

Mass. Institute of Technology.

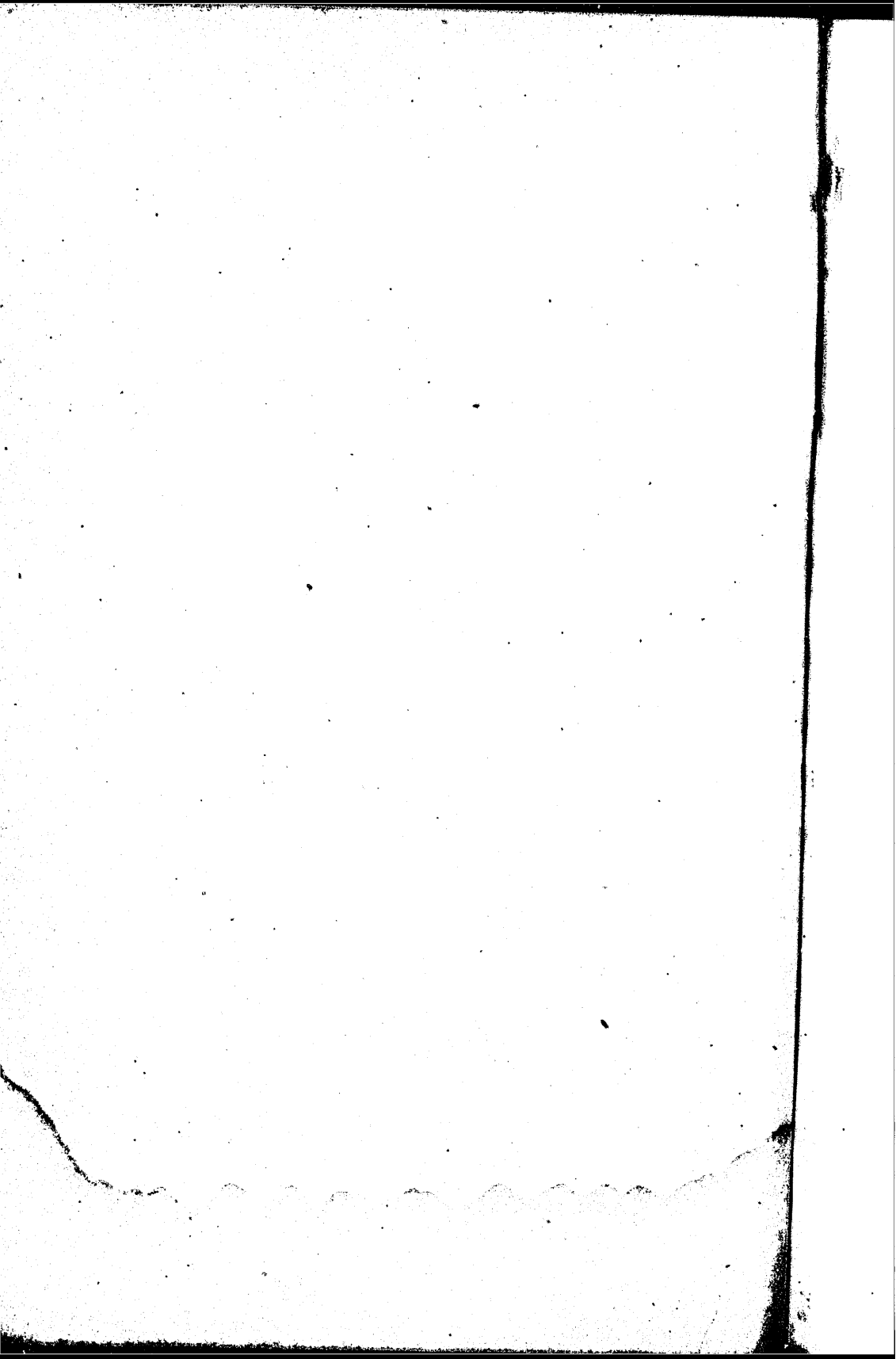
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President's Report,

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1888.



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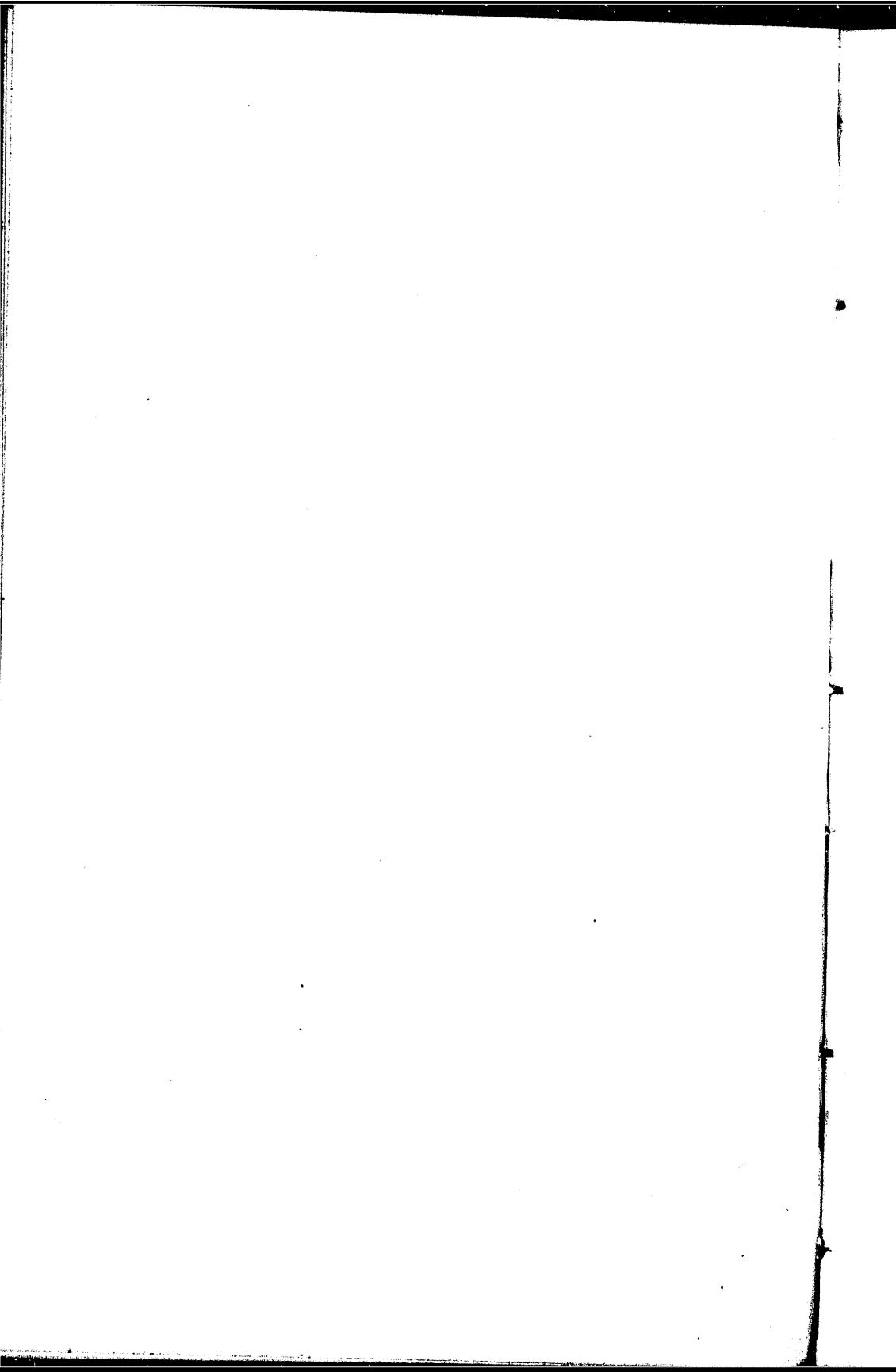
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To the Corporation of the Massachusetts Institute of Technology:

