MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

TWELFTH

ANNUAL CATALOGUE

OF THE

OFFICERS AND STUDENTS,

WITH A

STATEMENT OF THE COURSES OF INSTRUCTION.

1876-1877.

BOSTON:
PRESS OF A. A. KINGMAN.
1876.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

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CONTENTS.

Extracts from Acts of the General Court of Massachusetts, in relation to the Massachusetts Institute of Technology.

Act of Incorporation. "William B. Rogers [and others named], their associates and successors, are hereby made a body corporate, by the name of the MASSACHUSETTS INSTITUTE OF TECHNOLOGY, for the purpose of instituting and maintaining a Society of Arts, a Museum of Arts, and a School of Industrial Science, and aiding generally, by suitable means, the advancement, development, and practical application of sciences in connection with arts, agriculture, manufactures, and commerce."

Chapter 183, *Acts and Resolves of* 1861.

Grant of Public Lands. "When the Massachusetts Institute of Technology shall have been duly organized, located, and established, ... there shall be appropriated and paid to its treasurer, each year, on the warrant of the Governor, for its endowment, support, and maintenance, one third part of the annual interest or income which may be received from the fund created under and by virtue of the 130th chapter of the Acts of the 37th Congress, at the second session thereof, approved July 2, 1862 [giving Public Lands to the States in aid of instruction in Agriculture, the Mechanic Arts, and Military Science and Tactics]. . . . . Said Institute of Technology, in addition to the objects set forth in its Act of Incorporation [as above quoted], shall provide for instruction in military tactics."

Chapter 186, *Acts and Resolves of* 1863.

Power to confer Degrees. "The Massachusetts Institute of Technology is hereby authorized and empowered to award and confer degrees appropriate to the several courses of study pursued in said Institution, on such conditions as are usually prescribed in universities and colleges in the United States, and according to such tests of proficiency as shall best promote the interests of sound education in this Commonwealth."

Chapter 247, *Acts and Resolves of* 1868.

CORPORATION

OF THE

MASS. INSTITUTE OF TECHNOLOGY.

FOR THE YEAR 1876-77.

President,

JOHN D. RUNKLE.

Secretary.

SAMUEL KNEELAND,

Treasurer,

JOHN CUMMINGS.

Committee on the School of Industrial Science,

JOHN AMORY LOWELL, *Chairman,*
EDWARD ATKINSON,
THOMAS T. BOUVÉ,
J. ELIOT CABOT,
GEORGE B. EMERSON,
EDWARD S. PHILBRICK,
JOHN D. PHILBRICK,
WILLIAM B. ROGERS,
J. BAXTER UPHAM,

Treasurer, *ex-officio.*

Committee on Finance,

J. INGERSOLL BOWDITCH, *Chairman,*
WILLIAM ENDICOTT, JR.,
JOHN M. FORBES,
HENRY P. KIDDER,
JAMES L. LITTLE,
SAMUEL D. WARREN,

Treasurer, *ex-officio.*

Committee on the Museum,

ERASTUS B. BIGELOW, *Chairman,*
CHARLES H. DALTON,
JOSEPH S. FAY,
AUGUSTUS LOWELL,
HORACE McMURTRIE,
E. R. MUDGE,
OTIS NORCROSS,
M. D. ROSS,
STEPHEN P. RUGGLES,
NATHANIEL THAYER.

Committee on the Society of Arts,

MARSHALL P. WILDER, *Chairman,*
PHILLIPS BROOKS,
J. WILEY EDMANDS,
CHARLES L. FLINT,
JAMES B. FRANCIS,
J. C. HOADLEY,
FRED. W. LINCOLN,
SAMUEL K. LOTHROP,
ALEXANDER H. RICE,
HENRY B. ROGERS.

On the Part of the Commonwealth,

HIS EXCELLENCY, GOVERNOR ALEXANDER H. RICE.

HON. HORACE GRAY, *Chief Justice of the Supreme Court.*

HON. JOSEPH WHITE, *Secretary of the Board of Education.*

OFFICERS OF INSTRUCTION.

President.

JOHN D. RUNKLE, PH.D., LL.D.

JOHN D. RUNKLE, PH.D., LL.D.,
Walker Professor of Higher Mathematics.

JOHN B. HENCK, A.M.,
Hayward Professor of Civil and Topographical Engineering.

WILLIAM R. WARE, S.B.,
Professor of Architecture.

WILLIAM P. ATKINSON, A.M.,
Professor of English and History.

GEORGE A. OSBORNE, S.B.,
Professor of Mathematics.

EDWARD C. PICKERING, S.B.,
Thayer Professor of Physics, and Director of the Rogers Laboratory.

SAMUEL KNEELAND, A.M., M.D.,
Professor of Zoölogy and Physiology.

JOHN M. ORDWAY, A.M.,*
Professor of Metallurgy and Industrial Chemistry.

JAMES M. CRAFTS, S.B.,
Professor of Organic Chemistry.

ROBERT H. RICHARDS, S.B.,
Professor of Mining Engineering, and Director of the Mining and Metallurgical Laboratories.

THOMAS STERRY HUNT, LL.D.,
Professor of Geology.

GEORGE H. HOWISON, A.M.,
Professor of Logic and the Philosophy of Science.

WM. RIPLEY NICHOLS, S.B.,
Professor of General Chemistry.

CHARLES P. OTIS, PH.D.
Professor of Modern Languages.

CHARLES H. WING, S.B.,
Professor of Analytical Chemistry.

ALPHEUS HYATT, S.B., Custodian of the Boston Society of Natural History,
Professor of Palæontology.

WILLIAM H. NILES, PH.B., A.M.,
Professor of Physical Geology and Geography.

CHANNING WHITAKER, S.B.,
Professor of Mechanical Engineering.

* The instruction in Botany is at present given by Prof. Ordway.

CHARLES R. CROSS, S.B.,
Professor of Physics and Descriptive Astronomy.

GAETANO LANZA, S.B., C.E.,
Professor of Theoretical and Applied Mechanics.

LIEUT. HENRY W. HUBBELL, JR., U. S. ART'Y,
Professor of Military Science and Tactics.

EUGENE LETANG,
Assistant in Architecture.

WILLIAM E. HOYT, S.B,
Instructor in Civil Engineering and Stereotomy.

JULES LUQUIENS, PH.D.,
Instructor in Modern Languages.

CHARLES KASTNER,
Lowell Instructor in Practical Design.

WEBSTER WELLS, S.B.,
Instructor in Mathematics and Descriptive Geometry.

HENRY N. MUDGE,
Instructor in Mechanical and Free-hand Drawing.

WILLIAM FOSTER,
Assistant in the Mining and Metallurgical Laboratories.

LEWIS M. NORTON,
Assistant in Quantitative Analysis.

CHARLES C. R. FISH,
Assistant in General Chemistry and Qualitative Analysis.

WILLIAM O. CROSBY, S.B.,
Assistant in Palæontology.

JAMES B. STANWOOD, S.B.,
Assistant in Mechanical Engineering.

CLARENCE L. DENNETT, S.B.,
Assistant in Mechanical Engineering.

THOMAS W. ROBINSON, S.B.,
Assistant in Quantitative Analysis.

SILAS W. HOLMAN, S.B.,
Assistant in Physics.

JOHN B. HENCK, JR., S.B.,
Assistant in Physics.

FACULTY.

JOHN D. RUNKLE, PH.D., LL.D., *President.*
JOHN B. HENCK, A.M.
WILLIAM R. WARE, S.B.
WILLIAM P. ATKINSON, A.M.
GEORGE A. OSBORNE, S.B.
EDWARD C. PICKERING, S.B.
SAMUEL KNEELAND, A.M., M.D., *Secretary.*
JOHN M. ORDWAY, A.M.
JAMES M. CRAFTS, S.B.
ROBERT H. RICHARDS, S.B.
THOMAS STERRY HUNT, LL.D.
GEORGE H. HOWISON, A.M.
WM. RIPLEY NICHOLS, S.B.
CHARLES P. OTIS, PH.D.
CHARLES H. WING, S.B.
CHANNING WHITAKER, S.B.
CHARLES R. CROSS, S.B.
GAETANO LANZA, S.B., C.E.
HENRY W. HUBBELL, JR., U. S. ART'Y.

STUDENTS.

I. Civ. Eng.; II. Mech. Eng.; III. Min. Eng.; IV. Arch.; V. Chem.; VI. Metal.; VII. Nat. Hist.; VIII. Phys.; IX. Sci. and Lit.; X. Phil.

GRADUATE STUDENTS.

NAME.	HOME.	RESIDENCE.
Aspinwall, Thomas, *S.B.*, II, ...	Brookline.	Brookline.
Blodgett, Aaron D., *S.B.*, II, ...	Boston	83 Chambers St.
Flint, Albert S., II, (*A.B., Harvard College*) . . .	Salem	Salem.
Galloupe, Francis E., *S.B.*, II, ...	Lynn.	Lynn.
Gould, Robert H., *S.B.*, V,	E. Cambridge. . .	E. Cambridge.
Hamlin, Alfred D. F., IV, (*A.B., Amherst College,*)	Worcester . . .	Cambridge.
Kendall, William M., IV, (*A. B., Harvard College*)	Cambridgeport . .	Cambridgeport.
Knapp, J. Austin, *S.B.*, II,	Hanover	17 Milford St.
Longfellow, Alex. W., Jr., IV, (*A.B., Harvard Coll*)	Portland, Me. . .	Cambridge.
Main, Charles T., *S.B.*, II,	Marblehead . . .	8 St. Charles St.
Peabody, Henry G., IV, (*A.B., Dartmouth Coll.*) .	St. Louis, Mo., . .	Somerville.
Prichard, Charles F., *S.B.*, II, ...	Marblehead. . . .	8 St. Charles St.
Sargent, Francis T., *S.B.*, II,	Malden	Malden.
Schwarz, Theo. E., *S.B.*, V,	Boston	157 Charles St.
Shockley, Wm. H., *S.B.*, III,	New Bedford . . .	Boston.
Stone, Henry B., II, (*A.B., Harvard College*) . . .	Boston	94 Chestnut St.
Taylor, Eugene H., IV, (*B.S., Iowa College*) . .	Grinnell, Iowa . .	28 Hanson St.
Very, Frank W., *S.B.*, VIII,	Hyde Park . . .	Hyde Park.
Wheelock, Charles B. 3, V, *B. C. E., Cornell Univ.* .	Austin, Texas . .	46 Cortes St.

NAME.	HOME.	RESIDENCE.
Wheelwright, Edmund M., IV, (*A.B., Harvard Coll.*)	Jamaica Plain . .	Jamaica Plain.
Willard, Daniel W., *S.B.*, IV,	Jamaica Plain . .	Jamaica Plain.
Willson, Edmund R., IV, (*A.B., Harvard College*) .	Salem	Salem.

REGULAR STUDENTS.

FOURTH YEAR.

NAME.	COURSE.	HOME.	RESIDENCE.
Alden, John	V.	Randolph	Randolph.
Bartol, George . . .	III.	Lancaster	Charlestown.
Beal, J. Williams . .	IV.	So. Scituate. . . .	So. Scituate.
Beeching, Wm. H. . .	II.	Boston	117 Princeton St.
Capen, George W. . .	IV.	Canton	Canton.
Carter, Henry H. . .	I.	Roxbury	55 St. James St.
Chamberlin, William E.	IV.	Cambridgeport. . .	Cambridgeport.
Chapman, George H. .	II.	Winchester	Winchester.
Faunce, Linus . . .	II.	Kingston.	Kingston.
Fisher, Charles H. . .	II.	Canton	Canton.
Flint, William C. . .	III.	Salem.	Salem.
Furber, Pierce P. . .	IV.	Cottage Grove, Minn.	Chelsea.
Gay, Martin	I.	Staten Island, N. Y. .	94 Chandler St.
Gray, Joseph P. . . .	I.	Lowell	Lowell.
Grover, Edmund . .	I.	E. Walpole	E. Walpole.
Hale, Richard A. . .	I.	Lawrence	Lawrence.
Hardman, John E. . .	III.	Lowell	Lowell.
Hibbard, Henry D. .	III.	W. Roxbury . . .	W. Roxbury.
Holbrook, Henry L. .	II.	So. Abington . . .	So. Abington.
Jenney, Walter 3 . .	III.	Boston	525 Broadway.
Kirk, Joseph	II.	Dorchester	Cottage St.
Kittredge, George W. .	I.	No. Andover . . .	No. Andover.
Lawton, Charles F. .	I.	New Bedford . . .	44 Cortes St.
Mudge, Benjamin C. .	I.	Lynn	Lynn.
Nelson, George A. 1 .	I.	Lincoln	Lincoln.
Peabody, Cecil H. . .	II.	Chicago, Ill. . . .	Randolph.
Plimpton, Arthur L. 3.	I.	Boston	7 Hawthorn St.
Southworth, Harry C.	III.	Stoughton	Stoughton.
Stewart, Charles E. .	I.	Boston	363 Dorchester St.
Stimpson, Thomas F. .	III.	Swampscott. . . .	Swampscott.
Swain, George F. . .	I.	San Francisco, Cal. .	19 Ashland Pl.
Wiggin, Frank E. . .	I.	Boston	11 Wyman St.
Wood, Fred. W. . .	III.	Lowell	Lowell.

THIRD YEAR.

NAME.	COURSE.	HOME.	RESIDENCE.
Allbright, William B.	V.	Boston	Boston St.
Baker, Charles M.	IV.	Boston	22 Worcester St.
Dan, Takuma	III.	Fukuoka, Japan	12 Dartmouth St.
Eaton, Charles S.	IV.	Lowell	Lowell.
Edwards, Charles F.	III.	Lowell	Lowell.
Flint, Albert S. [1, 2] (*A.B., Harvard College*)	II.	Salem	Salem.
Higgins, Alfred S.	IV.	Boston	173 Warren Ave.
Kebler, Julian A.	I.	Cincinnati, O.	130 Highland St.
Morgan, Frank H.	V.	Portland, Me.	45 Poplar St.
Nichols, Everell J.	I.	Everett	Everett.
Norton, Charles H.	I.	Charlestown	Charlestown.
Peabody, Henry G. [2, 4] (*A.B., Dartmouth College*)	IV.	St. Louis, Mo.	Somerville.
Reed, Harry E.	V.	Lowell	Lowell.
Rich, Isaac	I.	Boston	706 Tremont St.
Ritchie, James	I.	Hyde Park	Hyde Park.
Rollins, James W., Jr.	I.	W. Roxbury	W. Roxbury.
Sawin, Charles D.	IX.	Charlestown	Charlestown.
Schwamb, Peter	II.	Arlington	Arlington.
Story, Isaac M.	I.	Somerville	Somerville.
Taney, Edmund	I.	Bangor, Me.	6 Sharon St.
Towne, Linwood O.	III.	Newtonville	Newtonville.
Williams, Emile F.	I.	Boston	21 Dover St.
Woolworth, James G.	V.	Westfield	128 Pembroke St.

