FIRST

ANNUAL CATALOGUE

OF THE

OFFICERS AND STUDENTS,

AND

Programme of the Course of Instruction,

OF THE

SCHOOL OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY,

1865-6.

BOSTON:
PRINTED BY JOHN WILSON AND SONS.
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MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

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NAMES OF STUDENTS.

The asterisk (*) denotes Students of the Session of 1864–5, who are still members of the School. The dagger (†), Students of the Session of 1864–5, who are not now members of the School.

Adams, Edward Dean . .	Boston	Special Student.
Allen, Frank Howard . .	Somerville . . .	Special Student.
*Appleton, Nathaniel Walker	Lowell	First Year.
*Bailey, Abraham	Charlestown . .	Second Year.
Blashfield, Edwin Howland .	Brooklyn, N.Y. .	First Year.
Bouvé, Walter Lincoln . .	Boston	First Year.
Bowditch, William Ernestus	Brookline . . .	First Year.
*Bowers, Harry Clay . . .	Philadelphia, Penn.	First Year.
Brooks, John Henry . . .	Milton	First Year.
Buck, Stuart M.	Boston	Special Student.
Cabot, Lincoln	Brookline . . .	First Year.
Chapin, Josiah Lewis . .	Lawrence . . .	Second Year.
Chapin, Edward Pike . .	Lawrence . . .	First Year.
Child, Samuel Guild . . .	Boston	First Year.
Cleveland, Henry Russel . .	Danvers	First Year.
Colburn, Walter Warren . .	Somerville . . .	First Year.
Conant, Nelson Whitney .	Louisville, Ky. . .	Second Year.
Cushing, Ben Lincoln . .	Cambridge . . .	First Year.
*Cutler, Elisha Pomeroy, Jr.	Charlestown . .	Second Year.
Devereux, Walter Forrest .	Salem	Special Student.
*Eastwood, Sam	Framingham . .	Second Year.

Edmands, John Rayner . .	Boston	First Year.
Firth, Frank Russell . . .	Boston	Second Year.
*Forbes, Eli	Clinton	Second Year.
Forbes, John Malcolm . .	Milton	First Year.
Fox, James Taylor . . .	Boston	Second Year.
Gelett, William	Kingston	Second Year.
Gilman, Charles Chadbourne	Chelsea	Second Year.
†Gorham, Arthur	Jamaica Plain . .	Special Student.
*Hall, Albert Francis . . .	Charlestown . . .	Second Year.
Harris, Edward Crehore . .	Roxbury	First Year.
†Higginson, Louis	Cambridge . . .	
Hough, Benjamin Kent, Jr.	Boston	First Year.
*Jackson, William . . .	Brighton	Second Year.
*Kreissmann, Charles . .	Boston	Second Year.
Ladd, William Jones . . .	Portsmouth . . .	Second Year.
*Lee, Charles Tennant . .	Charlestown . .	First Year.
Parkman, Henry	Boston	First Year.
Peck, John, Jr.	New York, N.Y. .	Second Year.
Perkins, Frank Henry . .	Boston	Second Year.
*Peterson, Andrew C. . .	Roxbury	First Year.
Poole, Herman	Boston	Second Year.
*Preble, Henry Oxnard . .	Cambridge . . .	First Year.
Preston, George Williams .	Boston	First Year.
Richards, Robert Hallowell .	Boston	Second Year.
Ritchie, Andrew Montgomery	Brookline . . .	First Year.
Ritchie, Thomas P. . . .	Brookline . . .	Special Student.
*Ross, Waldo Ogden . . .	Boston	First Year.
*Russell, Andrew Howland .	Plymouth . . .	Second Year.
Safford, Edward Stanley . .	Boston	Second Year.
Saltmarsh, Ernest Olmsted .	Hubbardston . .	Second Year.
*Sanford, Oliver Nason . .	Dorchester . . .	First Year.
Saroni, Charles Albert . .	Salem	First Year.
Sears, Walter Herbert . .	Plymouth . . .	Second Year.
†Sherman, F. C.	Brookline . . .	Special Student.

Smith, Charles Augustus	Newburyport	Second Year.
Standish, Miles	New Bedford	Second Year.
*Stevens, Eben Sutton	Webster	Second Year.
*Stone, Joseph	Charlestown	Second Year.
Stimpson, Frederic E.	Jamaica Plain	Special Student.
*Thom, George Henry	Bedford	First Year.
*Thorndike, George Francis	Boston	Second Year.
*Tilden, Bryant Parrott	Boston	Second Year.
*Tolman, James Pike	Roxbury	Second Year.
*Tryon, William	Boston	First Year.
*Tuckerman, Walter	New York, N.Y.	First Year.
Wardwell, Theodore Eames	Roxbury	First Year.
White, Henry Kirk	Chelsea	Second Year.
Whiting, Warren Mason	Framingham	First Year.
*Willey, Walter Tolman	Boston	First Year.
Wainwright, Isaac Parker	Boston	Special Student.
Wyman, George Dana	Woburn	First Year.

SCHOOL

OF THE

INSTITUTE OF TECHNOLOGY.

THE objects of the School of the Massachusetts Institute of Technology are, —

First, To provide a full course of scientific studies and practical exercises for students seeking to qualify themselves for the professions of the Mechanical Engineer, Civil Engineer, Practical Chemist, Engineer of Mines, and Builder and Architect.