THE experiences of the Institute of Technology during the past twelve months, and the general course of events, as affecting the school, have been altogether favorable and fortunate.

The class of 1887 graduated on the 31st of May. Of the 61 students of the fourth year, who were candidates for the degree of Bachelor of Science, 58 were admitted to that grade by your authority, upon the recommendation of the Faculty of the School of Industrial Science.

The class thus graduating consisted, without exception, of good students, well qualified and well disposed to do honor to the institution which trained them. Their entrance into the several industrial professions has been easy and rapid. The applications for students in all the technical courses equaled, and in some courses largely exceeded, the number graduating. In either chemistry or civil engineering it would have been practicable to place twice as many men as were available in eligible professional positions, between the close of the past and the opening of the present year. So great was the demand for members of the graduating class, that it was for the first time found impracticable to fill all the vacant assistantships, in the several laboratories, from our own numbers, and we were obliged in two cases to send to other institutions for men to take these positions, and, in a third case, to appoint one of our special students, not a graduate.

THE NEW YEAR.

The opening of the school year, 1887-88, witnessed large additions to the number of our students. The register of all the departments and schools under the control of the corporation shows an aggregate of 819 against 738 last year.

Omitting from consideration, as is usual, the students of the Lowell School of Practical Design, and the students of the High School of Mechanic Arts, we find the number in the School of Industrial Science to be 720, against 637 last year, showing an increase of 83, or thirteen per cent.

The following table exhibits the number of students in the School of Industrial Science each year, from the opening of the Institute to the present time :

Year.	No. of Students.	Year.	No. of Students.
1865-66	72	1877-78	194
1866-67	137	1878-79	188
1867-68	167	1879-80	203
1868-69	172	1880-81	253
1869-70	206	1881-82	302
1870-71	224	1882-83	368
1871-72	261	1883-84	443
1872-73	348	1884-85	579
1873-74	276	1885-86	609
1874-75	248	1886-87	637
1875-76	255	1887-88	720
1876-77	215		

Had the remarkable increase in the number of students since 1878 been secured by any lowering of the standard of scholarship, any surrender of the requirements for admission, for continuance in the school, or for graduation from it, that increase of numbers would not be to me a subject of pride or pleasure; but when I consider that this increase, to nearly four-fold the number, nine years ago, has taken place coincidentally with a steady advance in scholarship; that these great bodies

of students have come to us well knowing that the Institute is a place for hard study, and cheerfully accepting the conditions which we impose : this, I confess, appears to me a proper subject for congratulation. Not only so, but this readiness and eagerness on the part of so many young men to undertake severe and protracted courses of study, regarding which there can be no pleasing illusions, and which require the entire devotion of time and thought and strength for four years, affords a most gratifying indication of the essential manliness of young men.

Our experience, at least, furnishes no support to the view that, in order to make a school popular, the requirements for admission or continuance must be placed low, or, if the theoretical standard be high, administrative concessions must be freely made to the spirit of indolence or frivolity, or to the demands of sport or of society. Not only is it true that students, in increasing numbers, come to the Institute in spite of its reputation for hard work, but it is not less conspicuously true that, within the Institute, the students, by a very decided preference, select those courses which are recognized as involving the greatest amount of study and practice. It is, also, true that, within the several courses, those options which offer the largest capabilities are those most generally chosen.

The aggregate for 1887-88 is divided among the several classes as follows :

Graduate student, candidate for an advanced degree	1
Regular students, Fourth Year	80
“ “ Third Year	78
“ “ Second Year	124
“ “ First Year	237
Special students	200

Assigning the special students to classes according to the predominant studies pursued by them, we reach the following statement of the division of the whole body among the several years :

CLASS.	Regular.	Special.	Total.
Graduates of the M. I. T. . . .	1	1	2
Fourth Year	80	20	100
Third Year	78	42	120
Second Year	124	71	195
First Year	237	66	303
	520	200	720

STATISTICS OF EXAMINATIONS.

The results of the applications for admission to all classes of the School of Industrial Science thus far in the current school year, and of the examinations had there-upon, may be stated as follows :

Forty-nine were admitted without examination, either to the first-year class, upon presenting certificates of clear admission to some college of reputable standing, or, upon the presentation of diplomas of graduation from some degree-conferring institution, classical or scientific, to our second or third-year class as regular students, or to some department as special students; 199 were admitted upon examination, free of conditions; 61 were admitted with one condition imposed, 27 with two conditions, 11 with three conditions, 3 with four conditions; 36 applicants were rejected upon examination; 15 were admitted as special students, upon examination in the studies specially requisite to the partial courses which they proposed to follow.