SECOND YEAR.

NAME.	COURSE.	HOME.	RESIDENCE.
Alden, Frank E.	IV.	W. Roxbury	W. Roxbury.
Allen, Walter S.	V.	New Bedford	94 Chestnut St.
Barton, George H.	III.	Sudbury	Somerville.
Batchelder, Joseph F.	III.	Yokohama, Japan	West Newton.
Boyd, Henry A.	III.	St. John, N. B.	8 Centre St.
Braley, Samuel T.	II.	Brockton	Brockton.
Brown, Harry A.	IX.	Lowell	Lowell.
Cabot, John W.	III.	Boston	10 Pembroke St.
Campbell, Harry H.	III.	W. Roxbury	W. Roxbury.
Coffin, Frederic S.	III.	Auburndale.	Auburndale.
Curtis, Henry R.	I.	Rock Island, Ill.	707 Tremont St.

NAME.	COURSE.	HOME.	RESIDENCE.
Dunbar, William O.	II.	Canton	Canton.
Fabens, George W.	I.	Marblehead	Marblehead.
Fellows, Charles L.	I.	Concord, N. H.	53 Clarendon St.
Fifield, Charles B.	II.	Salem	Salem.
Gooding, Charles S.	II.	Brookline	Brookline.
Grant, Herbert C.	I.	Walpole, N. H.	51 Pinckney St.
Grimes, Frederic W.	II.	Mansfield, O.	Arlington.
Harlow, Alfred B.	IV.	Middleboro'	7 Linwood Sq.
Hartwell, Ernest G.	IV.	Waltham.	Waltham.
Hosea, Raphael M.	I.	Cincinnati, O.	9 St. James Ave.
Hosmer, Charles E.	V.	Boscawen, N. H.	611 Tremont St.
Howe, Horace J.	I.	Boston	796 Tremont St.
Jenks, Allan M.	IX.	Newport, N. H.	53 Clarendon St.
Knapp, Frederick B.	I.	Plymouth	51 Pinckney St.
Lane, Frederic H.	II.	Boston	623 Tremont St.
Lodge, Richard W.	III.	Boston	1423 Washington St.
Loring, Frederic R.	VII.	Boston	8 Greenwich Park.
Macfarlane, William W.	V.	Woburn	Woburn.
Metcalf, Arthur H.	II.	Pawtucket, R. I.	45 Upton St.
Miller, Edwin C.	II.	Boston	480 Columbus Ave.
Mitzuoka, Takeo	III.	Fukui, Japan	41 W. Newton St.
Morgan, Richard H.	IV.	New Bedford	94 Chestnut St.
Nichols, Gilbert M.	III.	Freetown	Cambridgeport.
Owen, Edward H., Jr.	II.	Waltham	Waltham.
Pickering, William H.	VIII.	Boston	84 Mt. Vernon St.
Riggs, George F.	I.	Cambridge	Cambridge.
Sonrel, Louis A.	IV.	Winchester	Winchester.
Stantial, Frank G.	V.	Melrose	Melrose.
Stearns, William S.	I.	Cincinnati, O.	90 Waltham St.
Waitt, Arthur M.	II.	Boston	24 Bedford St.
Wilson, Arthur E.	VIII.	Cambridge	12 Grenville Place.

FIRST YEAR.

NAME.	HOME.	RESIDENCE.
Almy, William F.	Fall River	293 Columbus Ave.
Ames, Frank A.	Canton	Canton.
Benedict, William L.	Boston	131 Warren Ave.
Brown, Arthur N.	Providence, R. I.	293 Columbus Ave.
Brown, Charles H.	Boston	341 Shawmut Ave.
Chappell, William H., Jr.	Chicago, Ill.	1507 Washington St.
Chase, Edwin E.	Lowell	Lowell.

NAME.	HOME.	RESIDENCE.
Clark, Fred W.	Chicago, Ill.	44 Cortes St.
Cobb, Henry I.	Brookline	Brookline.
Crowell, Samuel	Dennis	2 Derne St.
Cunningham, John A.	Milton	Milton.
Cutter, Ephraim	Cambridge	Cambridge.
Gardner, Joseph P.	Boston	152 Beacon St.
Greenough, Arthur T.	Jamaica Plain	Jamaica Plain.
Hamilton, George W.	Wrentham	68 West Cedar St.
Haseltine, William S.	Brookline	Brookline.
Haskins, William J.	Boston	Maywood St.
Howe, Louis P.	Marlboro'	44 Chandler St.
Hussey, Charles M.	New Bedford	19 Boylston Place.
Iasigi, Albert W.	Boston	43 Mt. Vernon St.
McQuesten, Fred.	Boston	61 Monmouth St.
Millen, Loring R.	Savannah, Ga.	6 St. James Ave.
Miller, Henry A.	Buffalo, N. Y.	12 Dartmouth St.
Miller, William T.	Boston	480 Columbus Ave.
Mills, Harvey P.	Boston	43 Hancock St.
Morton, N. Bowditch	Boston	Norfolk House.
Page, Frank A.	Quincy	Quincy.
Perry, Arthur P.	Portland, Me.	216 Springfield St.
Potter, Edward C.	Chicago, Ill.	474 E. Fourth St.
Preble, George H. R.	Boston	298 Columbus Ave.
Rogers, Robert	Gloucester	9 Newbury St.
Ross, John H.	Jamaica Plain	Jamaica Plain.
Sargent, Sullivan A.	Boston	16 W. Cedar St.
Small, Nathaniel C.	Milwaukee, Wis.	37 E. Springfield St.
Vining, Jared A.	S. Abington	S. Abington.
Wellman, Arthur G.	Brookline	Brookline.

STUDENTS NOT CANDIDATES FOR A DEGREE.

[Students who are taking studies in different years are placed under the highest year, and the other years are indicated by the Arabic figures affixed. The Roman numerals show that a student is taking parts of the corresponding Regular Course.]

FOURTH YEAR.

NAME.	COURSE.	HOME.	RESIDENCE.
Aspinwall, Thos., *S.B.*	$_{2}$ II.	Brookline	Brookline.
Bachelder, Charles S.	$_{1,3}$ V.	Brookline	Brookline.
Baldwin, George J.	VI.	New York, N. Y.	57 Warren Ave.
Hewitt, George H.	VI.	Springfield	86 Waltham St.

NAME.	COURSE.	HOME.	RESIDENCE.
Holman, Francis C.	III.	Boston	31 Bowdoin St.
Mori, Haryosh [3]	II.	Tokio, Japan	6 Centre St.
Porter, John A. [3]	VI.	Allston	Allston.
Prentiss, Frederick H. [3]	II.	Boston	16 Bulfinch St.
Spalding, Frederic P.	I.	Lowell	Lowell.
Very, Frank W., *S.B.*	VIII.	Hyde Park	Hyde Park.
Wheelock, C. B. [3] (*B.C.E., Cornell Univ.*)	V.	Austin, Texas	46 Cortes St.

THIRD YEAR.

NAME.	COURSE.	HOME.	RESIDENCE.
Adams, William W.	III.	Castine, Me.	Reading.
Bradford, William B.	II.	Dorchester	Sumner St.
Brown, Frederic J.	I.	Woburn	Woburn.
Fisher, William B.	III.	Brookline	Brookline.
Stone, Henry B. (*A. B., Harvard College*) [1, 3]	II.	Boston	94 Chestnut St.

SECOND YEAR.

NAME.	COURSE.	HOME.	RESIDENCE.
Atwood, Frank S. [1]	V.	Salem	Salem.
Betton, C. Grinnell [1]	V.	Boston	99 Mt. Vernon St.
Bixby, William P.	I.	Francestown, N. H.	113 Appleton St.
Blake, George	II.	Belmont	Belmont.
Bronson, Frank P.	VIII.	Ottawa, Ont.	Woburn.
Bryant, Henry	II.	Boston	61 Beacon St.
Castle, James B.	IX.	Honolulu, H. I.	17 W. Dedham St.
Chappell, Henry W. [3]	V.	Chicago, Ill.	1597 Washington St.
Grover, George C.	IV.	Dedham	Dedham.
Hall, Henry G.	II.	Boston	6 W. Cedar St.
Hemingray, Daniel C. [4]	V.	Covington, Ky.	9 St. James Ave.
Henshaw, John O.	I.	Cambridge	Cambridge.
Hotchkiss, William D.	I.	Chicago, Ill.	221 Shawmut Ave.
Johonnot, J. Oliver	V.	Newton	Newton.
Large, Walter	IX.	Dubuque, Iowa.	28 Hancock St.
Little, Philip	IX.	Boston	2 Commonw'lth Ave.
Lovis, Andrew M. [1]	I.	Boston	Broadway, P St.
Pope, Sidney T.	II.	Dorchester	Harrison Square.
Rea, William H.	II.	Pittsburgh, Pa.	5 St. James Ave.
Sargent, Winthrop O.	III.	Malden	Malden.
Smith, Frank L.	IX.	Boston	15 St. James Ave.

NAME.	COURSE.	HOME.	RESIDENCE.
Spicer, Vibe C.	II.	Winchester	Winchester.
Tibbits, James H. [3, 4]	V.	Mt. Vernon, N. Y.	81 E. Brookline St.
Woodbridge, Sam'l H.	VIII.	Williamstown	95 Camden St.
Young, J. Edson.	IV.	Groton	Cambridge.

FIRST YEAR.

NAME.	HOME.	RESIDENCE.
Bronson, Walter G.	Ottawa, Ont.	Woburn.
Bowditch, Susan H.	Brookline	Brookline.
Hastings, Thomas N.	Walpole, N. H.	Woburn.
Johnson, Emily.	Melrose	Melrose.
Parker, W. Prentiss	Boston	266 Seaver St.
Paxton, Blitz W.	San Francisco, Cal.	271 Columbus Ave.
Walsh, Frederick T.	Lowell	Lowell.
Whittier, Fred. W.	Lawrence	Lawrence.

SPECIAL STUDENTS IN ARCHITECTURE.

NAME.	HOME.	RESIDENCE.
Allen, Francis L.	Boston	12 Fairfield St.
Beebe, Frank H.	Boston	30 Beacon St.
Chapell, Raymond D.	Norwich, Conn.	1 St. Charles St.
Corser, Frederic G.	Rochester, N. Y.	6 Ferdinand St.
Du Fais, John L.	New York, N. Y.	67 Charles St.
Fairfield, William [1]	Malden	Malden.
Freeman, George A., Jr.	New York, N. Y.	37 Commonw'lth Av.
Gracea, Joseph J. [1]	Westfield	65 Charles St.
Hamlin, Alfred D. F. [2] (*A.B., Amherst College*)	Worcester	Cambridge.
Hammatt, Edward S. [2]	Rochester, N. Y.	3 Ringgold St.
Jaques, Herbert [2]	Boston	83 Boylston St.
Josselyn, Henry S.	Independence, Iowa	28 Hanson St.
Kendall, William M. (*A.B., Harvard College*)	Cambridgeport	Cambridgeport.
Longfellow, Alexander W., Jr. [2, 4] (*A.B., Harvard College*)	Portland, Me.	Cambridge.
Taylor, Eugene H. [1, 2] (*B.S., Iowa College*)	Grinnell, Iowa	28 Hanson St.
Wheelwright, Edmund M. [2] (*A.B., Harvard College*)	Jamaica Plain	Jamaica Plain.
Willard, Daniel W. [2] *S.B.*	Jamaica Plain	Jamaica Plain.
Willson, Edmund R. (*A.B., Harvard College*)	Salem	Salem.

STUDENTS IN PRACTICAL MECHANISM.

NAME.	HOME.	RESIDENCE.
Atkinson, James S.	Longwood	Longwood.
Bond, William C.	Boston	514 E. Broadway.
Clarke, Henry L.	Boston	9 Marlboro' St.
Devine, James V.	Boston	525 Fifth St.
Eldredge, Edward D.	Longwood	Longwood.
Faxon, Amos L.	Quincy	Quincy.
Flint, Charles L., Jr.	Boston	53 Union Park.
Gooding, Fred. M.	Waltham	Waltham.
Hale, Edward C.	Dover, N. H.	75 Charles St.
Hill, Noble H., Jr.	Boston	22 Union Park.
Hyde, Charles E.	Bath, Me.	7 Boylston Place.
Johnson, Charles B.	Concord	Concord.
Kendrick, George P.	Brookline	Brookline.
Melcher, George S.	Brookline	Brookline.
Morejon, Gonzalo M.	Bolondron, Cuba	Hotel Dwight.
Nye, Joseph K.	Fairhaven	50 Appleton St.
Paul, George A.	Boston	588 Tremont St.
Pratt, Charles R.	Jamaica Plain	Jamaica Plain.
Randall, Lyman D.	S. Braintree	S. Braintree.
Smith, Frank W.	Boston	2 Louisburg Square.
Vinal, Charles W.	Somerville	Somerville.
Whitney, George E.	Boston	Ashland House.

SPECIAL STUDENTS IN CHEMISTRY.

NAME.	HOME.	RESIDENCE.
Barnes, Edith	Northboro	Sherborn.
Capen, Bessie T.	Boston	1 Ringgold St.
Capen, Mary L. B.	Boston	155 Brookline St.
Cheney, Margaret S.	Jamaica Plain	Jamaica Plain.
Cole, Rhoda E.	Boston	447 Shawmut Ave.
Crosby, Alice B.	Boston	9 Sharon St.
Dawson, Sarah M.	Boston	37 Telegraph St.
Gould, Mrs. H. A.	Chelsea	Chelsea.
McKay, Mary C.	Boston	White St.
Melvin, Cynthia G.	Boston	516 Shawmut Ave.
Ordway, Elizabeth M.	Jamaica Plain	Jamaica Plain.
Palmer, Alice W.	Boston	Bellevue St.
Peabody, Lucia M.	Roxbury	9 St. James St.
White, Laura B.	Boston	157 W. Brookline St.

STUDENTS IN PRACTICAL DESIGN.