Second, To furnish such a general education, founded upon the Mathematical, Physical, and Natural Sciences, English and other Modern Languages, and Mental and Political Science, as shall form a fitting preparation for any of the departments of active life; and, —

Third, To provide courses of Evening Instruction in the main branches of knowledge above referred to, for persons of either sex who are prevented, by occupation or other causes, from devoting themselves to scientific study during the day, but who desire to avail themselves of systematic evening lessons or lectures.

REGULAR COURSE.

The studies and exercises of the first and second years, and the course of general studies in the third and fourth years, are required of all regular students. At the beginning of the third year, each regular student may select one of the following six courses, with a view of obtaining the corresponding degree or diploma:—

1. A Course in Mechanical Engineering.
2. „ „ „ Civil and Topographical Engineering.
3. „ „ „ Practical Chemistry.
4. „ „ „ Geology and Mining.
5. „ „ „ Building and Architecture.
6. „ „ „ General Science and Literature.

Special students will be admitted to partial courses in any of the departments of the School.

CONDITIONS OF ADMISSION.

To be admitted to the first year's course, the student must have attained the age of sixteen years, and must give satisfactory evidence, by examination or otherwise, of a competent training in arithmetic, algebra, geometry, English grammar, geography, and the rudiments of French. It is particularly important that applicants should write a rapid and legible

hand, as the examinations and other exercises of the School will be in great part conducted in writing. In general, the training given at the best High Schools and Academies will be a suitable preparation for the studies of this School.

In order to enter the second year's course, the student must be at least seventeen years of age, and must give evidence, by examination or otherwise, of such knowledge of the first year's studies as would enable a student of the first year to pass into the second; and a like rule will apply to the case of students seeking admission into the classes of the succeeding years.

To make the opportunities of instruction as widely accessible as possible, students will be allowed to enter special divisions of either of the courses, — as, for example, the classes of mathematics, of mechanical construction, of chemistry, of physics, or of mining and metallurgy, — on giving satisfactory evidence that they are prepared to pursue such special studies with advantage.

FIRST YEAR.

I. — Mathematics.

1. *Algebra.* — Quadratic Equations; Imaginary Expressions; Ratio; Proportion; Progression; Permutations and Combinations; Binomial Theorem; Indeterminate Coefficients; Theory of Logarithms, with Construction and Use of Tables; Elements of Probability.
2. *Plane Trigonometry.* — Different Methods of Measuring Angles; Trigonometrical Ratios and Functions; Construction and Use of Trigonometrical Tables; Solution of Triangles; Inverse Trigonometrical Functions; De Moivre's Theorem, with Applications.

3. *Solid Geometry.* — Plane and Solid Angles; The Prism and Pyramid; The Sphere, Cylinder, and Cone; Spherical Angles and Polygons.
4. *Spherical Trigonometry.* — Deduction of the Formulæ; Properties of Triangles and Polygons; Napier's Circular Parts and Analogies; Bowditch's Rules; Gauss's Equations; Solution of Right and Oblique Angled Triangles.

II. — Mechanical Drawing.

The use of mathematical instruments, and of water-colors and India-ink, will be taught in connection with the instruction in Geometry and Trigonometry. The course will include the graphical construction of problems in these branches.

III. — Free-hand Drawing.

Instruction will be given in drawing with chalk upon the black-board, and with charcoal, crayons, the pencil, and pen and ink. The students will draw from models, casts, and photographs, and from studies of landscape.

IV. — Elementary Mechanics.

1. *General Doctrine of Motions and Forces.* — Mechanical Constitution of Matter; Uniform and Varied Right-line Motions, and the Forces producing them; Composition and Resolution of Forces applied to a point.
2. *Mechanics of Solids.* — Composition of Forces applied to different points in a Mass; Statical Moments; Parallel Forces; Couples; Centre of Gravity; Kinds and Criterion of Equilibrium; Laws of Gravity; the Pendulum; Curve-line Motion; Motion of Projectiles; Molecular Actions; Friction, Elasticity and Strength of Solid Materials; Impact of Elastic and Inelastic bodies; Elements of Machinery; Statical and Dynamical Equilibrium of Machines; Principle of Virtual Velocities; Nature and Measure of Mechanical Work; Vis Viva.

3. *Mechanics of Liquids and Gases.* — Pressure and Equilibrium of Liquids; Pressure on Plane and Curved Surfaces; Centre of Pressure; Principle of Archimedes; Exercises in finding Specific Gravities of Solids and Liquids; Equilibrium of Floating Bodies; Motion and Moving Force of Liquids; Flow of Water through Orifices, Tubes, &c.; Principle of Torricelli; Nature of Liquid Vein; Impulse and Resistance of Water; Pressure and Equilibrium of Gases; Weight and Compressibility of Atmosphere; Air Barometers; Measurement of Heights; Mariotte's Law; Machines for rarefying and condensing Air; Motion and Moving Force of Airs; Flow of Air and Gases; Friction and Resistance of Air; Hydraulic and Pneumatic Instruments and Machines; Capillarity and Osmotic Force; Mechanism of Waves.
4. *Phenomena and Laws of Sound.* — Velocity in different Media, Reflection, Refraction; Musical Sounds, Intervals, the Gamut; Laws of Vibration of Columns of Air, Rods, Cords, Bells; Musical Instruments; Speech and Hearing.

V. — Chemistry.

The Elements of Inorganic Chemistry will be treated of in two courses, — of which the first will include the Chemistry of the Non-metallic Elements; the second, the Chemistry of the Metals.