The total number of applicants appears, therefore, to have been 401. Of those admitted upon examination, 41 have not thus far entered the school. In some instances, in the case of applicants heavily conditioned, this has been due to the advice of the Faculty that a longer period be taken for preparation; in some, to a change of plans, to sickness, or other causes.

EXAMINATIONS AT DISTANT POINTS.

In addition to the entrance examinations held in Bos-

RESIDENCE OF MASSACHUSETTS STUDENTS.

It has been said that 59.6 per cent of all our students are from Massachusetts. All the counties of the State, except the small county of Dukes and Nantucket, send students to the Institute of Technology. Ninety-six cities and towns are reported on the lists. The first column of the following table shows the number of cities and towns in each county sending pupils to the Institute; the second column gives the aggregate number from each county. It appears that Suffolk furnishes us 161 pupils; Middlesex comes next, with 116; Essex third, with 40; Norfolk fourth, with 39:

COUNTY.	No. of Towns.	No. of Students.	COUNTY.	No. of Towns.	No. of Students.
Barnstable . . .	4	4	Hampden . . .	4	9
Berkshire . . .	2	3	Middlesex . . .	26	116
Bristol . . .	5	21	Norfolk . . .	11	39
Essex . . .	19	40	Plymouth . . .	11	17
Franklin . . .	1	2	Suffolk . . .	3	161
Hampshire . . .	2	3	Worcester . . .	8	14
			Total . . .	96	429

The following is a list of the towns, twenty-five in number, which send four or more scholars to the Institute:

Boston 152	Lynn 7	Taunton 5
Newton 27	Melrose 7	Concord 4
Brookline 13	New Bedford 7	Holyoke 4
Cambridge 12	Salem 7	Milton 4
Lowell 11	Malden 6	Plymouth 4
Chelsea 8	Somerville 6	Stoughton 4
Lawrence 8	Winchester 6	Watertown 4
Fall River 7	Framingham 5	Worcester 4
Hvde Park 7		

PROPORTION OF OLD AND OF NEW STUDENTS.

The following table exhibits, for each year of the school's history, the distribution of the total number of students among two classes ; first, those students whose names are found upon the catalogue of the year preceding ; and secondly, those students whose names appear as new names upon the catalogue of the year to which the statement relates :

YEAR.	(1) Total No. of Students.	(2) No. of Students in the Cata- logue of the previous year who remain in the Institute.	(3) No. of New Students entering before issue of Catalogue.	(4) Of those in column (3) the following num- ber are reg- ular first-year Students.	(5) No. of New Students not of the regular first- year class.
1866-67	137	34	103	58	45
1867-68	167	79	88	54	34
1868-69	172	82	90	50	40
1869-70	206	90	116	63	53
1870-71	224	109	115	71	44
1871-72	261	122	139	82	57
1872-73	348	173	175	112	63
1873-74	276	171	105	59	46
1874-75	248	159	89	35	54
1875-76	255	139	116	65	51
1876-77	215	130	85	31	54
1877-78	194	96	98	47	51
1878-79	188	99	89	34	55
1879-80	203	102	101	34	67
1880-81	253	121	132	62	70
1881-82	302	136	166	86	80
1882-83	368	173	195	114	81
1883-84	443	231	212	140	72
1884-85	579	311	268	186	82
1885-86	609	369	240	177	63
1886-87	637	379	258	190	68
1887-88	720	396	324	229*	95

It appears from the foregoing that the number of students remaining over has been increased by 17, while the number registered for the first time is larger by 66 ; making the net gain, as previously stated, 83.

* In addition, 8 students are repeating the first year.

AGES OF STUDENTS ON ENTRANCE.

The next table exhibits the ages of our students upon entrance. The regular students of the first-year class number 237. From these we should except nine cases of students of unusual ages; viz., five of 22, one of 24, two of 25, and one of 30 years. These deductions leave 228 as the number of students whose ages have been made the subject of computation.

The results appear in the following table, in comparison with the corresponding results for 1886-87:

PERIOD OF LIFE.	1886-87.		1887-88.	
	Half-Year Groups.	Yearly Groups.	Half-Year Groups.	Yearly Groups.
16 to 16½ years	10		3	
16½ to 17 years	19	29	13	16
17 to 17½ years	16		34	
17½ to 18 years	33	49	41	75
18 to 18½ years	38		42	
18½ to 19 years	23	61	28	70
19 to 19½ years	21		30	
19½ to 20 years	15	36	16	46
20 to 20½ years	9		12	
20½ to 21 years	6	15	4	16
21 to 22 years	5	5	5	5
	195	195	228	228

From the foregoing tables it appears that the average age of the 228 students taken for this comparison, the present year, is 221.55 months, or 18 years, 5 months, and 17 days. This compares with the corresponding figures relating to the two previous entering classes, as follows:

	Av. Age in Months.
Class of 1889	218.53
Class of 1890	219.91
Class of 1891	221.55

The progressive enhancement of the age of students upon entrance must be regarded as a proper subject of con-

gratulation, when consideration is had of the nature of the work at the Institute, and the immediate entrance which it affords into professional practice.

It is true that the postponement of the age of entrance has of late caused some apprehension on the part of those who direct the classical colleges of New England, and that serious consideration has been given to various proposed means of meeting this tendency ; but their problem is not our problem. In the case of students graduating from classical colleges, there is generally to follow a course of two or three years in professional schools, whether of law, of medicine, or of divinity, which is, in turn, to be followed by a longer or shorter period — sometimes a long and weary one — of waiting for professional practice. Under these circumstances, it is undoubtedly a hardship that the age of graduation with the Bachelor's degree should be postponed beyond the 21st, much more, beyond the 22d, year of life. It is unquestionably true that a young man who commences the full, busy practice of his profession before he is 25 years of age has an advantage over one commencing at a later period, in the matter of freshness, spontaneity, hopefulness, and enthusiasm.

In our case the relations of instruction to professional practice are altogether different. A young man who has pursued one of our courses with credit may, if he pleases, enter into the practice of his profession the day after he graduates, often with a choice among several positions offered him. In these circumstances graduation at 22 years must be regarded as more fortunate than graduation at an earlier period ; while 23 or 24 years cannot be considered as in any sense excessive.