NAME.	HOME.	RESIDENCE.
Foster, Edwin L.	Boston	2679 Washington St.
Hyde, Frank	Danielsonville, Conn.	2 Lynde St.
Lewis, Clarence H.	Watertown	Watertown.
Mahan, John	Roxbury	Roxbury.
Powers, Herbert H.	Boston	8 Willard Place.
Symmes, Harry M.	Winchester	Winchester.
Underwood, Charles H.	E. Lexington	E. Lexington.
Washburn, Charles A.	Natick	Natick.
Winslow, Reuben	Boston	Winslow Place.
Bartlett, B. Adelaide	Boston	1199 Tremont St.
Bean, Elizabeth C.	Boston	2 Glenwood Place.
Bowen, Mary E.	Lowell	27 Warren St.
Caldwell, E. Mary	Fitchburg	1507 Washington St.
Capron, Kate C.	Boston	32 Dwight St.
Chandler, Alice	Brookline	Brookline.
Close, Eva M.	Boston	38 Bremen St.
Comer, Charlotte A.	W. Medford	W. Medford.
Comer, Frances T.	Boston	300 Shawmut Ave.
Cunningham, Ellen M.	Boston	348 Shawmut Ave.
Doane, Ellen A.	Boston	43 Dwight St.
Egerton, Caroline M.	Boston	45 Milford St.
Foster, E. Gertrude	Boston	2679 Washington St.
Gregory, Mary F.	Longwood	Longwood.
Hathaway, Alice E.	Springfield	Somerville.
Kennedy, Mindova	Boston	Hotel Berkeley.
McKey, Marion	Boston	146 Boylston St.
Mann, Harriet	Boston	127 Pembroke St.
Miller, Elizabeth B.	Grantville	Grantville.
Mowton, Maria.	Brookline	Brookline.
Munroe, Elizabeth B.	Cambridge	Cambridge.
Parker, Harriet A.	Boston	3 Allen Place.
Richards, Mary B.	Boston	46 Dwight St.
Runkle, Kate B.	Brookline	Brookline.
Salisbury, Agnes	Brookline	Brookline.
Seaverns, Anna W.	Boston	2 Dudley Place.
Shimer, Grace H	Lexington	Lexington.
Smiley, Helen A.	Melrose	Melrose.
Stafford, Lucy C.	Roxbury	55 Blue Hill Ave.
Starbuck, Florence [illegible]	Boston	348 Shawmut Ave.

NAME.	HOME.	RESIDENCE.
Tewksbury, Frances W.	Newtonville.	Newtonville.
Thayer, Harriet A.	Boston	21 Dwight St.
Vinal, Alice M.	Boston	134 Concord St.
Warren, Anna R.	Brookline	Brookline.
Wheeler, Caroline W.	Boston	54 Dwight St.
Whittemore, Ethel M.	Chapel Station	Chapel Station.
Wilbor, Elizabeth	Boston	554 Tremont St.
Wilbor, Louisa M.	Boston	554 Tremont St.

SUMMARY.

Graduate Students	22
Regular Students, fourth year	33
" " third "	23
" " second "	42
" " first "	36
Students not candidates for a degree, fourth year	11
" " " " third "	5
" " " " second "	25
" " " " first "	8
Special Students in Architecture	18
Students in Practical Mechanism	22
Special Students in Chemistry	14
Students in Practical Design	47
Deduct names counted twice	13
Total	293

CALENDAR.

School-year began	Monday, Sept 25, 1876.
School-year ends	Saturday, June 2, 1877.
The next School-year will begin	Monday, Sept. 24, 1877.
First Entrance Examinations	Monday, June 4, 1877, and Tuesday, June 5, 1877.
Second Entrance Examinations	Wednesday, Sept. 19, 1877, and Thursday, Sept. 20, 1877.
Examinations for advanced standing	Wednesday, June 6, 1877. and Friday, Sept. 21, 1877.

COURSES OF INSTRUCTION.

The Massachusetts Institute of Technology provides a series of scientific and literary studies and practical exercises, embracing pure and applied mathematics, the physical and natural sciences with their applications, drawing, the English language, mental and political science, French, and German. These studies and exercises are so arranged as to offer a liberal and practical education in preparation for active pursuits, as well as a thorough training for the various scientific professions. Ten Regular Courses, each extending through four years, have been established as follows: —

I. A Course in Civil and Topographical Engineering.
II. " " " Mechanical Engineering.
III. " " " Geology and Mining Engineering.
IV. " " " Building and Architecture.
V. " " " Chemistry.
VI. " " " Metallurgy.
VII. " " " Natural History.
VIII. " " " Physics.
IX. " " " Science and Literature.
X. " " " Philosophy.

These courses are identical during the first year; but for the three remaining years the studies in each course are arranged with reference to the end in view.

In these courses non-professional studies generally end at the middle of the fourth year; the second half of the year being mainly devoted to professional studies, including the preparation of the Thesis.

The courses in Natural History, Physics, Science and Literature, and Philosophy, differ from the others in having a less

distinctly professional character. The course in Natural History affords an appropriate general training for those whose ulterior object is the special pursuit of Geology, Mineralogy, Botany, Zoölogy, Medicine, Pharmacy or Rural Economy. The course in Physics is based on the mathematical and physical sciences, the course in Philosophy on the mathematical and philosophical sciences, and the course in Science and Literature on the sciences and modern literature, and each course offers a sound education as well as suitable preparation for any of the departments of active life.

In all the courses it is intended to secure to every student a liberal mental development and general culture, as well as the more strictly technical education which may be his chief object.

For proficiency in any one of these courses the degree of S.B., Bachelor of Science, is conferred.

Advanced courses of study have recently been established, and the degree of Doctor of Science authorized by a vote of the Corporation.

At the request of the Woman's Education Association of Boston, and with their generous coöperation, new laboratories have been recently provided for the special instruction of women. The design is to afford every facility for the study of Chemical Analysis, of Industrial Chemistry, of Mineralogy, and of Chemistry as related to Vegetable and Animal Physiology. These courses are intended for such as may be able to devote their whole time to the work, as well as for those who, by reason of other engagements, can spend only a few hours a week in these exercises.

The laboratories, which are in the Annex to the main building, are open from 8.30 A.M, till 5.30 P.M.

Students in these laboratories will pay the same fees as other students of the Institute.

The Institute also provides annually several courses of instruction, scientific and literary, open to both sexes. At present these courses are free, being supported by the Trustee of the Lowell Institute. Fuller details are given on page 60.

NEW DEPARTMENT OF PRACTICAL MECHANISM.

A series of shops having been provided for teaching the students in the department of Mechanical Engineering the use of tools in wood and iron work by the class system, a two years' course in Practical Mechanism has also been established for those who wish to become Master Mechanics rather than engineers, and especially for the large class of pupils to whom such a systematic training will prove a valuable foundation for further engineering or other scientific study.

It affords, also, a good English as well as a good disciplinary education, in preparation for any department of life.

To be admitted to this course the applicant must be at least fifteen years of age, and must pass a satisfactory examination in the following subjects: — Arithmetic, Geography, Spelling, Punctuation, English Composition, English and American History, and Algebra through simple equations.

Entrance examinations to this as well as to all the other courses, will begin on the first Monday in June, and on the Wednesday preceding the last Monday in September of each year. Tuition $125 a year.

This course constitutes a thorough preparation for admission to all the other courses of instruction in the Institute. The shop-work is strictly unique, there being, so far as is known, no other school for metal working conducted on the same plan, except in Russia. The President's report upon the Russian system can be had on application to the Secretary of the Institute. For course of study see page 22.

TWO YEARS' COURSE IN PRACTICAL MECHANISM.

FIRST YEAR.

		No. of Exercises	Hrs. per week
Shop Instruction		120	12
Algebra	1st half	45	3
Plane Geometry	2d half	45	3
Rhetoric and Composition		90	3
Mechanical and Free Hand Drawing		90	3

SECOND YEAR.

Shop Instruction		120	12
Algebra finished	1st half	45	3
Solid Geometry	2d half	45	3
English Literature		60	2
French		90	3
Mechanical and Free Hand Drawing		90	6

REGULAR COURSES.

ALL COURSES. — FIRST YEAR.

Algebra finished	1st half	45	3
Plane and Solid Geometry reviewed	2d half	15	3
Plane and Spherical Trigonometry	2d half	30	3
General Chemistry	1st half	60	6
General Chemistry	2d half	30	2
Qualitative Analysis	2d half	30	4
Rhetoric and Composition	1st half	30	2
Analysis of Terms and Sentences	2d half	30	2
French		90	3
Mechanical Drawing and Elements of Descriptive Geometry and Perspective		90	6
Free Hand Drawing		90	3
Physiology and Hygiene	2d half	30	2
Military Tactics		90	3

I. CIVIL ENGINEERING.

SECOND YEAR.

		No. of Exercises.	Hrs. per week.
Analytic Geometry	1st half	45	3
Calculus	2d half	45	3
Descriptive Geometry	1st half	30	2
Mechanical Drawing	1st half		4
Surveying		60	2
Topographical and Plan Drawing	2d half		7
Physics (Lectures)		90	3
French finished, German begun		90	3
Descriptive Astronomy	1st quar.	18	3
Physical Geography	2d quar.	27	3
English Literature	2d half	45	3
Military Science		24	1

THIRD YEAR.

Survey and Location of Roads	1st half	45	6
Construction of Roads	2d half	20	6
Water supply, Drainage, etc.	2d half	25	6
Drawing			3
Stereotomy	1st half	30	4
Bridge and Roof Construction	2d half	30	4
Applied Mechanics		90	3
German		90	3
Physical Laboratory		60	2
General Geology	1st quar.	21	3
Outlines of Zoology	2d quar.	21	3
Constitutional History	3d quar.	21	3
Formal Logic	4th quar.	21	3

FOURTH YEAR.

Stability of Structures	1st half	20	6
Strength of Materials	1st half	25	6
Structures of Stone	2d half	15	6
Structures of Wood	2d half	10	6
Structures of Metal	2d half	20	6
Geodesy	2d half	15	2
Topography (Field Practice)	2d half	10	
Physical Hydrography	2d half	30	4
Designing	1st half		10
Structure Drawing	2d half		6
Building Materials	2d half	10	3
Thesis Work			
Water power and Water wheels	2d half	25	4
Metallurgy of Iron	1st half	30	2
Applied Physics	1st half	30	2
German	1st half	45	3
Philosophy of Science	1st half	45	3

In addition to the prescribed studies, optional studies, selected from other courses, may be taken, with the consent of the Faculty.

II. MECHANICAL ENGINEERING.

SECOND YEAR.

		No. of Exercises	Hrs. per week.
Analytic Geometry	1st half	45	3
Calculus	2d half	45	3
Descriptive Geometry	1st half	30	2
Mechanical Drawing	1st half		4
Principles of Mechanism	1st half	30	2
Principles of Mechanism	2d half	60	4
Machine Drawing	2d half		4
Mechanical Laboratory	2d half		2
Physics (Lectures)		90	3
French finished, German begun		90	3
Descriptive Astronomy	1st quar.	18	3
Physical Geography	2d quar.	27	3
English Literature	2d half	45	3
Military Science		24	1

THIRD YEAR.

Machinery and Millwork	$\frac{2}{3}$ year	80	6
Strength of Materials	$\frac{1}{3}$ year	40	6
Mechanical Laboratory			2
Machine Drawing			4
Applied Mechanics		90	3
German		90	3
Physical Laboratory		60	2
General Geology	1st quar.	21	3
Outlines of Zoölogy	2d quar.	21	3
Constitutional History	3d quar.	21	3
Formal Logic	4th quar.	21	3

FOURTH YEAR.

Principles of Thermodynamics	1st half	90	6
Mechanism of the Steam Engine	2d half	50	8
Water power and Water wheels	2d half	70	8
Machine Drawing			6
Mechanical Laboratory			7
Building Materials	2d half	10	3
Thesis Work			
Metallurgy of Iron	1st half	30	3
German	1st half	45	3
Philosophy of Science	1st half	45	3

In addition to the prescribed studies, optional studies, selected from other courses, may be taken, with the consent of the Faculty.

III. MINING ENGINEERING.

SECOND YEAR.

		No. of Exercises.	Hrs. per week.
Analytic Geometry	1st half	45	3
Calculus	2d half	45	3
Qualitative Analysis	1st half	45	6
Surveying and Drawing	1st half		4
Mineralogy	2d half	45	6
Botany	2d half	30	2
Quantitative Analysis	2d half		4
Physics (Lectures)		90	3
French finished, German begun		90	3
Descriptive Astronomy	1st quar.	18	3
Physical Geography	2d quar.	27	3
English Literature	2d half	45	3
Military Science		24	1

THIRD YEAR.

Chemical Laboratory			10
General Quantitative Analysis (Lectures)	1st half	30	2
Mining Engineering		90	3
Structural Palæontology	2d half	15	2
Applied Mechanics		90	3
German		90	3
Physical Laboratory		60	2
General Geology	1st quar.	21	3
Outlines of Zoölogy	2d quar.	21	3
Constitutional History	3d quar.	21	3
Formal Logic	4th quar.	21	3

FOURTH YEAR.

Metallurgy	1st half	45	3
Ore dressing	3d quar.	15	3
Drawing	1st half		2
Mining and Metallurgical Laboratory	2d half		12
Chemical Laboratory			10
Assaying	2d half	13	
Thesis Work			
American Geology	1st half	45	3
Coal and Ore Deposits	2d half	15	3
Building Materials	2d half	10	3
Chemical Geology	2d half	15	3
German	1st half	45	3
Philosophy of Science	1st half	45	3

In addition to the prescribed studies, optional studies, selected from other courses, may be taken, with the consent of the Faculty.

IV. ARCHITECTURE.

SECOND YEAR.

		No. of Exercises	Hrs. per week.
Analytic Geometry	1st half	45	3
Calculus	2d half	45	3
Descriptive Geometry	1st half	30	2
Mechanical Drawing	1st half		4
Drawing	2d half		10
Elements of Architecture	1st quar.	30	4
Greek and Roman Arch. History	2d quar.	30	4
Mediæval (or Modern) Architectural History	2d half	60	4
Physics (Lectures)		90	3
French finished, German begun		90	3
Descriptive Astronomy	1st quar.	18	3
Physical Geography	2d quar.	30	2
English Literature	2d half	45	3
Military Science		24	1

THIRD YEAR.

Applied Mechanics		90	3
Theory of Architecture, Ornamentation, etc.	1st half	45	3
Specifications and Working Drawings		30	1
Stereotomy	1st half	30	4
Mediæval (or Modern) Architectural History	2d half	60	4
Drawing and Design			14
German		90	3
Physical Laboratory		60	2
General Geology	1st quar.	21	3
Outlines of Zoölogy	2d quar.	21	3
Constitutional History	3d quar.	21	3
Formal Logic	4th qnar.	21	3

FOURTH YEAR.

Strength of Materials	1st half	90	6
Scientific Construction	2d half	90	6
Building Materials	2d half	10	3
Theory of Architecture, Ornamentation, etc.	1st half	45	3
Specifications and Working Drawings		30	1
Mediæval (or Modern) Architectural History	2d half	60	4
Architectural Drawing and Design			10
Architectural Research	2d half		14
Thesis Work			
Applied Physics	1st half	30	2
German	1st half	45	3
Philosophy of Science	1st half	45	3

In addition to the prescribed studies, optional studies, selected from other courses, may be taken, with the consent of the Faculty.