In the first course, the laws of Chemical Action and Combination will be explained and illustrated, in connection with a systematic description of the several metalloids and of their most important combinations.

The non-metallic elements will be studied in the order of the following groups: —

Oxygen,	Fluorine,	Nitrogen,	Hydrogen.
Sulphur,	Chlorine,	Phosphorus,	
Selenium,	Bromine,	Arsenic,	Carbon,
Tellurium.	Iodine.	Antimony,	Boron,
		Bismuth.	Silicon.

The second course will include the preparation and proper-

ties of the chief metals, and of their most useful or remarkable compounds: —

Lithium,	Magnesium,	Aluminum,
Sodium,	Zinc,	Chromium,
Potassium,	Cadmium.	Manganese,
Silver.		Iron,
	Palladium,	Cobalt,
Calcium,	Tin,	Nickel,
Strontium,	Platinum,	Uranium.
Barium,	Iridium,	
Lead.	Gold.	Copper,
		Mercury.

In both these courses, the principles of Chemical Nomenclature and Classification, and the more striking facts in the History of the Elements and the present state of Chemical Theory, will be dwelt upon at such length as is consistent with the general elementary character of the lectures; but special attention will always be given to the description of those substances and processes which are of importance in common life or in the useful arts.

Practical instruction in Chemical Manipulations will also be given in the Laboratory to every student. This series of lessons will include practice in the construction and use of apparatus for preparing and experimenting with the common gases, acids, bases, salts, &c., which have been described in the lectures.

VI. — English Language and Literature.

The studies of the English department will embrace, 1st, Exercises in English Composition, arranged with special reference to the future wants of the students, and embracing, besides written abstracts of lessons, practice in the writing of letters, preparing of reports, &c., and having mainly in view the acquirement on the part of the students of a habit of clear, precise, and accurate statement of their thoughts upon paper. 2d, Lectures on the history and structure of the English language. 3d, The critical study of standard English writers.

A knowledge of the Latin language is not required for admission, and the course of instruction in English will be adapted to the wants of those who have not, as well as of those who have, studied it. But in view of the great importance of some knowledge of the language as an element in a thorough study of English as well as of French and the languages of Southern Europe, it is strongly recommended to pupils to acquire, whenever possible, such a knowledge of Latin as will enable them, at least, to read easy Latin prose.

VII. — Modern Languages.

In the study of the Modern Languages, the practical purposes of men engaged in scientific pursuits will be kept in view. Hence they will not be cultivated as *accomplishments;* but the first aim will be to enable the student to read such works as may have a bearing upon the studies pursued in the School, — so that, in the latter years of the course, French and German text-books may be used in any department, as well as English ones.

French alone will be studied during the first year, which will be devoted principally to reading, and to the translation of French into English. At the annual examination, a passage from any general work in French, free from too many idiomatic and conversational expressions or special technical terms, will be given to the student to be translated, without the assistance of the dictionary, into readable English.

SECOND YEAR.

I. — MATHEMATICS.

1. *Plain Co-ordinate Geometry.* — Elementary Principles and Definitions; The Point; Equations of the Straight Line, Circle, Parabola, Ellipse, and Hyperbola; General Equations of the First and Second Degrees, with Discussion and Tracing the Lines represented; Sections of a Cone; The Method of Abridged Notation, with Applications.
2. *Analytic Geometry of Three Dimensions.* — The Point; Equations of the Straight Line and Plane; and of Surfaces of the Second Degree, with their Classification and Properties.
3. *Differential Calculus.* — General Principles, Definitions, and Notation; Derivatives of the Simple Functions, with Rules and Applications; Derivatives of the Inverse Trigonometrical and Complex Functions; Successive Derivatives; Taylor's and Maclaurin's Theorems; Change of Independent Variable; Applications of the Differential Calculus to Indeterminate Forms, to Maxima and Minima, to Discussion of Curves, &c.
4. *Integral Calculus.* — First Principles and Notation; Limits of an Integral; Immediate Integration of Known Derivatives; Integration by Substitution and by Parts; Integration of Rational Fractions; Formulæ of Reduction; Applications of the Integral Calculus to finding the Lengths of Curves, Areas of Surfaces, Volumes of Solids, &c.

In all the mathematical studies, special attention will be paid to the elementary portions of the subjects; and the wants of the student, during his Professional Course, will be the guide in the applications, and in the selection of examples and illustrations. Parts of the Integral Calculus will immediately follow the corresponding parts of the Differential Calculus; and the two will be carried on together, both in the theory and applications.

II. — Navigation and Nautical Astronomy.

1. *Navigation.* — Theory and Use of the Mariner's Compass, Chronometer, and Sextant; Plane, Traverse, Parallel, Middle Latitude, Mercator's, and Great-Circle Sailing; Parallax; Refraction; Dip of the Horizon; Semidiameters; Time; Use of the Nautical Almanac, &c.
2. *Nautical Astronomy.* — Altitudes; Azimuths; Time and Hour Angles; Latitude; Longitude; Sumner's Method; Latitude and Longitude by Double Altitudes, &c.

III. — Surveying.

Surveying by Measurement of Lines alone; Compass Surveying; Trigonometrical Surveying; Levelling; Topographical Surveying; Plane Table Surveying; Theory and Adjustments of Instruments; Field-practice in the preceding branches; Office-practice in Plotting Surveys, Computing Areas, &c., and in Drawing Plans.