In this connection it may be interesting to note the ages at graduation of the class leaving us in May. Of the 58 members of the class the age of one is not known ; the remaining 57 were distributed among several periods of life, as follows :

Under 20	1	Between 22 and 23	7
Between 20 and 20½	2	“ 23 and 24	7
“ 20½ and 21	7	“ 24 and over	7
“ 21 and 21½	11		
“ 21½ and 22	15		57

PROPORTION OF REGULAR AND OF SPECIAL STUDENTS.

The following table exhibits both the absolute number of regular and of special students, as by the catalogue of each successive year, and the proportion existing between these two classes :

YEAR.	No. of Regular Students.	No. of Special Students.	Total No. of Students.	PERCENTAGE.	
				Regular.	Special.
1865-66	64	8	72	89	Per cent.
1866-67	110	27	137	80	11
1867-68	124	43	167	74	26
1868-69	105	67	172	61	39
1869-70	125	81	206	71	29
1870-71	143	81	224	64	36
1871-72	180	81	261	69	31
1872-73	235	113	348	68	32
1873-74	182	94	276	66	34
1874-75	170	78	248	69	31
1875-76	182	73	255	71	29
1876-77	134	81	215	62	38
1877-78	117	77	194	60	40
1878-79	103	85	188	55	45
1879-80	110	93	203	54	46
1880-81	140	113	253	55	45
1881-82	164	138	302	54	46
1882-83	219	149	368	60	40
1883-84	272	171	443	61	39
1884-85	368	211	579	64	36
1885-86	415	194	609	68	32
1886-87	442	195	637	69	31
1887-88	520	200	720	72	28

It will be seen that the tendency previously noted towards a progressive increase in the proportion of students taking the full regular course, still continues. The policy of the Institute regarding special students was very fully presented in the annual report for 1885.

WOMEN AS STUDENTS IN THE INSTITUTE.

The number of young women attending the Institute of Technology is never likely to be large, considering the nature of the professions to which our courses lead, and the severity of our requirements for admission and for graduation. At the same time the laboratories and class-rooms of the Institute are freely open to all women who think to find here opportunities for scientific study and experiment which are not afforded in schools for their own sex exclusively.

The number of women pursuing courses with us the present year is 25, of whom 4 are graduates of colleges. Of the total number 2 are regular students of the fourth year; 2 regular students of the second year; 3 regular students of the first year; 18 are special students. Of the four regular students of the upper classes, one takes Course IV, architecture; one Course VIII, physics; two Course IX, the general course; of the special students, 13 devote themselves chiefly to chemistry and physics; 4 chiefly to biology and allied subjects; 1 to the modern languages.

GRADUATES OF OTHER COLLEGES.

Twenty-three graduates of institutions conferring degrees are included in our list of students for the present year. Of these, two are our own graduates, one of whom is pursuing advanced studies as a candidate for the degree of Doctor of Philosophy. Twenty-one are graduates of other institutions, either scientific or classical, pursuing courses of study with us, either as regular students, candidates for our Bachelor's degree, or as special students. Of these, five are graduates of Harvard University, two each of Brown University, Yale University, and Colby University, while one comes from each of the following institutions: the University of the Pacific, Beloit College, Ohio State University, Boston University, Vassar College, University

of Minnesota, University of Wisconsin, Oberlin College, Haverford College, and the New Hampshire College of Agriculture.

Of the twenty-one, four are regular students of the fourth year, one each in mechanical engineering, in electrical engineering, in physics, and in general studies; one is a regular student in civil engineering, in the third year; two are regular students in mechanical engineering, and one in architecture, in the second year; one is a regular student in the first year. The remaining fourteen are special students.

THE COURSES OF INSTRUCTION.

The present fourth-year class comprises one or more candidates for the Bachelor's degree in each department of the Institute.

The following table presents the number of students in each of the regular courses. It will be seen that this statement relates to the second, third, and fourth years, choice of courses being made only at the end of the first year:

YEAR.	Civil Engineering.	Mechanical Engineering.	Mining Engi- neering and Metallurgy.	Architecture.	Chemistry.	Electrical Engineering.	Natural History.	Physics.	General Course.	Total.
4th Year Class . . .	10	27	5	5	9	19	3	1	1	80
3d " " . . .	17	20	4	5	8	20	1	2	2	78
2d " " . . .	23	42	7	8	6	22	2	3	11	124
Total	50	89	16	18	23	61	5	6	14	282

Not only do all the nine courses contain candidates for the degree of the Institute, in the fourth-year class, but these are fairly well distributed among the various branches of the several courses. Thus, in Course I, of the ten students, five follow the traditional line of instruction in civil

engineering, while five have taken railroad engineering. There are no students of the fourth year taking the option in geodesy and geology.

In Course II, of the twenty-seven students of the fourth-year class, four are taking the marine engineering option ; six, the locomotive engineering option ; seventeen, the mill engineering option.

In Course III, of the five students of the fourth year, three are following the mining branch ; two, the metallurgical.

In Course VII, of the three students of the fourth year, one is taking the full line of study and practice in natural history, while two are pursuing biology preparatory to medical studies.

The other courses are not divided into distinct branches, although in several of them extensive options are offered to the student. Speaking broadly, the optional studies of successive years, within any course, are so related to each other that the student, pursuing one or another "Option," acquires thereby a professional specialty, in addition to his general training and preparation for his profession.

The following table exhibits the number of persons who have graduated within each of the several courses, at each succeeding year since the first diplomas were conferred in 1868. In this table the term "General Courses" will be understood to embrace alike the "Science and Literature" Course of the period 1868-1880, and the Elective and General Courses of the period subsequent :

YEAR.	Civil Engineering.	Mechanical Engineering.	Mining Engineering.	Architecture.	Chemistry.	Metallurgy.	Electrical Engineering.	Natural History.	Physics.	General Courses.	Total.
1868	6	1	6	..	..	..	..	..	..	1	14
1869	2	2	..	..	1	..	..	..	..	1	5
1870	4	2	2	..	1	..	..	..	..	..	10
1871	8	2	5	..	2	..	..	..	..	..	17
1872	3	1	5	..	3	..	..	..	..	..	12
1873	12	2	3	1	7	..	..	..	..	1	26
1874	10	4	1	1	..	..	..	..	..	2	18
1875	10	6	6	1	1	..	..	..	1	2	27
1876	12	9	7	1	5	1	..	2	3	4	43
1877	12	6	8	4	2	..	..	..	..	..	32
1878	8	2	2	3	3	..	..	..	..	1	19
1879	6	8	3	1	3	..	..	1	1	..	23
1880	3	..	3	..	1	..	..	..	..	1	8
1881	3	5	6	3	8	..	..	1	..	2	28
1882	2	5	5	3	6	..	..	1	1	1	24
1883	3	7	4	1	3	..	..	..	..	..	18
1884	5	6	13	..	12	..	..	..	..	..	36
1885	4	6	8	2	4	..	2	..	..	1	27
1886	9	23	7	1	7	..	10	1	..	1	59
1887	10	17	8	1	9	..	8	1	1	3	58
Total	132	114	102	22	78	1	20	7	7	21	504
Deduct names counted twice											2
											502

THE WORK OF SPECIAL STUDENTS.