V. CHEMISTRY.

SECOND YEAR.

		No. of Exercises.	Hrs. per week.
Qualitative Analysis	1st half		6
Mineralogy	2d half	45	6
Chemical Philosophy	1st half	45	3
Botany	2d half	30	2
Quantitative Analysis	2d half		6
Technical French and German	2d half	15	1
Physics (Lectures)		90	3
French finished, German begun		90	3
Descriptive Astronomy	1st quar.	18	3
Physical Geography	2d quar.	27	3
English Literature	2d half	45	3
Military Science		24	1

THIRD YEAR.

Chemical Laboratory			14
General Quantitative Analysis (Lectures)	1st half	30	2
Quantitative Analysis, Special Methods	2d half	30	2
Industrial Chemistry	2d half	45	3
Chemical Physiology	1st half	30	2
German		90	3
Physical Laboratory		60	2
General Geology	1st quar.	21	3
Outlines of Zoölogy	2d quar.	21	3
Constitutional History	3d quar.	21	3
Formal Logic	4th quar.	21	3

FOURTH YEAR.

Chemical Laboratory			15
Organic Chemistry (Lectures)		60	2
Metallurgy	1st half	45	3
Drawing	1st half		2
American Geology	1st half	45	3
Chemical Geology	2d half	15	3
Coal and Ore Deposits	2d half	15	3
Building Materials	2d half	10	3
Assaying	2d half	13	
Thesis Work			
Applied Physics	1st half	30	2
German	1st half	45	3
Philosophy of Science	1st half	45	3

In addition to the prescribed studies, optional studies, selected from other courses, may be taken, with the consent of the Faculty.

VI. METALLURGY.

SECOND YEAR.

		No. of Exercises.	Hrs. per week.
Qualitative Analysis	1st half		6
Mineralogy	2d half	45	6
Chemical Philosophy	1st half	45	3
Botany	2d half	30	2
Quantitative Analysis	2d half		6
Technical French and German	2d half	15	1
Physics (Lectures)		90	3
French finished, German begun		90	3
Descriptive Astronomy	1st quar.	18	3
Physical Geography	2d quar.	27	3
English Literature	2d half	45	3
Military Science		24	1

THIRD YEAR.

Chemical Laboratory			14
General Quantitative Analysis (Lectures)	1st half	30	2
Quantitative Analysis, Special Methods	2d half	30	2
Industrial Chemistry	2d half	45	3
Chemical Physiology	1st half	30	2
German		90	3
Physical Laboratory		60	2
General Geology	1st quar.	21	3
Outlines of Zoology	2d quar.	21	3
Constitutional History	3d quar.	21	3
Formal Logic	4th quar.	21	3

FOURTH YEAR.

Metallurgy	1st half	45	3
Ore-dressing	3d quar.	15	3
Drawing	1st half		2
Mining and Metallurgical Laboratory	2d half		10
Chemical Laboratory			10
Assaying	2d half	13	
Thesis Work			
American Geology	1st half	45	3
Coal and Ore Deposits	2d half	15	3
Building Materials	2d half	10	3
Chemical Geology	2d half	15	3
German	1st half	45	3
Philosophy of Science	1st half	45	3

In addition to the prescribed studies, optional studies, selected from other courses, may be taken, with the consent of the Faculty.

VII. NATURAL HISTORY.

SECOND YEAR.

		No. of Exercises.	Hrs. per week.
Chemical Philosophy	1st half	45	3
Botany	2d half	30	2
Qualitative Analysis	1st half		6
Mineralogy	2d half	45	6
Physics (Lectures)		90	3
French finished, German begun		90	3
Descriptive Astronomy	1st quar.	18	3
Physical Geography	2d quar.	27	3
English Literature	2d half	45	3
Military Science		24	1

THIRD YEAR.

General Quantitative Analysis (Lectures)	1st half	30	2
Comparative Zoölogy	2d half	45	3
Chemical Laboratory			10
Chemical Physiology	1st half	30	2
Structural Palæontology	2d half	15	2
German		90	3
Physical Laboratory		60	2
General Geology	1st quar.	21	3
Outlines of Zoölogy	2d quar.	21	3
Constitutional History	3d quar.	21	3
Formal Logic	4th quar.	21	3

FOURTH YEAR.

Special Zoölogy, Special Geology, Special Botany, or Special Stratigraphical Palæontology	Laboratory		12
Thesis Work			
American Geology	1st half	45	3
Coal and Ore Deposits	2d half	15	3
Building Materials	2d half	10	3
Chemical Geology	2d half	15	3
Applied Physics	1st half	30	2
German		90	3
Philosophy of Science	1st half	45	3
Political and Industrial Geography	2d half	30	2

In addition to the prescribed studies, optional studies, selected from other courses, may be taken, with the consent of the Faculty.

VIII. PHYSICS.

SECOND YEAR.

		No of Exercises.	Hrs. per week.
Analytic Geometry	1st half	45	3
Calculus	2d half	45	3
Descriptive Geometry	1st half	30	2
Qualitative Analysis	1st half		6
Physical Laboratory	2d half	45	6
Chemical Philosophy	1st half	45	3
Botany	2d half	30	2
Physics (Lectures)		90	3
French finished, German begun		90	3
Descriptive Astronomy	1st quar.	18	3
Physical Geography	2d quar.	27	3
English Literature	2d half	45	3
Military Science		24	1

THIRD YEAR.

Physical Laboratory			4
Physics (additional Lectures)		30	1
Advanced Physics	2d half	15	2
Applied Mechanics		90	3
Strength of Materials	2d half	30	4
General Quantitative Analysis (Lectures)	1st half	30	2
Chemical Physiology	1st half	30	2
Chemical Laboratory	1st half		6
German		90	3
General Geology	1st quar.	21	3
Outlines of Zoology	2d quar.	21	3
Constitutional History	3d quar.	21	3
Formal Logic	4th quar	21	3

FOURTH YEAR.

Physical Research			15
Advanced Physics		30	2
Photography	1st half	15	4
Lantern Projections	1st half	15	4
Thesis Work			
Chemical Laboratory	2d half	45	6
Practical Astronomy	1st half	30	3
Mechanical Engineering	1st half	15	3
Principles of Thermodynamics	1st half	60	4
American Geology	1st half	45	3
Chemical Geology	2d half	15	3
Coal and Ore Deposits	2d half	15	3
Building Materials	2d half	10	3
German	1st half	45	3
Philosophy of Science	1st half	45	3
Political and Industrial Geography	2d half	30	2

In addition to the prescribed studies, optional studies, selected from other courses, may be taken, with the consent of the Faculty.

IX. SCIENCE AND LITERATURE.

SECOND YEAR.

		No. of Exercises.	Hrs. week.
English History and Literature		90	3
English Composition		60	2
Elements of Philosophy	1st half	45	3
French finished, German begun		90	3
Physics (Lectures)		90	3
Descriptive Astronomy	1st quar.	18	3
Physical Geography	2d quar.	27	3
Political and Industrial Geography	2d half	30	2
Descriptive Geometry	1st half	30	2
Elements of Architecture, or	1st quar.	30	4
Analytical Geometry	1st half	45	3
Mineralogy	2d half	45	6
Botany	2d half	30	2
Drawing			
Military Science		24	1

THIRD YEAR.

Political Economy	1st half	45	3
History (Constitutional)	2d half	45	3
English Literature (private reading)			
English Composition			2
Advanced French		90	3
German		90	3
Physical Laboratory		60	2
General Geology	1st quar.	21	3
Outlines of Zoölogy	2d quar.	21	3
Chemical Physiology	1st half	30	2
*Palæontology	2d half	30	2
*Industrial Chemistry	2d half	45	3
*Comparative Zoölogy	2d half	45	3
Formal Logic	4th quar.	21	3
Drawing (optional)			

FOURTH YEAR.

History (Commercial and Industrial)		90	3
English Literature (private reading)			
Philosophy of Science	1st half	45	3
Science of Language	2d half	45	3
German		90	3
Italian or Spanish		60	2
Applied Physics	1st half	30	2
Business Law	2d half	30	2
American Geology	1st half	45	3
Advanced Physical Research			
Geology	2d half	45	3
Thesis work	2d half		

In addition to the prescribed studies, optional studies, selected from other courses, ma be taken, with the consent of the Faculty.

* Two out of these three subjects will be required.

X. PHILOSOPHY.

SECOND YEAR.

		No. o Exercises.	Hrs. per we ek.
Elements of Philosophy, viz.,		90	3
Its Definition and General Problems; The Solutions proposed by the several Schools; Empirical Psychology			
French finished, German begun		90	3
Analytic Geometry	1st half	45	3
Calculus	2d half	45	3
Physics (Lectures)		90	3
Chemical Philosophy	1st half	45	3
Descriptive Astronomy	1st quar.	18	3
Physical Geography	2d quar.	27	3
English Literature	2d half	45	3
Military Science		21	1

THIRD YEAR.

Philosophy: Critical History of Modern Systems		150	5
Descartes, Spinoza, Leibnitz; Locke, Berkeley, Hume; Reid, the Transition to Kant			
Advanced French		90	3
German		90	3
History	1st half	30	2
Physical Laboratory	1st half	30	2
General Geology	1st quar.	21	3
Outlines of Zoölogy	2d quar.	21	3
Constitutional History	3d quar.	21	3
Formal Logic	4th quar.	21	3

FOURTH YEAR.

Philosophy: Critical History of Modern Systems		210	7
(*a*) Kant. (1st half. 75 lectures.)			
(*b*) Fichte. (1st half. 30 lectures.)			
(*c*) Transition from Kant to Hegel through Fichte. (2d half. 30 lectures.)			
(*d*) Hegel. (2d half. 75 lectures.)			
Thesis Work			
Philosophy of Science, viz.,	1st half	45	3
(*a*) Theory of Induction			
(*b*) Classification, Logical Connection, and Logical System of the Natural Sciences			
(*c*) Same treatment of the Mathematical Sciences			
(*d*) Logical Theory of the Calculus			
Science of Language	2d half	45	3
German		90	3
Earlier English Literature	1st half	45	3

In addition to the prescribed studies, optional studies, selected from other courses, may be taken, with the consent of the Faculty.

ADVANCED COURSES.

These courses are intended to afford to Bachelors of Science of this Institute, and others of equal attainments, the means of continuing their studies. For proficiency in them the degree of S. D., or Doctor of Science, has been authorized.

The particular course of study which a student wishes to pursue must be submitted in writing, and must meet the approval of the Faculty. The methods of instruction, whether by lectures or projects, or practice in the field or in the laboratories, will be those best adapted to each case. Frequent examinations will be held to test the progress of the student; but in voluntary subjects no examination will be required.

The minimum term of residence of candidates for a degree will be two years; but occasional short absences, when the time is spent upon professional work by advice of the Faculty, will not be considered as interruptions of the student's residence.

A candidate will be required to present at least one printed thesis on some subject embraced in his course.

The usual final examinations for the degree will be held, and these, with all previous examinations and the thesis, will be the tests of the student's proficiency.

CONDITIONS OF ADMISSION.

Regular Courses. To be admitted as a regular student of the first year's class, applicants must have attained the age of sixteen years, and must pass a satisfactory examination in arithmetic (including the metric system of weights and measures); algebra, through equations of the second degree; plane and solid geometry, including spherical geometry; French grammar, through regular and irregular verbs,[1] and the first two books

[1] Part I. of Otto's French Grammar represents what is required.

of Voltaire's "Charles XII" (*i.e.*, about sixty pages), or the equivalent of the same; English grammar, including, especially, the ability to detect the parts of speech, to use correctly the conjugation of verbs regular and irregular, to classify terms as Singular, General, and Universal, and to analyze phrases and sentences; English composition; rhetoric (so much as is included in the first part of Bain's Rhetoric, or its equivalent); history of the United States; and geography.[1] In general, the training given at the best High Schools, Academies, and Classical Schools, will be a suitable preparation for this School.

To be admitted as a regular student of the second year's class, applicants must be at least seventeen years of age, and must pass a satisfactory examination upon the first year's studies, besides passing the examination for admission to the first year's class; and a like rule applies to the case of applicants for admission into the classes of the succeeding years.

Graduates of Colleges will, in general, be presumed to have the requisite attainments for entering the third year as regular students, and may do so on satisfying the department which they purpose to enter that they are prepared to pursue their studies to advantage. Such students, if deficient in any of the scientific studies of the first two years, will have opportunities for making them up without extra charge, and will be required to pass an examination in them before entering upon the studies of the fourth year. Should they be already proficient in any of the general studies of the third and fourth years, they will be excused, if they wish, from attendance on the exercises in these subjects.

A knowledge of the Latin language is not required for admission; but the study of Latin is strongly recommended to persons who purpose to enter this School. Those who intend to take the course in Natural History will find it advantageous to acquire also the elements of Greek.

[1] For fuller details respecting the requirements for admission, and for specimens of the examination papers, see page 63.

Persons not candidates for a degree will be allowed to enter special divisions of either of the courses, — as, for example, the classes of mathematics, chemistry, physics, drawing, engineering, metallurgy, architecture, natural history, etc., — on giving satisfactory evidence to the Faculty that they are prepared to pursue with advantage the studies selected. They must be present for examination at the times stated below, and will be required to pass the entrance examination prescribed for regular students, in arithmetic, algebra through equations of the *first* degree, English grammar and rhetoric, and in such other subjects as may be deemed a necessary preparation for the profitable pursuit of the studies chosen.

Students may be admitted to the classes in Drawing and Architecture without examination.

There are also certain courses open to *advanced* students of either sex without examination. These courses will be advertised in September of each year.

An examination for admission to the first year's class will begin at 9 A. M., on the first Monday in June, and continue two days. A second examination will begin at 9 A. M., on the Wednesday preceding the last Monday in September, and continue two days. Attendance on both days of either examination is required. Applicants for advanced standing must present themselves at either the first or second entrance examination, as given above, and if they pass this examination, must present themselves for further examination at 9 A. M., on the Friday following either entrance examination. Applications for admission at other times than the above will be received only when sickness or some other equally good cause has prevented attendance on the days prescribed.

Advanced Courses. Bachelors of Science of the Institute may enter on these courses without examination. Bachelors of Arts, Science, or Philosophy of any other Institution may enter, on giving satisfactory evidence, by examination or otherwise, that they are qualified to pursue the course selected. Any person may enter who, by examination, is found qualified to take the degree of Bachelor of Science in the Institute.

METHODS AND APPARATUS OF INSTRUCTION.