IV. — Descriptive Geometry and its Applications.

Object of Descriptive Geometry; Method of Projections; Problems of Position relative to the Point, the Right Line, and the Plane; General Method of Changing the Planes of Projection; Method of Rotations; Solution of Special Problems by each of the preceding methods.

Representation of Surfaces of Single and of Double Curvature; Tangent Planes; Intersection of Cylinders and Cones by Planes, and subsequent Development of the Curves of Intersection; Intersection of Curved Surfaces.

Application of the preceding principles to various problems of Shades and Shadows; Isometric and Spherical Projections and the Construction of Maps.

Homologic Transformation.

Generation and Principal Properties of Developable Surfaces.

General Theory of Warped Surfaces.

Principal Properties of the Hyperbolic Paraboloid, the Hyperboloid, and the Helicoids.

Descriptive Geometry of one Plane, and its Application to Topography.

The above course will be illustrated by a set of models in relief.

V. — Mechanical Drawing.

The course of the previous year will be continued with applications to orthographical, isometric, and spherical projection, perspective, and shades and shadows, in connection with the instruction in Descriptive Geometry.

VI. — Freehand Drawing.

The exercises of the previous year will be continued, with modelling in clay and plaster, and the use of water-colors and distemper.

VII. — Experimental Physics.

1. *Phenomena and Laws of Heat.* — Expansion; Specific and Latent Heat, Fusion, Boiling, Evaporation; the Spheroidal State; Tension of Vapors; Saturated and Superheated Steam; Hygrometers, Steam Gauges; Radiation, Transmission, Absorption, Reflection, and Refraction of Heat; Luminous and Obscure Rays; Conduction and Convection; Sources and Mechanical Equivalent of Heat; the Steam Engine.
2. *Phenomena and Laws of Light.* — Intensity; Photometers; Reflection by Plane and Curved Mirrors; Refraction by Prisms and Lenses; Dispersion; the Spectrum; Achromatic Combinations; the Spectroscope, and its Uses; the Eye and Vision; Optical Instruments; Diffraction; Law of Interference; Doctrine of Undulations; Double Refraction and Polarization.
3. *Phenomena and Laws of Magnetism.* — Magnetic and Diamagnetic Bodies; Magnetizing by Induction; Terrestrial Magnetism; Declination Dip, and Intensity; Magnetic Charts; Mariner's Compass.
4. *Phenomena and Laws of Electricity.* — (1) Static Electricity, — Excitation, Distribution, Tension, Dissipation, Induction, Polarization of Particles, Electroscopes, Electrical Machines, Condensers, the Spark; Atmospheric Electricity. (2) Dynamic Electricity, — Voltaic and Thermo-electric Circles and Batteries; Effects of Current; Intensity, Ohm's Law; Rheometers; Electro-plating and Gilding; the Electric Light; Mutual Action of Currents; Action of Currents and Magnets; Induced Currents, Induction Coils; the Electric Telegraph.

VIII. — Chemistry.

A systematic course of instruction will be given in Qualitative Analysis by laboratory practice, and oral and written examinations.

The object of this instruction will be to enable the student to detect and prove the presence of any chemical element, whether in a simple or compounded condition. He will be taught to detect and isolate the more common bases and acids; and subsequently he will be exercised in the application of his acquired knowledge to the analysis of substances whose composition is unknown to him.

IX. — English.

The course for this year will embrace the study of General and Comparative Grammar (in connection with the instruction of the Professor of Modern Languages), the further and more minute study of the history and structure of the English language, the reading of English standard writers, and continued practice in Composition.

X. — Modern Languages.

German will be commenced the second year, and taught upon the same principles as French during the first year. The annual examination will embrace the common forms of German Grammar, verbs, &c., and a passage of easy German prose, to be translated without the aid of a Dictionary.

The study of French will be continued. An advanced class will be formed, composed of students of the second, third, and fourth years, in which they will have an opportunity to acquire some knowledge of the literature of the language; and, so far as practicable in such a course, they will be instructed in the conversational forms.

THIRD AND FOURTH YEARS.

Up to the end of the second year, the studies are the same for all regular students; each thus obtaining such an acquaintance with the whole field of practical science as is needed for the further pursuit of the studies of the School, in any of its departments: but, at the beginning of the third year, the system becomes so far elective, that each student may select one of the courses of study prescribed for the attainment of a degree.

Outlines of the Professional Courses are appended, and an enumeration of the General Studies of these two years. Detailed programmes will be given hereafter.

I. — Course in Mechanical Engineering.

1. *Analytic Mechanics.*

2. *Applied Mechanics;* comprehending —

   Strength of Materials, and Stability of Structures.
   Estimation of the Resistances of Friction and Rigidity.
   Pure and Applied Cinematics.
   Dynamics of Solids, and the Application to the Theory of Machines.
   Hydrostatics and Hydrodynamics.
   Thermodynamics.
   Estimation of the Useful Effect of Machines.

3. *Construction of Machines.*

   Calculation of the Strength and Proportions of the Parts of a Machine.
   Hand Machinery; as, Cranes, Derricks, Pumps, Turn-tables, &c.
   The Hydraulic Motors; Water-wheels, including Turbines; Water-Pressure Engines.
   Power and Strength of Boilers.
   Steam Engines, — Stationary, Locomotive, Marine; Air and Gas Engines.