The 200 special students in the School of Industrial Science cannot be classified systematically; but the following table exhibits the number of special students pursuing each particular branch of study, according to the attendance papers filed by them and approved by the Faculty:

NUMBER OF SPECIAL STUDENTS ATTENDING EXERCISES IN THE
FOLLOWING DEPARTMENTS OF STUDY OR PRACTICE.

Architecture	49	Geology, etc.	37
Applied Mechanics	25	German	76
Chemistry	80	Mathematics	85
Civil Engineering	29	Mechanical Engineering	31
Mechanical Drawing	34	Mining and Metallurgy	23
Descriptive Geometry	22	Physics	80
English	60	Shopwork	40
French	43	Heating and Ventilation	13
Total number of entries, by special students		727	
Total number of special students		200	
Average number of entries		3.6	

It may be of interest to note the numbers of students, either regular or special, pursuing certain leading branches of study, in each of the four years, which are as follows:

	First Year.	Second Year.	Third Year.	Fourth Year.	Total.
Mathematics	263	146	85	69	563
Chemistry	282	40	28	23	373
English	244	151	64	3	462
French	231	17	8	8	264
Physics . . . . .	..	167	94	30	291
German	26	156	104	6	292
Shopwork* . . . . .	..	91	29	36	156

THE CORPS OF INSTRUCTORS.

A still further increase of the instructing staff has been required during the year.

The number of instructors of all grades, excluding those persons who are announced as lecturers for the year only, is 75, against 69 last year.

The number of professors in the school is now 13; of associate professors, 6; of assistant professors, 9; of instructors, 30; of assistants, 17.

* Exclusive of students in the School of Mechanic Arts.

The following table shows the number of teachers of each recognized grade in each year since the foundation of the school :

YEAR.	Professors.	Associate Professors.	Assistant Professors.	Instructors.	Assistants.	Total.
1865-66	10	..	..	..	..	10
1866-67	12	..	..	2	..	14
1867-68	12	..	1	2	2	17
1868-69	13	..	..	6	1	20
1869-70	16	..	1	6	2	25
1870-71	18	..	2	7	5	32
1871-72	21	..	2	11	1	35
1872-73	23	..	2	9	1	35
1873-74	20	..	3	10	4	37
1874-75	20	..	3	7	3	33
1875-76	23	..	..	6	8	37
1876-77	21	..	..	4	10	35
1877-78	20	..	..	3	14	37
1878-79	18	..	..	7	12	37
1879-80	16	..	..	7	8	31
1880-81	15	..	2	6	7	30
1881-82	17	..	3	6	11	37
1882-83	16	..	3	10	11	40
1883-84	15	..	8	15	10	48
1884-85	14	3	11	15	14	57
1885-86	14	6	7	17	18	62
1886-87	12	7	6	27	17	69
1887-88*	13	6	9	30	17	75

The changes of the year affecting the list of instructors have been numerous. Associate Professor George F. Swain has been appointed Hayward Professor of civil engineering, and placed in permanent charge of that important and growing department of the Institute. During the year Professor Swain's professional accomplishments have received most honorable recognition in his appointment, under a law of the last Legislature of Massachusetts, as Engineer to the Board of Railroad Commissioners, charged with conducting an examination of all railroad bridges within the limits of the Commonwealth.

* In addition there are 3 instructors and 4 assistants in the School of Mechanic Arts.

Mr. Charles D. Jameson, owing to ill health, was obliged to resign his position as instructor in railroad engineering. I am happy to add that Mr. Jameson has since so far recovered his health as to enable him to accept the professorship of engineering in one of the important institutions of the West.

The vacancy created by Mr. Jameson's withdrawal from the Institute of Technology was filled by the appointment of Mr. C. Frank Allen, as assistant professor of railroad engineering. Professor Allen graduated from the Institute in the class of 1872. From that time until 1879 he was engaged upon works of water supply and sewerage, in Providence and in the vicinity of Boston. During that period Mr. Allen was active in the organization of the Institute Alumni Association, and in engaging the aid of the alumni in support of the school, then in its lowest state of depression. In 1879 Mr. Allen went West and entered the service of the Atchison, Topeka, and Santa Fé Railway, where, with an interval of service on the Mexican Central road, he remained until called to his present position. His experiences during the past ten years have embraced almost every branch of railroad work and have eminently fitted him for his present duties.

Another appointment to the Faculty, during the year, has been made within the same department, Mr. Dwight Porter having been appointed assistant professor of civil engineering. Professor Porter graduated from the Sheffield Scientific School, of Yale College, in the class of 1880, with high honors. He immediately entered the employ of the government, as an expert special agent of the tenth census, and for about three years was engaged in a hydrographic reconnoissance of various portions of the United States. His reports on water power employed in manufactures, as contained in Volume 16 of the census, exhibit marked abilities and thorough scientific training. In 1883 Mr. Porter was appointed instructor in drawing and mathematics in

this school, and in 1884 instructor in civil engineering. As an important part of his duties, Professor Porter has charge of the instruction in sanitary engineering.

In the department of mining engineering and metallurgy, Mr. Frederick W. Clark has been appointed assistant professor. Professor Clark graduated in the class of 1880; and, after about two years and a half of professional practice in the mining districts of Idaho and Colorado, returned to the Institute as an instructor, in which capacity he has served with marked success, besides greatly aiding Professor Richards in the extension and development of the mining and metallurgical laboratories.