Ordinary Exercises. Instruction is given by lectures and recitations, and by practical exercises in the field, the laboratories, and the drawing rooms. The progress of each student is tested by frequent oral examinations. Text-books are used in many, but not in all departments. A high value is set upon the educational effect of laboratory practice, drawing, and field-work.

Written Examinations. Besides the oral examinations in connection with the ordinary exercises, written examinations are held from time to time, particularly in those departments in which the oral examination of the students is necessarily too infrequent to be exclusively relied upon.

Near the close of the months of January and May, general examinations are held, — that of January embracing the subjects studied during the first half-year, that of May covering the studies of the whole year. Each examination on a distinct subject is marked on a scale of 100, and the marks of each student are reported to his parent or guardian. These returns are intended to enable the parent or guardian to judge of the proficiency of his son or ward in each department of instruction. The examinations of January and May form the basis of admonition or advice from the Faculty in the case of students who are not profiting by their connection with the School. A student who fails to pass the May examination in any subject will not be permitted to enter upon the studies of the following year without passing a new examination. Such students must appear for re-examination at 9 A.M., on the Friday preceding the first Monday in October.

The Instruction in Chemistry. In the chemical laboratories provision is made for teaching General Chemistry, Qualitative Analysis, Quantitative Analysis, Organic Chemistry, Assaying,

Determinative Mineralogy, the Use of the Blowpipe, Metallurgy, and Industrial Chemistry.

During the first term of the first year, instruction is given in General Chemistry by recitations and lectures, and by practical exercises in the laboratory, where every student is provided with a desk and the necessary apparatus, and is required to perform, under the supervision of the professors, a large number of experiments selected to illustrate the laws of chemical action and the properties of all the more important chemical elements. In the second term, a systematic course of instruction in Qualitative Analysis is given, by laboratory practice and by oral and written examinations.

During the first term of the second year, further instruction is afforded in Qualitative Analysis as well as instruction in Chemical Philosophy. In the second term of the second year, and in the third and fourth years, the principal subjects of study are Volumetric and Gravimetric Analysis, Organic Chemistry, Gas Analysis, the Preparation of Chemical Products, Assaying, Mineralogy, the Use of the Blowpipe, Metallurgy, and Industrial Chemistry. A large portion of the time is allotted to work in the laboratories. In the third year, lectures are given on Quantitative Analysis and on Physiological and Industrial Chemistry. In the fourth year, the lecture room exercises are devoted to Organic Chemistry and Metallurgy. During the last two years the student is required to make reference to standard works and original memoirs in English, French, and German. Both regular and special students are encouraged to undertake experimental researches, and are assisted in bringing them to useful results.

New laboratories are in course of construction for work with the microscope, spectroscope and other optical apparatus, in connection with the instruction in Chemistry and Biology; also for researches in Organic and Industrial Chemistry, and for giving women opportunities for laboratory work.

The Instruction in Physics. During the second year the whole subject is discussed in a series of lectures, which are attended by all the regular students. The various branches are treated both mathematically and experimentally. In all cases the theoretical discussion of a question is followed by a full account of its practical application.

The first part of the course is devoted to Mechanics of solids, liquids, and gases, and is designed both to prepare the student for an extended study of General Physics, and to serve as an introduction to Analytical and Applied Mechanics.

The Institute possesses an extensive and constantly increasing collection of physical apparatus. The lectures are also illustrated by a large number of photographs on glass, which are projected upon a screen by means of a calcium light.

In the third year the students enter the *Rogers Laboratory of Physics* and learn to use the different instruments, and to prove many of the fundamental laws of nature. Some of the experiments, as for instance those with the microscope and spectroscope, and the determination of specific gravities, have a direct value; others are intended to establish certain principles in the mind; others again serve to cultivate manual skill in handling minute or delicate objects; and still others exercise his reasoning faculties, and show him how to apply his mathematics to concrete problems. This course, therefore, has a value beyond the direct application of the experiments, in the direction of general culture, teaching the student to derive conclusions from observed facts, and showing him the various methods of experimental research.

In the fourth year a portion of the students carry on work of a more technical nature, or more closely connected with their professional studies. In this course original investigation is stimulated as far as possible, and the result has been a considerable number of published memoirs.

Besides the above, the students in the department of Physics pursue the following practical courses: —

Photography. Methods of photography and its connection with lithography and printing; preparation of baths; taking glass negatives, lantern slides, paper positives; photographs of microscopic objects, of spectra and other scientific applications.

Lantern Projections. Sunlight, calcium, magnesium, and electric lights; lanterns, condensers, and projecting lenses; projection of views, of real objects; tanks, chemical and electric decompositions; projection of spectra.

Mechanical Engineering. Tests of engines and boilers; evaporation per pound of coal; measurement of power; transmission and absorption dynamometers; coating of steam pipes; friction of belts and pullies; strength of materials.

Meteorology. Atmospheric temperature, pressure, and moisture; velocity of the wind; magnetic elements; electricity of of the air.

Astronomy. Sextant, and its adjustment; determination of latitude, time, longitude, and meridian; transit, its adjustment and corrections; measurement of time; transit in prime vertical; transit circle; zenith telescope; altitude and azimuth instrument; equatorial telescope; position and spider-line micrometer; principal objects, the sun, moon, planets, double stars, clusters, and nebulæ.

Advanced Physics. As most of the students taking the course in Physics intend to make teaching their profession, a special course is prepared with this object in view, in which each student in turn prepares a particular subject, giving the result of his own or others' researches, and presents it in the form of a lecture, illustrated, as far as possible, by experiments.

Teachers of physics, or others properly qualified, may enter the laboratory, and take the whole or any part of the above courses.

The Instruction in English and History. In this department lessons are given, in the first half of the first year, in the history and constitution of the English language, and in that part of Rhetoric which relates to written composition; and in con-

nection with this series of lessons, weekly written exercises are required of all regular students. During one half of the second year a course of lessons in literature and criticism is given, and during one fourth of the third year a course of lessons in political and constitutional history, accompanied, in each case, by the reading of some suitable text-book. Attendance on these three courses in the department of English and History is required of all regular students.

Department of Science and Literature. In addition to the exercises and lessons enumerated above as required of regular students of all departments, a wider course of study, both in History and Literature, is required of all candidates for a degree in the department of Science and Literature. This corresponds to the technical scientific instruction required in other departments. The wider course in History will have for its object the acquirement of a fuller and more accurate knowledge of recent and contemporary history and, more particularly, of the present social and industrial condition of the leading nations of the civilized world. The wider course in literature will consist of a more extended course of critical reading of standard English writers.

The Instruction in Logic and Philosophy. The work done under these heads consists, first, of that required of all regular students; and, second, of that which constitutes the main work in the special Department of Philosophy.

I. The subjects required of all regular students are the Rudiments of Logic and the Philosophy of Science. In these, the aim of the instruction will be to familiarize all with the logical principles underlying the sciences which form the subjects of their other studies, and warranting the methods of investigation which are taught in each. The final object will be, to acquaint each student with the Laws of Belief, so far as they have been reduced to system.

In the teaching of Logic, especial attention will be paid during the first year to the structure and analysis of sentences,

and to the classification and analysis of terms. In the third year, the forms of Deductive Inference will be taught.

The instruction in the Philosophy of Science will include, as requirements for *all* regular students, (1) the Theory of Induction — its Nature, Limits, and Canons, and (2) the Classification, Logical Connection, and Logical Structure of the Natural Sciences. It will add, as requisites for the students in Engineering, Architecture, Physics, and Philosophy, (3) the Classification and Logical Structure of the Mathematical Sciences, and (4) the Logical Theory of the Calculus.

II. The requirements for regular students in the special department of Philosophy are embraced in a somewhat detailed study of the history and criticism of that subject. In this, the ground chosen will be that of Modern Philosophy. Such references to ancient systems as may be necessary merely to explain the modern will of course be made; and the central works of the leaders of the modern systems will be the text upon which the instruction will be founded.

For details of the course, see page 32.

The Instruction in Modern Languages. The object of the instruction in French and German is to enable the student to avail himself of the literature in these languages relating to his particular department of professional study. Since many important sources of information, such as periodicals and works for consultation and reference, are only accessible in one or the other of these languages, it is desirable that he should become able to use them as soon as possible. But although the object is the practical one of learning in the shortest time to read with readiness a foreign scientific work, it is believed that this can be satisfactorily accomplished only by a thorough and systematic training in the forms, laws and usages of the language; since it is only in this way that the essentials of *accuracy* and *strength* can be attained, and the acquisition be a permanent one. It is not understood by this, however, that these forms, laws, and usages are to be learned by themselves as detached facts; on

the contrary they are to be constantly studied and practised as parts of an actual organism, the language, and on this depends the value and interest of the work. Reading, talking and composition exercises are arranged in accordance with these views.

French is continued at the rate of three exercises a week through the first year and until a period of two years' study, including the time of preparation, has been devoted to the same. German is commenced at the beginning of the second year (or after the French is finished), and continued at the same rate as the French, and for a like period. To this point these languages are studied by all regular students.

In the courses of Science and Literature and Philosophy, French and German are continued after they are finished in the professional courses. More difficult authors in both languages are studied, with more especial reference to the literature of the same. The special object of these courses being to afford a general education, it is intended that the languages should be taught here accordingly, and in a more disciplinary and extended manner than where the main object is to learn to read in the shortest time.

The elements of Italian and Spanish are taught in optional classes in the third and fourth years, for the benefit of those who may have special reasons for making a beginning in those languages. It is, however, recommended to students to go farther in French and German rather than to take up a new language.

Opportunity is offered in the "Advanced courses" for the study of the older forms of the Modern Languages, and of the subject of linguistic science.

A knowledge of Latin is very desirable to those pursuing any of the latter studies, and in some of them it is essential. A previous study of Latin is also of very great help to all the students in the Modern Languages. The vocabulary and forms of the French come directly from it; and a previous, though brief, study of it gives the student a training in language which will enable him to take up the French and German with greater facility and to advance much more rapidly.

The Instruction in Descriptive Geometry and Drawing. Descriptive Geometry is taught under the main divisions of Planes; Developable Surfaces; Warped Surfaces, and Double Curved Surfaces; and each under the subdivisions, relative to the kinds of problems treated, of Projections; Tangencies; Intersections, and Developments.

The exercises are of two kinds. In the lecture room, instruction, with models and diagrams, is combined with testing the student's knowledge as gained from a text book. In the drawing room, the student aims to construct such problems, each week, from the lessons for that week, as shall, during the course, give him practice in all the usual operations belonging to the subject.

The Instruction in Stereotomy is given by means of lectures and drawing exercises, illustrating a variety of problems in Stone Cutting, on plane, double-curved, and warped surfaces. The application of Descriptive Geometry is extended to the construction of the oblique arch and winding staircases of various forms, so as to include a large number of useful and practical problems.

The Instruction in Civil Engineering is given by means of lectures and recitations, and by practice in the field and in the drawing rooms. The use of the various instruments for measuring lines and angles, and of the level, is taught mainly by actual work in the field; first, in ordinary surveying and levelling; then in laying out curves, both circular and parabolic; and afterwards in the survey of a railway line, and in staking it out ready for construction. These surveys are plotted and represented on finished plans. The necessary computations of areas, earth-work, etc., are also made. In most of the remaining subjects peculiar to this department, as set down in the Course of Instruction, Rankine's Civil Engineering is used as a text-book; and the aim is to enable the student, by means of suitable explanations, illustrations and examples, to acquire a

thorough working knowledge in these branches. The department has a good stock of excellent field instruments. An *Observatory*, erected upon the Institute building, from which a large number of U. S. Coast Survey stations are visible, is used in the instruction in triangulation and geodesy. Observations are also made for the determination of the meridian, and of latitude and longitude.

The Instruction in Designing Bridges and Roofs. Problems are given to the fourth year's class to be worked out by each student independently, in the form of original design for structures to meet stated requirements of loading and limits of stress. Working drawings are made in the usual form of workshop practice, showing dimensions and combinations of parts corresponding to the calculated stresses. Computations are checked by graphical determinations, and these diagrams are affixed to the finished drawings of the structure.

During the third year, a course of lectures on Construction is given, preliminary to the course in Designing. These lectures comprise a careful analysis of a wide range of engineering works, selected and described so as to make the student familiar with existing structures to such an extent that he may have at his command a variety of forms and mechanical combinations of practical value, from which he can choose when he is required to design bridges and roofs in the fourth year's course.

The Instruction in Topography is mainly given in the field by means of the Plane-Table, as perfected and used in the United States Coast Survey. The maps are completed in the drawing rooms, where instruction is given in the conventional modes of shading and topographical illustration.

The Instruction in Hydrography is given by means of a series of exercises in making marine surveys for engineering purposes. Maps prepared from notes of the surveys, showing currents,

soundings and contours, are used principally in suggesting river and harbor improvements, and the construction of engineering works in navigable waters.

The Instruction in Mechanical Engineering. Subjects, not text-books, form the basis of this course of instruction. But the best text-books and engineering publications are freely consulted and carefully studied. The department has a valuable Technical Library for the use of the students.

Two classes of lectures are carried on simultaneously. In one class the Mathematical, and in the other class the Practical aspects of the subject are considered.

Weekly excursions are made, through the courtesy of the managers, to establishments where machinery is manufactured, or where it is in operation. The gentlemen in charge often explain to the students the interesting operations which they are directing. Sometimes they loan working drawings, and allow detail measurements of machines to be made. Thus the students observe how the subject is practically treated. They make written and graphical reports of their excursions.

The students are sufficiently expert in drawing, at the middle of their second year, for ordinary practical purposes. They then cease to draw for mere practice, but use their graphical skill in various ways. They work out problems in machine construction. They plot the results of laboratory experiments and of calculations. They record the information which they gain, from time to time, by the careful examination of machinery and of working drawings.

Their drawings are frequently pencil sketches, not drawn to scale, but giving dimensions. Or each student makes one or more detail drawings to scale, in pencil or ink, on Manila or Whatman's paper, from his own measurements, of a motor or machine. The students interchange and trace these drawings. Thus each one becomes possessed in his own right of a full set of details without an excessive expenditure of time.

The Mechanical Engineering Laboratory is fitted with Steam Boilers, Superheaters, Engine, Calorimeter, Indicators, Pressure Gauges, Thermometers, and all the usual apparatus for producing and using steam, and for testing its nature and action. Within a few months a substantially and accurately constructed mercury column has been erected in this laboratory. It is convenient for use, and is accompanied by delicate and manageable apparatus, by the aid of which, instruments indicating pressure or temperature can be tested with rare precision. The laboratory is also supplied with Transmission and Absorption Dynamometers. The students become practised in the use of the laboratory apparatus.