Construction and Arrangement of Machinery in Mills for Grinding, for Textile Manufactures, &c.

4. *Descriptive Geometry applied to Masonry, Carpentry, and Machinery.*

Drawing of Machines, Working Plans and Projects of Machinery, Mills, &c.

5. *General Studies.* (See p. 24.)

II. — Course in Civil and Topographical Engineering.

Analytic Mechanics; Applied Mechanics; Spherical Astronomy.

Higher Geodesy; Determination of Latitude and Longitude; Levelling by Barometer.

Survey, Location, and Construction of Roads, Railways, and Canals.

Measurement and Computation of Earth-work and Masonry.

Hydrographical Surveying; Tide Gauges; Soundings.

River and Harbor Improvements.

Descriptive Geometry applied to Masonry and Carpentry.

Structures of Wood; Framing; Trusses, Girders, and Arches; Roofs and Bridges.

Structures of Stone; Foundations; Retaining Walls; Arches; Bridges.

Structures of Iron; Foundations; Beams, Girders, and Columns; Roofs and Bridges.

Geology and Chemistry of the Materials used in Construction.

Supply and Distribution of Water; Distribution of Gas; Drainage.

Field-practice.

The Drawing of Plans, Profiles, Elevations, Sections, &c.

General Studies. (See p. 24.)

III. — Course in Practical Chemistry.

1. *Industrial Chemistry.*

Chemical Analysis, Quantitative; both Inorganic and Organic, embracing the Analysis and Commercial Testing of —

Ores, Metals, Alloys, and Mineral Materials; Soda-ash,

Bleaching-salt, Saltpetre, Paints, Drugs, and Manures; Drinking and Mineral Waters.

Lectures on Industrial Chemistry; on the Manufacture of Glass, Pottery, Soda-ash, Acids, Soap, Gas, &c.; on the Arts of Dyeing, Calico-Printing, Tanning, Brewing, Distilling, &c.

Descriptive Mineralogy.

Drawing, — of Apparatus, and of Machinery and Plans for Chemical, Dyeing, and Print-Works.

2. *Metallurgy.*

Special Geology of Coal, Iron, &c.; as in the course of Practical Geology and Mining.

Chemical Analysis; including, chiefly, Assays in the Wet and Dry Ways of Ores, Fluxes, Slags, and of the Metals and their Alloys.

Lectures on Metallurgy.

Metallurgical Implements, Structures, and Processes; Crucibles, Furnaces, Blowing-machines, Fuels, and Fluxes.

Details of the Smelting and Manufacture of Iron, Copper, Lead, Zinc, Silver, &c.

Drawing, — Plans and Projects for Furnaces, Refineries, Hot and Cold Blast Apparatus, &c.

3. *General Studies.* (See p. 24.)

IV. — Course of Practical Geology and Mining.

Chemical Analysis, Quantitative; as under the preceding head.

Descriptive and Determinative Mineralogy; Use of the Blowpipe.

Lectures on Combustion and Fuel, and on Warming, Ventilating, and Lighting.

Historical Geology, and Paleontology, — Successive Systems, Groups, and Formations, with their leading Fossils.

Detailed Study of the Geology of North America.

Special Geology of Coal, Iron, Copper, Salt, Plaster, &c., with particular reference to North-American localities; and an account of important Mines, Quarries, &c.

Lectures on Mining.

Prospecting, Breaking Ground, Boring, Blasting, Tubing, Sinking Shafts, Driving Tunnels, Ventilating and Lighting.

The different Methods of working Mines.

Mining Machinery and Motors, — Engines, Horses, Pumps, Wagons, Drums, Ropes, &c., for conveying and raising the Material.

The Dressing and Concentration of Minerals, — Crushers, Stamps, Washers, Amalgamators, &c.; and Machinery used in the Pennsylvania Anthracite Region.

Quarrying and Open Mining.

Details of Mining in this country; with History, and Statistics of Mining generally.

Drawing, — Topographical and Geological Sections and Maps; Conventional Representation of Rocks; Coloring of Maps and Sections; Plans and Sections of Mines, Quarries, and other open Workings; Mining, Machinery, and Implements.

General Studies. (See p. 24.)

V. — Course of Building and Architecture.

The first two years' course affords such a knowledge of Mathematics, Chemistry, Physics, and Drawing, as will best enable students to pursue this course to advantage. Other students, however, will be admitted to it as special pupils; and it is hoped that practising draughtsmen, whose opportunities of study are limited, will avail themselves of those here offered. The courses of study will be extensive and thorough; but their object will be to furnish the instruction and discipline that cannot be obtained elsewhere, rather than to cover the whole ground of architectural study. Much of the ordinary detail of work must necessarily be left for the students to acquire in architects' offices. The course will, however, be practical, as well as theoretical, and will embrace the scientific study of construction and of materials, in connection with the courses of Engineering above described, as well as that of composition and design, and of the history of the art. It will consist chiefly of a series of projects in con-

struction and design, to be worked out by the student. These will be illustrated by lectures upon the theory and practice of the art, pertinent to the subjects in hand.

The General Studies will be required of the regular students in this department. (See p. 24.)

VI. — Course of Science and Literature.

This course, besides including all the "General Studies" of the third and fourth years, as hereafter enumerated, will embrace selections from the following list of scientific studies: —

Analytical Mechanics and Astronomy.
Specialties of the Professional Courses.
Physics (continued).
Analytical and Higher Chemistry.
Geology (continued).
Zoology, Botany, and Paleontology; Physiology and Comparative Anatomy.