In the department of architecture, Mr. Thomas O'Grady having withdrawn from the position of instructor, Mr. Eleazer B. Homer has been appointed in his place. Mr. Homer graduated from the Institute in the class of 1885, and has since that time and up to the date of his appointment been engaged in professional work in the office of Messrs. Hartwell & Richardson, Boston. That department has been still further reinforced, to meet the demands of an increasing number of students, by the appointment, as junior instructor, of Mr. Dwight H. Perkins, who completed the two years' partial course in architecture at the Institute, with marked success, in May last.

In the department of chemistry Professor Pope has continued to give the lectures to the first-year class in general chemistry, formerly given by Professor Nichols. Mr. Howard V. Frost still remaining abroad, in further pursuit of his chemical studies, the charge of the laboratory of general chemistry has devolved upon Mr. Frederick L. Bardwell, who has shown great energy and good judgment in the conduct of this large and difficult department. Mr. Augustus H. Gill, instructor in general chemistry, after a valued service of three years, resigned to enter the employ of the State Board of Health, in connection with the system of water analysis, which will be spoken of hereafter. Mr.

Peter Burns, a graduate of Iowa Agricultural College, one of the assistants of last year, has been appointed instructor in Mr. Gill's place. In the laboratory of analytical chemistry the teaching staff has been strengthened by the appointment of Mr. Henry P. Talbot, of the class of 1885, as instructor, after two years' experience as an assistant.

In the department of physics, Mr. W. H. Pickering having resigned, as will be hereafter more fully explained, Mr. William L. Puffer, of the class of 1884, has been appointed instructor, after three years' service as an assistant.

In the department of mechanical engineering Mr. Allyne L. Merrill, of the class of 1885, has been appointed instructor, after two years' service as an assistant, to fill the vacancy caused by the resignation of Mr. Alfred L. Fitch, after three years of valued service in that laboratory. The mechanical engineering laboratory has been strengthened by the appointment of an additional assistant.

Mr. H. W. Tyler, of the department of mathematics, has, during the year, gone abroad, under a two years' leave of absence, to further pursue his mathematical studies.

The increase in the numbers of the first and second-year classes has required an addition to the instructing staff in the department of modern languages. Mr. Eugene H. Babbitt has been appointed to the position of instructor. Mr. Babbitt was graduated from the Connecticut State Normal School in 1880 and from Harvard in 1886, with highest honors in Modern Literature. He spent the year 1886-7 in Berlin and Paris, and has already achieved marked success as a teacher, both before entering Harvard and during his senior year there. The instruction in English has been further strengthened by the appointment of an assistant in this department.

Instruction in Spanish is given by Mr. John F. Machado of Salem, an accomplished scholar, to whom Spanish is his native tongue.

Dr. Edward G. Gardiner, during the past three years

assistant in the biological laboratory, has been appointed instructor in biology. Mr. Charles W. Eaton, for three years assistant in drawing, has been appointed an instructor.

The assistants for the school year, 1887-88, are as follows: Dana P. Bartlett and George W. Patterson, Jr., in mathematics; Fred P. Emery (A. B., Dartmouth), in English and history; John M. Fox, in drawing; Arthur G. Robbins, in civil engineering; Edward F. Miller, Ralph E. Curtis, and William O. Hildreth, in mechanical engineering; Timothy W. Sprague, in mining and metallurgy; Edward S. Foss, Charles B. Kendali, and Joseph P. Grabfield, in general chemistry; Frederick Fox, in sanitary chemistry; Arthur A. Noyes and Alfred J. Wakeman, in chemical analysis; Harry E. H. Clifford and Walter S. Moody, in physics.

In addition to the regular staff of instruction the following gentlemen have been appointed lecturers for the current year: George W. Blodgett, S.B., on applications of electricity to railway working; Henry M. Howe, A.M., S.B., on metallurgy; C. Howard Walker, on history of ornament; Ross Turner, on water color and sketching; Charles W. Hinman, S.B., on the manufacture of illuminating gas; Walter S. Allen, S.B., on the manufacture of fertilizers; Eliot Holbrook, S.B., on railroad maintenance; Charles E. Mills, in charge of life class; David A. Gregg, on fine art; David L. Barnes, on locomotive construction; Anthony C. White, S.B., on the distribution of electricity for commercial purposes; Edward Blake, Ph.B., on the construction and applications of electro-motors.

The following table exhibits the number of instructors of all classes, including the lecturers appointed for the current year, assistants performing the duties of instructors, assistants in drawing rooms and laboratories, and also instructors and assistants in the mechanic arts:

	Civil Engineering.	Mechanical Eng. and App. Mechanics.	Mining Engineering and Metallurgy.	Architecture.	Chemistry.	Physics and Elect. Engineering	Biology, Zoology, etc.	Mineralogy, Geology and Geography.	English and Political Science.	Language.	Mathematics.	Drawing and Descrip. Geometry.	Mechanic Arts.	Military Tactics.
Professors.....(13)	1	1	1	1	1	1	1	1	2	1	2			
Associate Professors (6)				1	1	1	1			1	1			
Assistant Professors (9)	3	2	1		1			1				1		
Instructors.....(33)	4			2	7	3	1	1	2	3	3	3	3	1
Assistants.....(21)	1	3	1		6	2			1		2	2	3	
Total.....(82)	5	10	3	4	16	7	3	3	5	5	8	6	6	1
Lecturers.....(12)	1	1	1	4	2	3								
Total..... (94)	6	11	4	8	18	10	3	3	5	5	8	6	6	1

CHANGES IN COURSES OF STUDY AND IN LABORATORY ACCOMMODATIONS.

In the report of last year the introduction of certain extensive "options" into the civil engineering course was mentioned. The option in railroad engineering has already proved attractive to a considerable proportion of the students of the department. No important change from the projected scheme has been found necessary.

The option in geodesy and geology, instituted for the first time last year, has this year been put into definite form, and a complete scheme of study, down to the end of the fourth year, has been adopted by the Faculty. The course, as arranged, provides for very extended instruction in geodesy and topography, as well as in the geological and mathematical subjects which find their application in the execution of geodetic or geological surveys. Already there are students of the third year taking this option, with a view to graduation in 1889.