This course has been supplemented by the erection and equipment of instruction shops for giving a practical knowledge of the nature of metals and skill in arts of the metal worker.

The Instruction in Mineralogy. Determinative Mineralogy is taught by the study of crystalline forms and the physical properties of minerals, the use of the blowpipe, and by the handling of specimens.

The collections of minerals in use for instruction is placed in the study room of the Mining department, and is convenient at all times for reference.

The Instruction in Geology and certain related subjects is given as follows: —

In the third year is given a course of twenty-one lectures on Descriptive and Theoretical Geology, embracing the Classification of the Sciences; Scope of Geological Studies; Nature of Rocks, or Lithology; Stratigraphy; Succession of Formations; Zoological History; Geological Dynamics; Chemical and Physical Forces; Aqueous and Igneous Agencies; Currents; Sedimentation; Elevation and Subsidence; Geographical Distribution of Formations; Nature and Origin of Mountains; Volcanic Action.

In the fourth year are given: — a course of forty-five lectures on American Geology, comprising Geological History; Geology

of North America, considered lithologically, stratigraphically, and palæontologically; Comparative Geognosy: — a course of ten lectures on Practical Lithology, comprising the mineralogical composition of Rocks; Building-stones, their cohesion, porosity, etc.; Granites, Marbles, Limestones, Sandstones, Slates; Limes, Cements, and Mortars; Ornamental Stones and Gems: — and a course of fifteen lectures on Chemical Geology, or the chemical history of the globe; comprising the Origin of Rocks, both stratified and unstratified; the History of Veinstones and Ore-deposits; the Formation of Coal and Petroleum; the Chemistry of Salt-deposits and of Mineral Waters; the Seat and Origin of Volcanic and Earthquake phenomena; and a course of fifteen lectures on Economic Geology, mainly devoted to a detailed description of the coal and ore-deposits of North America, especially such as are most extensively worked.

The Instruction in Palæontology is given to students of the third year.

Palæontology, including the history of ancient animal life, and the study of the distinctive and characteristic fossils of the different formations, is taught as a necessary foundation for the further study of Geology. The aim of the course is to give the student a practical acquaintance with the structure of the characteristic families and orders of living and extinct animals, and by a judicious selection of examples to familiarize him to some extent with the genera which characterize various formations.

The handling and drawing of specimens by the students is an essential feature of the method of instruction. The lectures of the instructor are devoted largely to explanatory demonstrations of the specimens which the students are at the same time drawing.

The Instruction in Mining is given to students of the third year by a course of eighty lectures on the general character of the various deposits of the useful minerals, in the theory and

practice of mining operations, such as prospecting, boring, sinking of shafts, driving of levels, different methods of working, hoisting, pumping, ventilation, etc. These lectures are illustrated by drawings; and by a set of models from Freiberg, Saxony, which show in detail the methods of working underground by underhand and overhand stoping, the timbering and walling of shafts and levels, the arrangements of pumps, man engines, ladder ways, hoisting ways, the sinking of shafts, etc.

In the fourth year, ore-dressing and metallurgy are taken up in a course of sixty lectures. This is followed by a series of continuous practical exercises in the concentration and smelting of ores in the Mining and Metallurgical Laboratories, and the student is thus afforded opportunities for acquiring a familiar knowledge of the subject, founded on actual experiment.

The Professors in this department hope to give each student of Mining and Metallurgy at least one chance during his course of study, to join a party organized for visiting some of the more interesting mining regions.

The valuable scientific library and the large geological collection of the late Prof. Henry D. Rogers of the University of Glasgow, presented to the Institute by Mrs. Rogers, are accessible to the students in Geology and Mining. This collection is made up chiefly of fossils and rock specimens from American localities, and is especially rich in coal-plant fossils.

The Mining and Metallurgical Laboratories. These Laboratories furnish to the student in Mining and Metallurgy the means for studying experimentally the various processes of ore-dressing and smelting. Ores of different kinds may be here subjected, on a small scale, to the same modes of treatment as have been adopted at the best mining and metallurgical establishments.

The mining laboratory is supplied with two suites of milling apparatus; —

I. A five-stamp battery, a sorting cone, an Atwood amalgamator, concentrators for tailings, and an amalgamating pan.

II. A Blake crusher, crushing rolls with automatic screens, a sorting cone, a Spitzkasten, two automatic machine jigs, a side bump table, an end bump table, a settling tank, and a centrifugal pump, which throws the water from the machine back to the feed tank. The same water is used over and over again to avoid loss in slimes.

This laboratory also contains the following auxiliary apparatus: — a steam engine and boiler, a Whelpley and Storer pulverizer, an edge-stone mill, and a Sturtevant blower. The metallurgical laboratory contains a blast furnace, a reverberatory smelting furnace, a roasting furnace, a furnace for cupellation, furnaces for fusion, crucible and muffle assay furnaces, a blacksmith's forge, and a melting kettle.

The experimental work of the laboratory is carried on by the students under the immediate supervision of an instructor. A sufficiently large quantity of ore is assigned to each student, who first examines it for its component minerals, sorts and samples it, and determines its character and value by analysis and assays, and makes such other preliminary examinations as serve to indicate the proper method of treatment. He then treats the given quantity, makes a careful examination of the products at each step of the process, ascertains the amount of power, water, chemicals, fuel, and labor expended, wherever practicable, and thus learns approximately the effectiveness and economy of the method adopted. Each student is assisted in working his ore by his classmates, who have an opportunity in this way to run the engine, boiler, machines and furnaces.

The Institute is from time to time receiving ores of gold, silver, lead, copper, antimony, zinc, iron, etc., from various localities on this continent. These ores are worked, and reports sent to those who contributed them; and it is hoped that by such coöperation the laboratory will continue to receive the necessary amount and variety of ores.

Models, etc., relating to the Engineering Courses. The collections under this head consist of models in wood, in metal,

and in plaster, besides lithographs, photographs, and drawings collected in the United States and in Europe.

They illustrate the following subjects: —General Descriptive Geometry, Linear Perspective, Shades, Shadows and Reflections, Masonry and Stone Cutting, Joints, Girders and Trusses for Wood and Iron Structures, Furnaces and Boilers, Steam and Water Motors, Machines and their details.

The Instruction in Architecture. It is the object of this Department to give to its students the instruction and discipline that cannot be obtained in architects' offices. The course is, however, practical as well as theoretical, and, besides the scientific study of construction and materials, it comprises the study of building processes, and of professional practice and procedure, as well as that of composition and design, and of the history of the art. It is calculated to meet the wants not only of young men who propose to pursue a comprehensive course of architectural study, but of those who are looking only for such an elementary training as shall qualify them for positions as draughtsmen.

The degree of Bachelor of Science is given in Architecture to all students who, at the conclusion of their fourth year, have passed the prescribed examinations and have executed in a satisfactory manner the drawings and designs required.

The more strictly professional work begins in the second year, the first half of which is given to the study of the Five Orders, and their applications, and to Greek and Roman Architectural history. At the same time the students of the third year attend a series of lectures upon ornament, composition, and the theory of architecture. In the last half of the year the historical studies are continued, and both classes, for convenience, attend the same exercises. The mediæval period, from the fall of the Roman Empire to the fall of Constantinople, and the modern period, including that of the Renaissance, are taken up in alternate years, so that each class is carried over the whole ground.

In the same way the study of specifications and working drawings, which runs through the third and fourth years, is pursued by the two classes together, carpentering and its related subjects occupying one year, and masonry and stone-work the next. In the fourth year the study of full-sized ornament and detail is taken up and the studies of the preceding years are reviewed. During the third and fourth years the students are constantly practiced in original design, the character of the problems given out and the time allowed for their completion varying according to the advancement of the class and the kind of drawings required. Each set of drawings is examined and criticised before the class.

Special exercises are also had in shades, shadows, perspective, and the perspective of shadows, and in tracing and sketching, and drawing upon the blackboard. Opportunity is also afforded to sketch, measure, and draw out buildings already erected.

Special students in Architecture are received into a special course, occupying two years, and embracing all the subjects mentioned in the three preceding paragraphs. If not proficient in free-hand drawing and in practical geometry they will be required to make themselves so during the first half of the year, in addition to their other exercises. Such students, upon passing the entrance examination, will be permitted to pursue any other studies taught in the school which they are prepared to pursue to advantage. The fee for this special course is the same as for the regular courses.

The Architectural Museum. Several thousand photographs, prints, drawings, and casts, have been collected for this Department, by means of a special fund raised for the purpose.

The collection of casts comprises architectural details and specimens of carving and sculpture illustrating various periods of art. It includes a valuable collection of sculptures from Lincoln Cathedral, and a large number of casts of Moorish ornamental details, recently presented by the Spanish Government, through the Spanish Commissioner at Philadelphia.

To these collections the following additions have been made, mostly by gift: —

A considerable collection of photographs, lithographs and drawings, presented to the Institute by French, English and American architects, taken from their own works, including sets of actual working drawings, with details and specifications.

A complete series of drawings, mostly presented by the late Ernst Benzon, Esq., of London, formerly a merchant of Boston, illustrating the course of Architectural instruction in the *Ecole des Beaux-Arts* in Paris: — *Esquisses-Esquisses*, *Projets Rendus*, *Projets d'ordre*, *Projets de Construction*, *Grand Prix de R e*, *Envoi de Rome*.

Specimens of modern English and American stained glass and tile-work, partly purchased, and partly presented by the makers, with cartoons and drawings illustrating the process of manufacture.

The publications of the Royal Institute of British Architects, and of the *Société Centrale des Architectes*, in Paris, have been presented by the authorities of these institutions. The library already contains nearly four hundred volumes.

The Instruction in Natural History. This will be given with the aid of the collections and library of the Boston Society of Natural History, which, by an agreement between the Society and the Institute, are freely open to the students. These collections rank among the first in the country for extent and value, and in many departments are unsurpassed; the library is rich in works on Natural Science, many of them finely illustrated, and embraces the leading American and European journals and periodicals on Natural History. It is believed that the facilities thus afforded to the students of the Institute are ample for the most thorough instruction in Zoölogy, Palæontology, and other branches of Natural Science. This instruction will be given by the Professors of the Institute and partly in

the lecture room and Palæontological laboratory of the Natural History Society, whose building is upon the same square.

Botany is more generally required than heretofore, as affording the proper and natural introduction to the study of Zoölogy, Palæontology, and Biological Chemistry; and as being the science best calculated to train the mind for close observation, accurate description, and systematic classification. The instruction is given by lectures, recitations, and practical exercises in the examination of living plants and tissues. The numerous conservatories in Boston and vicinity furnish the means of studying hand specimens in many of the natural orders, and the wild flowers of early spring are usually obtained before the end of the school year.

The Instruction in Physical Geology and Geography. This department of instruction has been organized for the purpose of giving the student a knowledge of geography in its more advanced and scientific relations.

The instruction given in the first half of the second year, is analytical; beginning with the earth as a whole, then resolving it into its more extensive divisions, and continuing on to those which are more limited. The features of the different regions and their geological origin are thus presented in their natural relations.

The course in Political and Industrial Geography given during the second half of the fourth year is synthetic in character. The influence of geographical features, climates, etc., upon the distribution of plants and animals, also their direct and indirect influence upon the life, industries, and advancement of man are taught, with the hope of contributing to the completeness, unity, and utility of the entire course of study.

The Instruction in Military Science and Tactics. In conformity with the requirements of the Act of Congress of July 2, 1862, and of the Act of the General Court of Massachusetts in furtherance thereof, the Institute provides instruction

n military science and tactics. An officer of the U. S. Army is detailed by the U. S. Government as Professor of Military Science and Tactics. During the first year all students are required to attend three times a week an exercise in tactics, unless specially excused. For these exercises they are organized as a battalion of two companies, and are required to provide themselves with a uniform consisting of dark blue pantaloons, cap with silver ornament, and double-breasted sack-coat with black gutta-percha buttons. These uniforms are manufactured from measures and by contract, to secure uniformity of material and manufacture, as well as cheapness. The whole cost will not exceed twenty-five dollars. The uniform must be worn at drill, and being inconspicuous, may be worn at other times if the student chooses. Arms and equipments are lent to the School by the United States. During the second year all regular students, and all special students who take one or more studies, in addition to the special ones, are required to attend one lecture a week, for twenty-four weeks, upon military science, pertaining chiefly to the duties of officers in disciplining, feeding, clothing, camping, marching troops, and the general sanitary measures necessary to maintain them in health. Whilst this instruction would be of service to the country in the emergency of a war, it will also be useful to the graduates of the Institute, when, as Engineers, they are called upon to take charge of large bodies of laborers. The matter of attendance at drill is under the control of the Professor; but excuses of general application can be granted by the Faculty only. Applications to be excused from drill will be granted when based on the following grounds, viz.: —

1st. Being an Alien.
2d. Being a College Graduate.
3d. Being over twenty-one.
4th. Having a surgeon's certificate of disability.
5th. Being able to pass an examination satisfactory to the Department.

Only the first and second classes mentioned, can, however, be exempt from the instruction of the second year.

A large drill-hall, which includes a well equipped gymnasium, is used by all classes in the Institute.

Excursions. In aid of the practical studies of the school, and as a means of familiarizing students with the actual details of work, they are required, in term time, to make visits of inspection to machine-shops, engines, mills, furnaces, and chemical works, and to important buildings and engineering constructions within convenient reach.

In the vacations more extended excursions are made for the survey of mines, and for the study of metallurgical works and noted specimens of engineering. During the past summer the whole school, with a large number of graduates, encamped on the grounds of the University of Pennsylvania, and spent two weeks in visiting the Centennial Exhibition. The Mining students, with one of the Professors, also spent a week in visiting the Anthracite region of Pennsylvania, the Zinc mine and works at Bethlehem, and the Cambria Iron Works at Johnstown.

THE SOCIETY OF ARTS.

One of the primary objects of the founders of the Institute of Technology, as shown by the extract from the charter given on page 4, was the establishment of a Society of Arts. This Society was organized in 1861, and now numbers about 350 members. It holds regular meetings at its rooms in the Institute Building, on the second and fourth Thursdays of each month from November to May inclusive. At these meetings are presented communications on various subjects of applied science, with the exhibition of machines and apparatus illustrating important inventions in the mechanic and useful arts. Students of the school may be present at these meetings, by permission of the Secretary of the Institute.

THE BOSTON PUBLIC LIBRARY.

The professors and students of the Institute are allowed the full use of this extensive library. Copies of the complete catalogues of the Library are kept at the Institute for convenience of reference, and the Library Building is near at hand. The Library now contains over 300,000 volumes; and its reading-room is supplied with all the best scientific and technical periodical publications. New books of value are promptly bought, on proper application to the authorities of the Library. No college or school in the country has better facilities in these respects than those which the Trustees of the Boston Public Library have put at the disposal of the officers and students of the Institute of Technology.