In making the selection, regard will be had, in each case, to the best scientific training of the student, to his special aptitudes for science, and to his future aims in life.

GENERAL STUDIES.

In connection with these six courses, instruction will be given to all regular students during the third and fourth years, as follows: —

1. Extended Study of French and of German, for the first of which either Spanish or Italian may be substituted.
2. Lectures on History, Political Economy, and the Science of Government.
3. Lectures on Mental and Moral Philosophy.
4. Instruction in Logic, Rhetoric, and the History of English Literature.
5. Instruction in Zoölogy, Physiology, and Botany.

STEREOTOMY AND PERSPECTIVE.

The instruction in Descriptive Geometry will be extended during the third and fourth years so as to embrace the practical problems which occur in the construction of stonework, carpentry, and machinery, such as the making of zinc and pasteboard patterns for arches, domes, and staircases, for the articulations of timber, and for the parts of machines.

The study of Projections will also be extended, so as to embrace the various methods of Rectilinear and Panoramic Perspective, with the delineation of shadows and reflections.

DRAWING.

After the first two years, the students will have exercises in Mechanical and Freehand Drawing, and in modelling in clay and plaster, appropriate to the special subjects upon which they are engaged. Instruction will be given under the supervision of the several professors, in the making of the sketches, diagrams, patterns, models, and working drawings used in their respective departments, as is indicated in the detailed outlines of the several courses given above.

The elements of Lithography and Photography will be taught to such as desire to learn them.

MILITARY TACTICS.

The regular students of the School will be taught the use of small-arms, and the simpler parts of tactics; and, for this purpose, will be organized into one or more companies, to meet on stated days for military instruction and exercise.

METHODS AND APPARATUS OF INSTRUCTION.

The instruction in this department of the School will be given through the medium of—

1. Lectures and Familiar Expositions.
2. Oral and Written Examinations.
3. Practice in Physical and Chemical Manipulations.
4. Laboratory Training in Chemical Analysis, Metallurgy, and Industrial Chemistry.
5. Drawing and the Construction of Special Plans and Projects of Machines and Works of Engineering and Architecture.
6. Practical Exercises in Surveying, Levelling, Geodesy, and Nautical Astronomy.
7. Excursions for the Inspection and Study of Machines, Motors, Processes of Manufacture, Buildings, Works of Engineering, Geological Sections, Quarries, and Mines.

I.—LECTURES AND EXPOSITIONS.

As a general rule, each lecture will be preceded by an examination on the previous one, in which the teacher will have the opportunity of re-enforcing the instruction already given, as well as of testing the progress of individual students.

Every student will be required to take notes of the lectures as they proceed, and, in addition to these notes, he will be expected to study or to consult text-books or works of reference, whenever such are appointed to be used. But in view of the value of the method of lectures, combined with examinations, as a means of commanding the attention and stimulating the zeal of students, this method will be used whenever practicable; and in no case will mere text-book recitation be exclusively relied upon.

II. — WRITTEN EXAMINATIONS.

Besides the daily oral examinations already referred to as accompanying the lectures, written examinations will be held once a month, at which each class will be examined in the subjects lectured upon or appointed for study during the interval just elapsed.

At or near the close of each half of the School Year, viz., in the months of February and May, *general examinations* will be held; that of February embracing the subjects studied during the first half-year, that of May covering the studies of the whole year. No student who fails to pass the annual examination will be permitted to enter upon the studies of the following year.

III. — PRACTICE IN PHYSICAL AND CHEMICAL MANIPULATIONS.

It will be the object of these exercises to make the student practically familiar with the adjustments and use of the apparatus and agents employed in the more important experiments and processes in natural philosophy and chemistry. With this view, the students, under the direction of their teacher, will be called, by small classes at a time, to execute with their own hands various experiments in mechanics, pneumatics, sound, optics, electricity, and other branches of experimental physics, to exhibit chemical re-actions, to fit up chemical apparatus, to prepare gases and other products, and demonstrate their properties by suitable experiments; accompanying these manipulations, when required, with an explanation of the apparatus used or of the process or experiment performed.

A high value is set upon the educational effect of laboratory practice, in the belief that such practice trains the senses to observe with accuracy, and the judgment to rely with confidence on the proof of actual experiment.

IV. — LABORATORIES AND LABORATORY TRAINING.

The laboratory arrangements of the School are designed, when complete, to embrace the following departments: —

1. Laboratory of Physics and Mechanics.

In this laboratory, it is proposed to provide implements and apparatus with which the student may be exercised in a variety of mechanical and physical processes and experiments. Thus he may learn practically the methods of estimating motors and machines by the dynamometer, of experimenting on the flow of water and air and other gases, and of testing the strength of the materials used in construction. He may become familiar with the adjustments and applications of the microscope; be trained in observing with the barometer, thermometer, and hygrometer; and, in a room fitted up for photometry, may learn the mode of measuring the light produced by gas and other sources of illumination, and the value of different kinds of burners, lamps, and their appendages.

2. Laboratories for Chemical Analysis.

In these laboratories, provision will be made for a complete and comprehensive course of instruction in qualitative and quantitative analysis, embracing organic as well as inorganic substances, and blending lectures with the systematic practice of the laboratory.