In connection with the option in geodesy and geology within the Institute of Technology, and also with a view to supplying a public want which has for a long time been felt, provision has been made for a Summer Course in topography, geodesy, and geology, extending through the early part of the vacation following the close of the third year. Such a summer school will allow of more continuous field practice than it is possible to provide in connection with the exercises of either term. The object in view will not be the accomplishment of a certain piece of topographical or geodetic work, but the instruction of the student, by actual practice in the field, in the methods of carrying on geological or geodetic surveys. A base line will be measured, and the methods of extending the triangulation and of filling in the details will be fully explained and exemplified. Field geology will also constitute an important feature of this course. The instruction will be given by members of the teaching staff of the Institute. The school will be established in some favorable location in the State of Massachusetts, presumably in the Connecticut Valley; and the work will be, as far as possible, connected with that of the Massachusetts State survey, now approaching its completion.

Attendance upon the summer school of geodesy and geology will be obligatory upon all students in the civil engineering department who take the option in geodesy and geology; and the school will be open, without extra charge for tuition, to all properly qualified students of the Institute. Students from without the Institute will be admitted upon their exhibiting the proper qualification and upon the payment of a moderate tuition fee. A circular is now in course of preparation which will present, for public information, a full account of the civil engineering department in all its branches, after the changes made during the past and the present year. The work in this department is being more and more turned in the direction of original

research. Among the theses of last year were two which deserve to be ranked as real additions to our knowledge of the subjects of which they treat. The results of one of them—a laborious and extended investigation into the changes of dimension of American cements during induration, by Messrs. W. C. Cushing and W. S. Thompson—were last summer presented to the American Society of Civil Engineers, and will be published in the transactions of the society. The other—an investigation of the flow of water over submerged weirs, by Mr. J. W. Smith—will be published at an early date.

Owing to the increase in the number of students in this department, it was found necessary to increase the amount of space allotted to it; and the department accordingly relinquished room 23 to the teachers in architecture, and itself took possession of room 14—the large hall on the first floor of the new building. The surrender to a single department of this room—heretofore used for lectures, public gatherings, etc.—is a matter of regret, though rendered unavoidable by the demands of present instruction. We can only hope that, in some not distant future, the acquisition of other buildings will render it feasible to restore this valuable room to its original use.

In the department of mechanical engineering there have been no essential changes during the year, but only those additions and alterations which are involved in any vigorous and healthy growth. Professor Peabody's notes on thermodynamics and steam engineering, heretofore given to the students in cyclostyle, have been very fully developed, and have been printed for more convenient use. The three options of the fourth year have been allowed more time, and each will receive a certain further development during the present year. The laboratory is in better working order than ever before; and it is believed that, in the variety and scope of the experiments and researches there conducted, it has no superior among the educational

institutions of the world. An investigation which deserves to be singled out from among the work of the past year was that conducted by Mr. F. H. Crane, of the class of 1886, on the degree of accuracy that may be expected from dynamometers. The number of students in this laboratory is already so large as to test its capacity to the utmost.

The course in architecture has been still further amplified and enriched since my report of last year. A small pamphlet giving an account of the instruction in this department has, within a few weeks, been issued for public information. The large increase of students in this department has rendered it necessary to assign it additional space, and accordingly room 23, when relinquished by the department of civil engineering, was made over into a lecture room and a drawing room, for students in architecture.

In the department of chemistry the year has witnessed a greatly needed addition, in the construction of underground vaults for storage on the Clarendon street side of the new building. These vaults have a floor extent of 60 x 35 feet, and are more than 6 feet in the clear; have been constructed with great pains to secure solidity and dryness; and are capable of holding as large an amount of chemical stores and supplies as it will ever be necessary to keep on hand. The space in the new building, thus cleared, will probably be assigned to the department of industrial chemistry, for the greatly needed extension of its laboratories. Above, room 36 in the third story, heretofore used for all branches of sanitary chemistry, has been assigned exclusively to work upon water analysis, under an arrangement with the State Board of Health, now to be mentioned; and room 34, on the same floor, has been fitted up for the analysis of foods. The name of Wm. Ripley Nichols has been permanently affixed to the library of the chemical department, which now contains more than 2,800 volumes and 2,000 pamphlets.

On the first of June of the current year, at the request

of the State Board of Health, the chemical department of the Institute, with the approval of the Executive Committee of the corporation, took charge of a chemical investigation of the water supplies of Massachusetts. The investigation, as laid out by the Board of Health, was of the most comprehensive nature, and liberal arrangements were made to secure its success. Room 36 of the new building was, as stated, assigned to this service, which was placed under the charge of Professor Drown, assisted by Mrs. Richards, with four other graduates of the Institute. This direct and intimate association of the chemical work of the State with the courses of instruction in water analysis, regularly carried on in the Institute of Technology, has proved to be of much value to the department of sanitary chemistry. During the first six months following the inauguration of this service, not less than 1,300 samples of potable waters, representing the water supply of every important city and town in the Commonwealth, were analyzed by Professor Drown and his assistants. In addition to all the salaries requiring to be paid in connection with the service, the State Board of Health makes an allowance of \$1,500 annually, for the rent of the laboratory and for the chemicals and apparatus used in the work.

The regular work in all the other chemical laboratories has been carried forward during the year with even more than the success achieved in the past.

In the department of physics, including electrical engineering, the steady and healthy growth alluded to in my last report has continued without abatement. The laboratory and lecture courses already established have been extended, and a new course of lectures and exercises in the electrical testing of dynamo machines, by Mr. William L. Puffer, one of the instructors in the department, has already been begun. A new course on electric motors will be given by Mr. Edward Blake, and one on the distribution

of electricity, by Mr. Anthony C. White, both of whom were formerly students at the Institute.

The retirement of Mr. William H. Pickering, after a valuable service of over six years, as assistant and instructor in the department of physics, to accept a responsible position in the Harvard College Observatory, has rendered it necessary to rearrange the instruction in photography, which he so successfully developed. In view of the great pressure exerted upon the time of the students, it has seemed to be desirable to reduce the amount of instruction in this subject absolutely required of all, while the extent or the variety of instruction open to those individually wishing or needing advanced work in this direction has been in no way diminished.

Several papers from the Rogers Laboratory have been published during the past year, in the proceedings of the American Academy and elsewhere; and a number of others are already completed, so far as the results of investigation are concerned, and only wait to be put into proper form for publication.