THE THOMAS SHERWIN SCHOLARSHIP.

This scholarship for regular students has been founded by the English High School Association, in memory of the late Thomas Sherwin, who, for more than thirty years, was the distinguished master of the English High School of the City of Boston. Mr. Sherwin was also an active and influential member of the Corporation of the Institute. The pupil to receive the benefit of this Scholarship "is to be a graduate of the English High School in the city of Boston."

THE CHARITABLE MECHANIC ASSOCIATION SCHOLARSHIPS.

Two scholarships have been founded by the Massachusetts Charitable Mechanic Association, in the Department of Practical Mechanism.

These scholarships are awarded on competitive examination to sons of past and present members of the Association.

ADVANCED SCHOLARSHIPS.

Five advanced scholarships, of $200 each, have been established, and will be awarded to such applicants as are recommended by the Faculty.

DIPLOMAS AND CERTIFICATES.

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 to which it relates.

The degrees or diplomas corresponding to the ten Regular Courses of the School are as follows: —

I. A Degree in Civil and Topographical Engineering.
II. " " " Mechanical Engineering.
III. " " " Geology and Mining Engineering.
IV. " " " Building and Architecture.
V. " " " Chemistry.
VI. " " " Metallurgy.
VII. " " " Natural History.
VIII. " " " Physics.
IX. " " " Science and Literature.
X. " " " Philosophy.

To be entitled to either of these degrees, the student must have passed satisfactory examinations in all the prescribed studies and exercises of the four years; and in addition, a final, or degree examination, embracing all the subjects which particularly relate to his course. He must, moreover, prepare a dissertation on some subject included in his course of study, or an account of some research made by himself, or an original report upon some machine, work of engineering, industrial works, mine, or mineral survey, or an original architectural design accompanied by an explanatory memoir. This thesis or design must be approved by the Faculty.

The examinations for these degrees are held in the month of May, and are partly oral and partly in writing.

The title of the degree in these courses is S. B., or Bachelor of Science, in the department of ————————.

The degree of S. D., or Doctor of Science, is awarded for proficiency in Advanced Courses of study.

Besides the degrees or diplomas of the Regular Courses and of the Advanced Courses, certificates of attainment in special subjects are given to such students as on examination are found to have the required proficiency in them.

REGULATIONS OF THE SCHOOL.

School-year. The school-year begins on the last Monday in September, and ends on the Saturday preceding the first Monday in June. On legal holidays the exercises of the school are suspended. There is a recess of one week ending at 9 A.M., on the first Tuesday in February.

Bond or Deposit. Every student is required, on entering the school, either to give a bond for two hundred dollars to pay all charges accruing under the regulations of the school; or to deposit, if he prefer so to do, the sum of two hundred dollars with the Secretary of the Institute, to be accounted for at the end of the school-year, or whenever the depositor leaves the school, in case he leaves it before the end of the year. This deposit must be renewed at the beginning of each year. The bond must be executed by two bondsmen, satisfactory to the Secretary of the Institute, one of them being a citizen of Massachusetts; and it must be filed within ten days after the date at which the student joins the school.

Fees. The fee for regular students is $200 per year, payable by students who have given bonds, $125 at the beginning, and $75 at the middle (first Tuesday in February) of the school-

year. For one-half, or any less fraction of the school-year, the fee is $125. Students not candidates for a degree pay, in general, the full fee; but when a few branches only are pursued, and the time required for instruction is limited, some deduction may be made. The fee for students in the advanced courses is the same as that for regular students.

Attendance. Regular students are expected to attend all the exercises of their several courses. Students not candidates for a degree are expected to attend all the exercises in the subjects they have selected. A monthly return of absences and tardinesses is made by the Secretary of the Faculty to the parent or guardian of every student not of age. Tardiness consists in entering a lecture room, drawing room, or laboratory, more than five minutes after the hour designated for the beginning of the exercise. Students are, in general, expected to devote themselves to the work of the school between the hours of 9 A. M., and 5 P. M. (4 1-2 P. M., in winter), except during the interval for dinner. There are no exercises on Saturday afternoon, and the building is closed.

Discipline. While within the limits of the Institute, students are expected to behave with decorum, to obey the regulations of the school, and to pay a due respect to its officers. They are required to avoid all running, loud talking, whistling, or other noise in the halls and passages of the building. Every student will be held responsible for the furniture which he uses and the cost of repairing any damage thereto will be charged to him. In case of injury to the building, or to any of the furniture, apparatus, or other property of the Institute, the damage will be charged to the student or students known to be immediately concerned; but if the persons who caused the damage are unknown, the cost of repairing the same will be assessed equally upon all the students of the school. Conduct inconsistent with the good order of the school, if repeated after admonition, will be followed by the dismissal of the offender.

Residence and Expenses. As the exercises of the school begin at nine o'clock in the morning, and end at half past four or five o'clock in the afternoon, students may conveniently live in any of the neighboring cities or towns on the lines of the various railroads, if they prefer to do so.

The cost of board and rooms in Boston, and the neighboring cities and towns, need not exceed from six to eight dollars a week. The cost of board at the Institute restaurant is three dollars and fifty cents per week, and conveniently located rooms may be found at a cost of two dollars and upwards additional per week.

The cost of books, drawing instruments, paper, etc., exclusive of chemical breakage, is from twenty-five to thirty-five dollars a year.

FREE COURSES OF INSTRUCTION.

The Trustee of the Lowell Institute has established, under the supervision of the Institute of Technology, courses of instruction, generally in the evening, open to students of either sex, free of charge.

This department of the school 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, physics, drawing, chemistry, geology, natural history, physiology, English, French, German, history, navigation and nautical astronomy, architecture, and engineering.

The subjects, and the extent of the several courses, will be made known 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 as may be

prescribed in regard to attendance and to order in the class or lecture-room.

The conditions of attendance on these gratuitous courses are as follows : —

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. The number of students in each class is necessarily limited. The selection will be made under the direction of the Faculty.

The courses for 1876–77 are on the following subjects : —

I. *General Chemistry.* Twenty-four laboratory exercises, of two hours each, on Wednesday and Saturday afternoons, at 2½ o'clock, by Prof. Nichols, beginning Nov. 8.

II. *Qualitative Analysis.* Twenty-four laboratory exercises, of two hours each, on Wednesday and Saturday afternoons, at 2½ o'clock, by Prof. Nichols, beginning Nov. 8.

III. *Geology.* Eighteen lectures, on Tuesday and Friday evenings, at 7½ o'clock, by Prof. T. Sterry Hunt, beginning Tuesday, Nov. 7.

IV. *Surveying and Geodesy.* Eighteen lectures, on Monday and Thursday evenings, at 7½ o'clock, by Prof. Pickering, beginning Monday, Nov. 6.

V. *The Philosophy of Government.* Eighteen lectures, on Monday and Wednesday evenings at 7½ o'clock, by Prof. Howison, beginning Monday, Nov. 6.

VI. *Practical Mechanics.* Eighteen lectures, on Tuesday and Thursday evenings, at 7½ o'clock, by Prof. Lanza, beginning Tuesday, Nov. 7.

The Trustee of the Lowell Institute has also made provision for a course of free instruction in Practical Design for Manufactures, open to pupils of both sexes. Students are received at the beginning of the school year in October, to whom is

taught the art of making patterns for Prints, Delaines, Silks, Paper-Hangings, Carpets, Oil-Cloths, etc.

The Course embraces: — 1. Original Design, or Composition of Patterns; 2. Secondary Design, or Variation of Patterns; 3. The Making of Working Drawings; 4. Technical Manipulations.

Instruction is given personally to each student over his work, with occasional general exercises. Students supply their own instruments and materials.

The class is under the personal direction of Mr. Charles Kastner, for fourteen years designer at the Pacific Mills, formerly Director of the Atelier Lebert in Paris, and nephew and pupil of M. Jean Baptiste Lebert, *Dessinateur*, of Mulhouse in Alsace.

Applicants for admission to the above Course are required to bring specimens of their work, exhibiting an acquaintance with Free-hand Drawing, and some familiarity with the use of mathematical instruments.

For circulars giving fuller information, address the Secretary of the Institute.

REQUIREMENTS FOR ADMISSION.

In order to afford to instructors and others a somewhat definite idea of the requirements for admission to the school, the following statements and suggestions are made.

Arithmetic. — The candidate will be expected to be familiar with the ordinary operations of arithmetic in both simple and compound numbers, with common and decimal fractions, with the computation of interest, etc. In the metric system a general knowledge will be required of the origin and advantages of the system, of the manner of designating the multiples and divisions of the units of length, capacity, etc., and especially of the relation existing between the measures of weight and those of length and capacity. Ability to perform ordinary arithmetical problems in the metric system will be required, but no stress will be laid upon the conversion of the ordinary United States weights and measures into the corresponding values of the metric system; as, however, the metric weights and measures are used constantly immediately on the students' entering upon the work of the school, practical familiarity with them is very desirable.

Geography. — A good elementary knowledge of the motions of the earth, of the mathematical measurements and divisions of its surface, and of the outlines of physical and political geography is required. The candidate for admission should be able to correctly define any of the principal physical features of the earth's surface, such as peninsulas, gulfs, etc.; he should be able to locate and describe the chief natural and political divisions, and the most important mountain chains, river-systems, etc. A more complete knowledge of North America and Europe is expected than of the other continents, but minute details and statistics, such as the lengths of rivers and heights of mountains, are not required. Practice in free-hand map drawing from memory is earnestly recommended, and proficiency in the art will receive the merit it so justly deserves.

English Grammar. — In English Grammar, candidates must be able to distinguish at sight between the several parts of speech, and to give the proper inflections of nouns, pronouns, adjectives, and verbs; especially the comparison of irregular adjectives, the principal parts of irregular verbs, and, in all verbs, the exact forms corresponding to the distinctions in mood and in tense. Particular

attention should be paid, in preparing for the Institute, to distinguishing prepositions from conjunctions, and subordinate conjunctions from co-ordinate. The same is true in regard to demonstrative, indefinite, relative, and interrogative pronouns.

Candidates must also know how to classify terms (whether single words or phrases) into substantives and attributives, and must be familiar with the subdivisions of substantives into singulars, generals, and universals. They must have a good degree of skill in separating sentences into subject, copula, and predicate; and, in case these terms are complex, must know how to separate them into base and determinant, and how to tell whether the determinant *changes* the meaning of the base or merely *unfolds* it. In case the meaning is *changed*, they must be able to show whether the modifiers are objective, or signify some other relation, *e. g.*, time, place, cause, comparison or possession.

In regard to all the foregoing matters, teachers should aim to secure *practical skill in applying the distinctions to examples*, rather than a mere knowledge of their definitions. *In the examination for admission, this skill in practice will be made the vital point.*

[The less familiar of the foregoing distinctions may be defined as follows: —

A *singular* term is one that denotes absolutely but one object of a kind, whether that object be a solitary individual, or a solitary group of individuals. A singular may therefore be either a proper or a collective noun, or any phrase equivalent to either. For example, Julius Cæsar, London, this city, the committee, the cities of the plain.

A *general* term is one that denotes more than one object of a kind, but less than all the possible members of it. It may do this either (1) by naming any *one* of them *indeterminately* (as *man, a man, some man or other*), or (2) by naming several *distributively* (as *men, some men, five men*), or (3) by naming *all* within certain limits — all the *actual* cases as contrasted with all *possible* cases (as *men*, in the sense of *most men* or *all men* hitherto or *all men now living*). For example, cities, all the continents, the continents.

A *universal* term is one that denotes absolutely all the objects of a kind, *i. e.*, all *possible*, future as well as present and past. For example, truth, the true, duty, the beautiful, space, time, causality, all triangles, every circle.

The *base* of a complex term is that word, or combination of words, in it that expresses the starting-point of the thought denoted by the whole term. For example, man, in the term "good man"; good man, in the term "every good man."

The *determinant* of a complex term is the word, or combination of words, added to the base, and characterizing it. For example, good, in the term "good man"; every, in "every good man"; of all times, in "the wise and good of all times."

All the other distinctions mentioned above, are to be taken according to the customary usage in treatises on grammar.]

English and American History. — The examination in this subject will be upon the period of the American Revolution beginning with the accession of George III; and a better and more thorough knowledge of this portion of history — but rather of the causes of the revolution and the lives and characters of the chief actors than a minute acquaintance with the details of military transactions, will be expected, than can be obtained from the mere study of the names and dates of a school compendium.

Rhetoric. — In Rhetoric the examination will be confined to those parts of any school manual which give the rules for the construction of sentences, and treat of the qualities which characterize a good style. The object of this examination will be to test the candidate's ability to write good English, and as a preparation for it, *practice* in English composition is strongly recommended in preference to the study of the remaining portions of the Rhetorics.

French. The essential part of the *French requirement for admission* to the school is the grammar, or knowledge of the forms and structure of the language, and we would offer with this in view the following suggestions in regard to the preparatory study.

a. The *verb* should be made the main study, and the other parts of speech in proportion to the closeness of their relation to the same.

b. The *regular conjugations* should be mastered before taking up the study of the irregular ones, and so of the other regular forms and usages as compared with the exceptions and idioms.

c. Next to the verb in importance comes the pronoun, particularly the *personal pronoun*, the form and value of which depends mainly upon its relation to the verb, whether as subject, direct object, *dative*, or as connected by a preposition, a careful analysis alone eliciting the specific relation in each case; hence the importance of a thorough analytical training.

d. The amount of *reading matter* is not so much for the sake of the knowledge of words and its intrinsic value, as to afford a sufficiently wide field for exercise in analysis and the discrimination of forms, quality being more important than quantity, and accuracy essential.

e. In regard to pronunciation, it is more important that the student have an accurate conception of the nasal, e, é, è, and u sounds, the connection of words, and the division into syllables, than greater fluency with less accuracy.

English Literature. — The examination will be upon the literary history of the latter part of the Eighteenth, and the early part of the Nineteenth century. The candidate will be expected to be familiar with the names and general character of the leading writers of that period, and to show an acquaintance, from actual reading, with some portion of its literature.

Algebra.— Besides possessing ability to perform ordinary algebraic operations, the candidate must be able to solve simple and quadratic equations with two or more unknown quantities, and must understand theoretically and practically the involution of algebraic expressions, the extraction of square and cube root, fractional and negative exponents and radicals.

Geometry. — In plane and solid (including spherical) geometry, the amount contained in the standard text-books on the subject will be required.

ENTRANCE EXAMINATIONS. SEPTEMBER, 1876.

ARITHMETIC.