3. Laboratory for Metallurgy.

Connected with the general laboratories is a laboratory of metallurgy, designed for special instruction in whatever relates to practical mineralogy, the chemical valuation of ores, and the operations of smelting and other processes for the separation and refining of metals.

In aid of these instructions, the student will have the opportunity of studying the models of mines, and of mining and metallurgical implements and machinery, and the collections of rocks, fossils, minerals, and ores, with their manufactured products, provided and arranged specially to facilitate his studies in this department.

4. Laboratory for Industrial Chemistry.

It is further proposed to connect with the general laboratories a department of industrial chemistry, where students may have an opportunity of becoming practically familiar with the materials, implements, and processes of the more important chemical arts and manufactures.

In this department will be provided a collection of dye-stuffs, mordants, discharges, and other substances used in the operations of dyeing, color-printing, and bleaching; together with such apparatus as may be necessary, on a small scale, to exemplify these several processes as in actual use.

Here the student will have access to sets of specimens, embracing the crude materials and products of the glass and pottery, and brick and tile manufactures, the different soaps, soda-ash, bleaching-salts, acids, saline products, lakes, pigments, inks, cements, tanning substances, and other materials and products of the chemical arts; and will be provided with facilities for studying practically the re-actions and processes connected with their use and manufacture.

Provision will also be made in this laboratory for the practical illustration of the chemical modes of engraving and lithography; and for exhibiting the various methods and processes of electro-metallurgy as applied to silvering, gilding, and the deposition of copper and brass.

V. — VISITS AND EXCURSIONS FOR OBSERVATION AND PRACTICE.

In aid of the practical studies of the School, and as a means of initiating students into the actual details of the professions for which they are preparing, they will be required from time to time, in the progress of the course, assisted by one or more of their teachers, to make visits of inspection to machine-shops, engines, mills, furnaces, and chemical works, and to important buildings and engineering constructions which are within convenient reach.

With a like view, and under the same direction, they will be expected to spend a part of the vacations of the second and third years in excursions for observation and practice, extending sometimes to distant points, and so arranged as to afford to each class the experience and training most likely to be useful to them in their future pursuits.

Thus, in consonance with their special studies, they will severally employ themselves in the details of road, railway, and topographical surveys, barometric measurement, triangulation, and geodetic astronomy; in taking notes and making drawings of such processes, machinery, works of engineering, and buildings, as are instructive or remarkable; and in making themselves practically familiar with the working details of laboratories, print-works, furnaces, forges, rolling-mills, and founderies; with the methods of geological exploration, the tracing of veins and beds, the sinking of shafts, the conduct of open and underground operations, the mechanical arrangements for raising the product to the surface and preparing it for use; and, in general, with all the processes and constructions appertaining to the practice of industrial metallurgy and the working of quarries and mines.

THE SCHOOL YEAR.

The School Year begins on the first Monday in October, and ends on the Saturday preceding the first Monday in June.

On Christmas and New Year's Day, Thanksgiving and Fast Days, and other legal holidays, the exercises of the School will be suspended.

The examinations for admission will take place in the first week of June and the last week of September.

FEES.

The fee for the first year's course will be $100; for the second, $125; and for the third and fourth, $150 each; payable, one half at the beginning, and one half at the middle of the School year.

Each student will be furnished with the necessary apparatus, which he will be expected to restore in as good order as when received.

The fees for special students will vary according to circumstances, and the length of the course.

DISCIPLINE.

All the exercises of the School will be included within the hours of 9, A.M., and 5, P.M., with an interval for dinner. During these hours, or while within the building of the Institute, students will be expected to behave with decorum, and to comply with the regulations of the school. Conduct inconsistent with the good order of the School will be followed by the dismissal of the offender. Beyond the limits of the Institution, the student is in no way under the control of the Faculty.

It will be observed that the hours are so arranged, that

students living in towns adjoining Boston, or residing at a considerable distance, can attend all the exercises.

A punctual attendance upon all prescribed exercises will be required, and a regular return of absences will be made to the parent or guardian of each student.

GRADUATING EXAMINATIONS.

The examinations for degrees will be held in the month of May, and will be partly oral and partly in writing. In both, the questions will range over the entire series of studies on which the student is required to be prepared.

As part of these examinations, the candidates will be called upon to exhibit the drawings and projects prepared by them for the occasion, and to perform such laboratory manipulations and exercises as the Faculty may assign.

At the same time, the theses of the candidates will be presented for examination; and, where expedient, their authors will be called upon to explain or defend them.

DIPLOMAS AND CERTIFICATES.

As the diploma or certificate is intended to be not only a reward to the student for his diligence and attainments, but an assurance to the public of his knowledge and skill in the particular department of science to which it relates, it will be conferred on such students only as by their examinations and other exercises give proof that they possess the prescribed qualifications; but all persons who fulfil this requirement shall be entitled to the testimonials of the Institute, without regard to the length of time they may have spent in the School.

The degrees or diplomas corresponding to the leading divisions of the School will be as follows: —

1. A Degree in Mechanical Engineering.
2. „ „ „ Civil and Topographical Engineering.
3. „ „ „ Practical Chemistry.
4. „ „ „ Geology and Mining Engineering.
5. „ „ „ Building and Architecture.
6. „ „ „ General Science and Literature.

