optics which can be afforded. The ray of white solar light incident at the surface of a drop of rain is refracted and separated into colours; this spectrum on the back of the drop cannot emerge, because the angle of incidence of the rays exceeds the critical angle (Art. 115); they are consequently reflected, and emerging at the point they next meet the surface of the drop, reach the eye. Thus the light undergoes two refractions and one reflection.

The rays must have an angle of incidence such that they may emerge from the drop parallel. The only drops fulfilling this condition will be situated on a conical surface, the eye of the spectator being at the vertex of the cone. Thus the rainbow must be a portion of a circle since the only drops which can impress the eye with this series of colours must be thus arranged. The formation of halos is to be explained by the same principles.

NAT. PHIL., *Optics*, Chap. XVIII.
Physics, Art. 226.

125. The secondary rainbow is produced by the light undergoing two refractions and two reflections, before it meets the eye.

The light may be so incident on the under surface of a drop of rain that the rays will emerge parallel after two refractions and two reflections. The drops in this case also must be arranged on a conical surface so that the bow will be a portion of a circle. A tertiary and other bows may also be produced; for these the light suffers two refractions and three, four, or more reflections respectively.

The colours in the secondary bow are in an inverse order of arrangement from the primary.

LECTURE XV.

INTERFERENCE OF LIGHT.

126. The solar spectrum, when obtained in great purity, is interrupted by a vast number of black lines.

These interruptions can only be rendered visible when the spectrum is produced with great care. In the spectrum from lamp-light they are brigh and fiery. *Physics*, Art. 227.

127. If a pencil of light be introduced into a dark chamber through a small orifice, and viewed across a sharp edge of any body, the shadow will not be distinctly defined, but bounded by coloured fringes.

These fringes are parallel to the edge across which the light passes, and when a simple colour is used the fringes are light and dark bands succeeding each other with great regularity. They are termed Grimaldi's fringes.

It follows from the preceding phenomena that rays of light under certain circumstances exert mutual actions on each other; this action is termed interference, and these phenomena, being totally inapplicable on any theory of emission, lead at once to the theory of undulations.

Grimaldi found that a body already illuminated may become less bright on receiving light from another source.

NAT. PHIL., *Optics*, Chap. XII.
Physics, Arts. 239, 240.

128. Light from the same source, reflected at two mirrors, inclined at a very small angle, so that the rays cross each other, will form on a screen bands alternately light and dark and parallel to the common intersection of the mirrors.

The production of these phenomena by Fresnel furnishes the most unquestionable evidence that the light does interfere with itself; that one ray of light added to another ray under certain conditions may produce blackness. If the light from one mirror be stopped, the bands vanish, and the screen is perfectly bright; if a transparent substance, as glass, be interposed, the bands are shifted but not destroyed.

The formation of colours in thin plates is at once referred to the principle of interference; also the dark and coloured rings, when solar light is received on two pieces of glass, whereof one is plain and the other slightly convex and pressed together; and the beautiful rings and colours seen in soap bubbles. *NAT. PHIL.*, *Optics*, Chap. XIII.
Physics, Arts. 241—246.

129. A pencil of light in its passage through a rhomb of Iceland spar is separated into two pencils of equal intensity.

This phenomena of double refraction may be seen with many substances, besides that form of carbonate of lime called Iceland spar. A black spot or line upon white paper viewed through a rhomb of this substance appears double.

These two pencils are termed the ordinary and the extraordinary pencil, because the former follows the law of sines, or the ordinary law of refraction, the latter another law. The pencils possess very different properties, as is shown by placing one rhomb above another and then viewing any object.

In some positions four images are seen, in others only two. Thus the pencils have reference to the planes of the crystal; and Newton was led to the idea that a ray of light has sides or poles, that is, some distinct relation to space; whence this class of phenomena received the term of the *polarization* of light.

Light may by reflection be affected in a similar manner; and the discovery of polarization by reflection has led the way to a most brilliant series of discoveries and speculations on the properties and nature of light. *NAT. PHIL.*, *Double Refraction and Polarization of Light.*
Physics, Arts. 247—251.

LECTURE XVI.

THEORY OF LIGHT.

130. Light may be supposed to be an undulation excited in an elastic medium.

It is necessary to refer the various phenomena of light to some mechanical action, of which a distinct conception may be formed. It is supposed in the undulatory theory that light is an effect of the action of a very elastic medium termed ether, as sound is the effect of the action of air. This medium is supposed to be of unlimited extent, and to occupy the space void of ponderable matter in the interior of bodies: the sensation of light is referred to the mechanical action of the vibration of ether on the eye or organs of seeing, as the sensation of sound is referred to the effect of the mechanical action of the aërial vibrations on the ear or organs of hearing.

Thus we have waves of light as of sound, and any portion of a large wave may be separated from the rest and considered as the origin of a fresh wave diverging from it.

According to the other theory, that of emission, light is referred to the mechanical action of particles projected forward from the luminous body in every direction.

Independently, however, of the fact that many of the phenomena are utterly inexplicable on this hypothesis, we cannot conceive it possible for particles to be transferred with the immense velocity at which we know light to travel. Motion must be supposed to exist wherever there is light; the only motions with which we are acquainted are motions of translation and of vibration.

131. Each portion of a wave of light on meeting with a reflecting or refracting surface may be supposed to originate a fresh series of waves.

The reflection of light is explained by supposing that the new wave moves with equal velocity in every direction; the refraction of light by supposing that the new wave moves with less velocity within the refracting surface than in the air. The laws of reflection and refraction are readily explicable on these principles.

The focus is the point at which all the waves unite after reflection or refraction; this point becomes the origin of a fresh series of spherical waves which diverge in every direction.

132. The phenomena of interference are necessarily involved in the theory of undulations.

Two waves starting from two different sources may be so related as to conspire to augment or diminish the vibrations of the ether. This may be illustrated by conceiving that we have two liquids, as oil floating above water, and that, a similar undulation existing in each, the crest of the wave in oil is exactly over the hollow of the wave of the other, the surface will be level instead of undulated; here one wave is said to interfere with the other and to produce rest, and this takes place when one wave is half its length in advance of the other.

If now the crests and hollows of the wave coincide, the elevation and depression are doubled. In light we may suppose that the waves may be so related that the motion of the particles will be augmented in some cases and destroyed in others. The intensity of the light will be increased or diminished accordingly.

We are driven to some hypothesis of this nature to explain and express the fact that one portion of light may be added to another portion and produce absolute darkness, and that this takes place whenever one portion of the light has travelled some odd multiple of a certain quantity, called half the length of the wave, further than the other portion.

The waves of light do not, as in sound, diverge in every direction on passing through a hole, which is the necessary consequence of the lengths of the waves being indefinitely smaller than the breadth of the hole.

The phenomena which are not perfectly explicable on the theory of undulations are few; whereas no theory of emission can account for many phenomena. The theory of undulations may be false, but the theory of emission cannot be true.

See Brewster's *Optics*.
Encyclopædia Metropolitana, Art. Light.
Young's *Lectures*.
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SIR, *August*, 183

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