1. Add together $1\frac{0}{3}$, $\frac{3}{5}$, $\frac{4}{7}$, $1\frac{7}{5}$, and from the sum subtract $1\frac{2}{3}$ of $\frac{3}{5}$ of $\frac{4}{7}$ of $\frac{5}{3}$.

2. Least Common Multiple of 25, 8, 11, 7, 21, 33.

3. Extract square root of $1\frac{6}{2}\frac{4}{1}$: of 11.56.
Extract cube root of 39.304.

4. If 4 men can mow a certain piece of land in 6 days, working 10 hours a day, how many days would it take 6 men to mow the same land, if they worked 8 hours a day?

5. What would be the amount of $1215.50 at compound interest for 3 years, at $7\frac{3}{1}\frac{}{0}$ per cent.?

6. When gold is worth $12\frac{1}{2}$ per cent. premium in currency, what is the value in gold of a dollar currency.

7. What would be the length of one side of a cube occupying the space of 1 liter.

8. How many cubic centimeters are there in one cubic decimeter?

9. What would be the superficial contents of a rectangular parallelogram 1 meter, 3 millimeters long and 25 centimeters broad?

10. Give the table of capacity measure (unit 1 liter) and the table of weight (unit 1 gram.).

11. We buy cloth by the yard: what unit of measure should we use if the metric system were adopted? What unit of weight would be used generally by the retail grocers? In terms of what unit of weight would coal probably be sold?

ALGEBRA.

1. Divide $18x^5 - 15x^4 + 26x^3 - 25x^2 + 9x - 6$ by $6x^2 - x + 2$.

2. Find the Least Common Multiple of $x^2 + x - 6$ and $x^2 - 7x + 10$.

3. Factor the expression $x^2 + y^2 - z^2 - 2xy$.

4. Reduce the fraction $\dfrac{\dfrac{1+x}{1-x} - \dfrac{1-x}{1+x}}{\dfrac{1+x}{1-x} + \dfrac{1-x}{1+x}}$ to its simplest form.

5. A father said to his son, "Two years ago I was three times as old as you; but in fourteen years I shall be only twice as old as you." What were the ages of each?

6. Given $\left\{\begin{array}{r} 11x - 4y + 2z = 3 \\ 3x - y + z = 2 \\ 4x + 3y - 3z = -19 \end{array}\right\}$. Find values of x, y, z.

7. Extract the square root of $9x^4 - 30x^3 + x^2 + 40x + 16$.

8. Given $\left\{\begin{array}{r} x^2 + xy + 2y^2 = 16 \\ x - y = -4 \end{array}\right\}$. Find values of x and y.

9. Multiply $x^{-\frac{1}{2}}y^{\frac{2}{3}} - 3x^{\frac{1}{2}}y^{\frac{1}{3}} - x^{\frac{3}{2}}$ by

$$2x^{-\frac{3}{2}} + 6x^{-\frac{1}{2}}y^{-\frac{1}{3}} - 2x^{\frac{1}{2}}y^{\frac{2}{3}}.$$

GEOMETRY.

1. If a straight line drawn parallel to the base of a triangle bisects one of the sides, it bisects the other also; and the portion of it intercepted between the two sides is equal to one-half the base.

2. The diameter perpendicular to a chord, bisects the chord and the arcs subtended by it.

3. An angle formed by two secants intersecting without the circumference of a circle, is measured by half the difference of the intercepted arcs.

4. Prove that the side of the regular inscribed hexagon is equal to the radius of the circle.

5. Define a frustum of a regular pyramid. Define lateral area. Prove that the lateral area of a frustum of a regular pyramid is equal to half the sum of the perimeters of the upper and lower bases multiplied by the slant height.

6. Define a polar triangle. Prove that if A′B′C′ is the polar triangle of ABC, then, conversely, ABC is the polar triangle of A′B′C′. (See Figure on blackboard.)

7. Calculate the volume, lateral area and total area of a cone whose altitude is 12, and radius of base 5. Also of a cylinder whose altitude is 6 and radius of base 4. ($\pi = 3.1416$.)

ENGLISH GRAMMAR.

I. Tell the part of speech of each word italicised in the following passage:

> "*The* livelong *day* Lord Marmion *rode*:
> The *mountain* path the Palmer show'd,
> *By* glen *and* streamlet winded *still*,
> *Where* stunted birches hid the rill."

II. Tell (1) the case and number of *path* and *birches*; (2) write the possessive plural of *path*, and the possessive singular of *birches*; (3) the objective singular of *they*, and the possessive plural of *whom*. Compare (4) *stunted*. Give (5) the principal parts of *rode* and *show'd*, and tell their tense and mood.

III. Select all the pronouns and conjunctions from the following passage, and classify them accurately: —

> "Some feelings are to mortals given,
> With less of earth in them than heaven:
> And if there be a human tear
> From passion's dross refined and clear,
> 'Tis that which pious fathers shed
> Upon a duteous daughter's head!"

IV. In the first line just quoted, is "Some feelings" a substantive or an attributive term? Of which class is "to mortals given"? Is "Some feelings" singular, general, or universal? Is it simple, complex, or compound? To which of these last three classes does "to mortals given" belong?

V. (1) Divide "The livelong day Lord Marmion rode" into Subject, Predicate, and Copula. (2) Divide the predicate into its Base and Determinant, and tell the relation which the determinant bears to the base. What word is understood before "the livelong

day"? (3) What word is understood in the sentence "The mountain path the Palmer show'd, by glen and streamlet winded still," and what is the complete subject of this sentence? Write the sentence over, placing all the words in their natural logical order.

VI. After supplying the omitted word alluded to in (3) just above, separate the sentence "—— the Palmer show'd" into its Subject and Predicate, and divide both into Base and Determinant, giving the relations of each determinant to its base. Classify the term "The Palmer," both by form and by meaning.

RHETORIC AND LITERATURE.

I. 1. What is the difference between a loose and a periodic sentence?

2. Give a rule for the position of adverbs.

3. Point out and correct the faults in the following sentence:

"The former, being a man of good parts of learning, and after some years spent in New College in Oxford, of which his father had been formerly fellow (that family enjoying many privileges there, as of kin to the founder), had spent his time abroad in Geneva, and among the Cantons of Switzerland."

4. Point out and correct the ambiguities in the following sentences:

a. "Just at this moment I met a man who seemed a suspicious sort of fellow and turned down a lane."

b. "There was a public house next door which was a great nuisance."

II. 1. Name the English poets or prose writers whose writings you have studied in school. Give a short account of some one author or book.

2. Who wrote *a*, Tam O'Shanter; *b*, The Rambler; *c*, Childe Harold; *d*, Marmion; *e*, The Wealth of Nations; *f*, Elegy in a Country Churchyard; *g*, The Decline and Fall of the Roman Empire; *h*, The Fortunes of Nigel; *i*, The Essays of Elia.

3. Write a few lines or verses of any poem you may have committed to memory.

4. Give some account of your English reading out of school.

HISTORY.

[The candidates were required to answer ten of the following questions.]

1. Why was the British conquest of Canada one cause of the American Revolution?

2. Explain the conduct of the British Government in regard to the trade of the Colonies as another cause.

3. When and where was the first Congress of the Colonies held after the accession of Geo. III? What action did it take? When was the next Congress held? Compare the action of the two.

4. What were the "Mecklenburg Resolutions"?

5. Where was the battle of Bunker Hill fought? What movement compelled the British to evacuate Boston?

6. When did the new American nation first come into existence? What was its first Government? its first Constitution? What is a Constitution? How were the Colonies transformed into States?

7. How old was Washington when the war broke out? Where was he, and what was he doing?

8. Describe Washington's movements after the evacuation of Boston to the close of 1776.

9. Who captured Ticonderoga? Why was it an important point?

10. Give the public office held by the following persons in England, and the side they took in regard to America; — Pitt; Burke; Lord North; Charles Townshend; George Grenville; the Marquis of Rockingham. What was the character and conduct of Geo. III? What was the feeling of Parliament? How far did it represent the feeling of the people?

11. Give some account of the battles of Trenton and Princeton. Who was Col. Rahl, and how came he to be in the British service?

12. Describe the American situation during the winter of 1777.

13. 1778. Who captured Stony Point from the British? Where is it?

14. Congress issued letters of Marque. What are they? What was the result?

15. Describe the character and conduct of Gen. Charles Lee.

16. What was the character of the warfare carried on by the British during 1778? Give examples.

17. Give your idea of the character and conduct of Washington as a military man.

18. What motives influenced the French government to assist the Americans? How did they furnish aid?

19. Give the names and nationalities of any five distinguished foreigners who volunteered to serve in the American army.

20. Who was Marion? Tarleton?

21. Give the titles of any books on English and American History which you have studied in school, and of any you have read out of school.

GEOGRAPHY.

1. Define Geography.
2. What is a valley — an ocean — a state?
3. Name the principal tributaries of the Mississippi River.
4. Bound the State of New York.
5. What is the capital of Oregon?
6. What part of North America lies directly west of Ireland?
7. Draw a map of South America representing the principal mountain chains and rivers if you can. If you cannot draw the map name the provinces and states, then the peninsulas and capes, and finally the rivers, if you have time, of the Atlantic Coast of North America, beginning at the Gulf of St. Lawrence and ending at the Gulf of Mexico.
8. Bound Turkey in Europe.
9. What language is commonly spoken in Holland? What is the character of the surface of that country?
10. Where are the Azores Islands?

FRENCH.

I. *Translate:* Il avait onze ans lorsqu'il perdit sa mère. Cette princesse mourut d'une maladie causée, dit on, par les chagrins que lui donnait son mari, et par les efforts, qu'elle faisait pour les dissimuler. Charles XI avait dépouillé de leurs biens un grand nombre de ses sujets; une foule de citoyens ruinés, — nobles, marchands, fermiers, veuves, orphelins, remplissaient les rues de Stockholm, et venaient tous les jours à la porte du palais pousser des cris inutiles: la reine secourut ces malheureux de tout ce qu'elle avait; elle leur donna son argent, ses pierreries, ses meubles, ses habits même.

1. Parse, giving the conjugation, tense and person, the forms *perdit*, *avait dépouillé*, *remplissaient*, *mourut*.

2. Conjugate in full the future of *perdit*, the present of *remplissaient* and the preterit of *dissimuler*.

3. What is the difference between the pronouns *les* and *leur* in *les dissimuler* and *leur donna*; give the singular form of each.

4. The pronouns just mentioned are placed *before* their verbs, are they ever placed *after*? if so, say when, and give an instance.

5. Render in French: *they were dissembling; I am losing.*

6. Give the singular of *des cris inutiles*, of *tous les jours*; the feminine sing. of *ces malheureux*, and the plural of *à la porte du palais*.

Translate: (Find words in I.) 1. Many subjects of the king lost their goods. 2. That prince despoiled them. 3. A great throng of wretched (people) was filling the street. 4. The queen threw to them money, clothes, and all the jewelry she had on her. 5. They said to him: Give us bread, since (*puisque*) you ruined us. 6. The streets of that city are large and beautiful.

II. *Translate:* Charles XII, impatient de ne pas aborder assez près ni assez tôt, se jette de sa chaloupe dans la mer, l'épée à la main, ayant de l'eau par delà la ceinture: ses ministres, l'ambassadeur de France, les officiers, les soldats, suivent aussitôt son exemple, et marchent au rivage malgré une grêle de mousquetades. Le roi, qui n'avait jamais entendu de sa vie de mousqueterie chargée à balle, demanda au major général Stuart, qui se trouva auprès de lui, ce que c'était que ce petit sifflement qu'il entendait à ses oreilles. "C'est le bruit que font les balles de fusil que l'on vous tire," lui dit le major.

1. Give the principal parts (infin., pres. and past participles, 1st pers. pres. and preterit indic., 1st pers. pres. subj.) of *jette*, *suivent*, *entendu*, *font*.

2. Conjugate in full the preterit of *entendu*, imperfect of *jette*, and compound of present of *se trouva*.

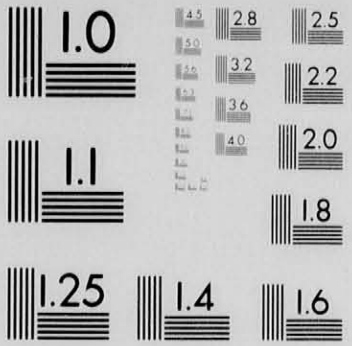
3. Point out the subject and the object in the sentence: *que font les balles*; what would the meaning be if *que* were changed to *qui*: *qui font les balles*?

4. Give the French for "the officer's sword, the French soldier, much noise, here is bread and water."

5. Give the feminine and the plural forms of *lui* in *auprès de lui*.

Translate: (Find words in II.) 1. I have thrown myself at his feet.[1] 2. The bullet which is to (will) kill[2] me is not yet cast.[3] 3. The shore on which we found ourselves was desert.[4] 4. What are these soldiers doing? 5. The soldiers did not follow an officer whom they detested.[5] 6. Do you hear the noise these guns make? 7. Come near me.

[1] pied. [2] tuer. [3] fondre. [4] désert. [5] détester.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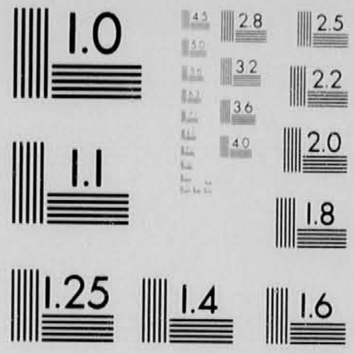
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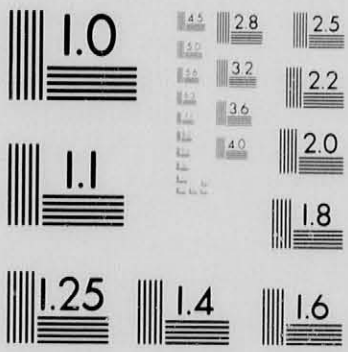
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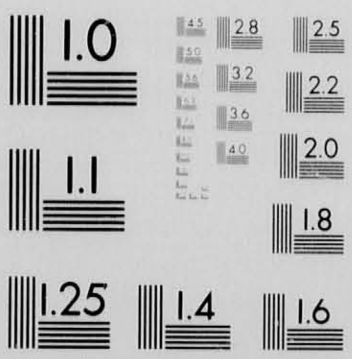
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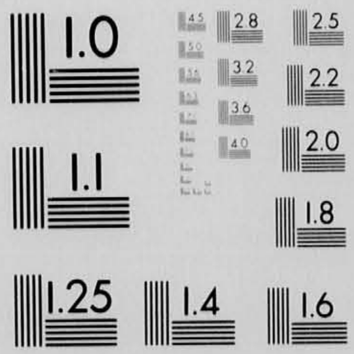
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