To be entitled to either of these degrees, the student must pass a satisfactory examination on the whole course of studies and exercises prescribed in his department, including the elementary and general, no less than the advanced and special subjects. He must, moreover, prepare a dissertation on some subject included in the course of study, or submit an original report upon some machine or work of engineering, or some mine or mineral survey, or scientific investigation, which shall be approved by the Faculty. He will be required, also, to have sufficient familiarity with French and German to be able to read without difficulty works in these languages relating to science and the arts.

Besides the degrees or diplomas covering the complete courses of study above referred to, there will be given certificates of attainment in special subjects to such students as, on examination, are found to have attained the required proficiency in them.

EVENING COURSES OF INSTRUCTION.

THIS department of the School is intended for the benefit of persons of either sex who are prevented by occupation or other causes from availing themselves of scientific instruction during the day, but are desirous of pursuing such studies in a systematic way by the aid of evening lessons and lectures. It will embrace a number of distinct courses, more or less varied from year to year by the omission or interchange of particular subjects, but including in their entire scope, instruction in mathematics, mechanics, physics, chemistry, geology, natural history, navigation and nautical astronomy, architecture, engineering, philology, and literature.

After the present year, in which the commencement of these courses is unavoidably delayed, they will be opened early in November of each session, and be continued for five months.

The programme of subjects, and the extent of the several courses, will be made known early in October of each year.

As it is the object of this branch of the School to provide substantial teaching, rather than merely popular illustration of the subjects, it is expected that all persons attending these courses will come with a serious purpose of improvement, and that they will cheerfully comply with such rules in regard to attendance and to order in the class or lecture-room as may be prescribed.

Except in the case of courses in which provision may be made for gratuitous instruction, a fee will be required, payable in advance, not exceeding five dollars for a course of not more than twenty lessons or lectures.

LOWELL COURSES OF EVENING INSTRUCTION.

The Trustee of the Lowell Institute proposes to establish, under the supervision of the Insitute of Technology, courses of evening instruction, to be open to students of either sex, free of charge.

For the present session, the courses included under this provision are as follows: —

A Course of Eighteen Lectures on Mathematics, by Prof. Runkle, on Tuesdays and Thursdays, at 7½ P. M., beginning Dec. 5, at 28, Chauncy Street, Room No. 1.

A Course of Eighteen Lectures on Descriptive Geometry, with Application to the Arts, by Prof. Watson, on Tuesdays and Thursdays, at 7½ P. M., beginning as soon as Prof. Runkle's course closes.

A Course of Eighteen Lectures on the Chemistry of the Non-metallic Elements, by Prof. Storer, on Mondays and Fridays, at 7½ P. M., beginning at a day hereafter to be announced.

A Course of Eighteen Lectures on the Chemistry of Metals, by Prof. Eliot, on Mondays and Fridays, at 7½ P. M., beginning when Prof. Storer's course closes.

A Course of Eighteen Lectures on the English Language and its Literature, by Prof. Atkinson, on Tuesdays, at 7½ P. M., beginning Dec. 5, at 16, Summer Street, Room No. 3.

A Course of Eighteen French Readings, by Prof. Bôcher, on Wednesdays, at 7½ P. M., beginning Dec. 6, at 16, Summer Street, Room No. 3.

The conditions of admission to these gratuitous courses will be, —

1. Candidates must have attained the age of eighteen years.
2. Their applications must be made in writing, addressed to the Secretary of the Faculty, specifying the course or courses they desire to attend, mentioning their present or prospective occupations, and, where the course is of a nature demanding preparation, stating the extent of their preliminary training.

3. No student will be admitted to more than four lectures per week during the session.
4. The number of students will be limited to forty in the Mathematical Class, forty in the Class of Descriptive Geometry, and one hundred in each of the other classes.

Should the number of candidates exceed the limits above stated, the prescribed number in each class will be drawn by lot.

TABULAR VIEW

OF THE

LECTURES AND EXERCISES OF THE STUDENTS.

Tabular View of the Lectures and Exercises of the Students of the First Year, 1865–66.

DAYS.	9—10½.	10½—12.	12—1½.	1½—3.	3—5.
MONDAY . . .	Mathematics . . .	Mechanical Drawing	Physics	. . . . .	. . . . .
TUESDAY . . .	Mathematics . . .	Freehand Sketching	English	. . . . .	French.
WEDNESDAY .	Mathematics . . .	Chemistry	Freehand Sketching	. . . . .	. . . . .
THURSDAY . .	Mathematics . . .	Mechanical Drawing	. . . . .	. . . . .	French.
FRIDAY . . .	Mathematics . . .	English	Physics	. . . . .	Chemical Manipulations.
SATURDAY . .	Mathematics . . .	Military Tactics . .	. . . . .	. . . . .	. . . . .

Tabular View of the Lectures and Exercises of the Students of the Second Year, 1865–66.

DAYS.	9—10½.	10½—12.	12—1½.	1½—3.	3—5.
MONDAY . . .	Descriptive Geometry	English	Physics	. . . . .	German.
TUESDAY . . .	Freehand Sketching	Mathematics . . .	Chemistry	. . . . .	Surveying.
WEDNESDAY .	Descriptive Geometry	Mechanical Drawing	Geology	. . . . .	German.
THURSDAY . .	Freehand Sketching	Mathematics . . .	Physics	. . . . .	Surveying.
FRIDAY . . .	Descriptive Geometry	Mechanical Drawing	Physics	. . . . .	Mathematics.
SATURDAY . .	Chemistry	Military Tactics . .	. . . . .	. . . . .	. . . . .