Thanks to the liberality of the corporation and to the kindness of appreciative friends, our collection of physical apparatus, while not in any way showy, is of the greatest value for actual work, and, with the material additions that are made each year, will continue to be sufficient even for our large needs. The recent generous gift, from Mr. Thomas A. Edison, of a powerful incandescent dynamo machine, with all its appurtenances, forming a complete plant for electric lighting, gives to the Rogers Laboratory additional and important facilities for study and investigation. The 150 lamps attached to this machine will be used to light the drawing rooms of the departments of mechanical engineering, architecture, and civil engineering.

The number of students in the course in electrical engineering (VI) is steadily increasing, while there are now,

for the first time in the history of the Institute, candidates for the Bachelor's degree in the course in physics (VIII) in all three of the professional years, viz., one in the fourth year, two in the third year, and three in the second year, while one graduated from this course in June, 1887 — a gratifying evidence that the value of the more purely scientific, as distinct from technical, training, given in the school, is coming to be more widely recognized than hitherto.

It is also hoped that, by the beginning of the next school year, the department will be able to offer to the public somewhat definitely laid-out graduate (commonly called post-graduate) courses, having a minimum duration of one and two years, and leading to advanced degrees in electrical engineering. There is little doubt that, if such courses are actually instituted, the facilities thus offered will speedily be made use of by our own graduates and by those of other institutions.

The department of natural history, Course VII, for the first time, contains this year as many as three candidates for the Bachelor's degree in the fourth-year class, of whom two have it in contemplation to pursue medical studies, upon their graduation from the Institute.

The general course (IX) has been further extended and improved during the year, to enable it to perform that part in the work of the Institute which has been assigned to it by the faculty and government. The changes which have been made are all in the direction which had been previously marked out for the development of this course. A considerable number of the students of the second year have already shown their appreciation of the advantages offered upon this side of the school by entering Course IX. A pamphlet descriptive of the studies and exercises of the course was issued during the summer vacation, for the information of the students and of the public.

CONCLUDING REMARKS.

I have more than once, in the course of this report, had occasion to refer to the standard of scholarship maintained at the Institute. Without regard to this it is, in my judgment, impossible for any one, no matter how near at hand, to understand this school; to appreciate what it is, and why it is such, what it is doing, and how that is done.

The main fact regarding the Institute of Technology, that which renders possible such work as is done here, is the predominant character and spirit of its scholars. This is not to deny credit to the Faculty of today or of the preceding time, since, although the nature of the studies and exercises pursued contributes in an important degree to the result, that result could have been attained only through years of patient, careful, persistent, courageous effort on the part of the teachers in raising and maintaining the standard of scholarship; in creating a public sentiment within the school favorable to manly endeavor, repugnant to foppery, extravagance, triviality, and indolence, and even in educating a wide constituency outside the school, so that our pupils come to us, as a rule, prepared to acquit themselves like men, neither expecting nor desiring any other way of life.

In my last annual report it was said that the Institute of Technology required half a million of dollars for immediate and imperative needs, and that it would take a million to place this institution in as good a financial condition as the poorest school of its rank in the United States. During the twelve months that have elapsed something has been done towards supplying the deficiencies so painfully felt.

By the will of the late Richard Perkins of Boston, who died December 6, 1886, the Institute received \$100,000. In addition to the relief afforded to the finances of the school by this munificent bequest, it was gratifying to

learn that it was the result of no sudden thought or casual impulse, but was due to a deep interest for many years cherished by Mr. Perkins, in the work of the school. Before he became a confirmed invalid he found great pleasure in visiting the buildings of the Institute, and, without making himself known, observing the students in their drawing rooms and laboratories.

During a confinement of eight years that interest did not fail, but prompted one of the largest and most timely benefactions in the history of the school. By the liberality of Mrs. Perkins, as residuary legatee under her husband's will, the entire sum was paid over as soon as the will had been admitted to probate. Of the amount thus received, the whole is to be maintained as a permanent fund, the income arising from one half to be used in assisting needy and deserving students, the interest arising from the other half to be applied, at the discretion of the corporation, according to the needs of the Institute. In partial recognition of this gift it has been directed that one of the existing professorships shall hereafter be known as the "Richard Perkins professorship of analytical chemistry."

In accordance with a vote of the corporation, passed at our meeting in December a year ago, the corporation, through its officers, presented a petition to the Legislature of the Commonwealth, in January, asking for a grant of \$200,000 from the public treasury, in order that the Institute might be placed upon a more assured foundation. The petition recited the successive acts of the Legislature in the establishment and organization of the Institute, as well as the principal facts in the history of the school; and set forth, as strongly as might be, the present needs of the institution and its claims upon the favorable consideration of the Commonwealth.

In support of this petition, the officers and other members of the corporation appeared before the appropriate committees of the Legislature and urged the unconditional

grant of the entire sum named. Deeply to our regret, however, the Legislature appropriated only one half of that amount, *i. e.*, \$100,000, of which \$50,000 should be payable on the 1st of December, 1887, and the remaining \$50,000 on the 1st of December, 1888, the grant being, moreover, coupled with two conditions: First, that \$100,000 from other sources should be added to the funds of the Institute prior to the first payment to be made from the treasury; and secondly, that twenty free scholarships should be established and maintained in the Institute, upon terms which will be found in the text of the law appended to this report.

The first condition has been complied with, largely through the devoted and self-sacrificing labors of Mr. William Endicott, Jr.; and on the 30th of last month the President and Treasurer filed with the Auditor of the State the required certificate, to the foregoing effect. The names found upon the list of this subscription are largely the familiar names which have been prominent in every previous effort for the maintenance and enlargement of this school.

The second condition affixed to the State grant is of a more serious character; and it has seemed best to the executive committee and the finance committee not to draw the first installment of the State grant, now due, until an appeal can be made to the Legislature, at the approaching session, to reduce the burden thus laid upon the finances of the institution. The regular fee for tuition in the school is \$200. At that rate, twenty scholarships would cost the Institute the sum of \$4,000 annually, which is nearly the whole amount which, at current rates of interest, the entire State grant could be expected to yield. It is felt that, considering the contribution to our funds of one million, two hundred thousand dollars by private citizens, the Commonwealth of Massachusetts can afford to do something

more than this for an institution of such wide and increasing usefulness.

It is proposed, therefore, should it meet the approval of the corporation, to ask the Legislature to increase the amount of the authorized grant by the further sum of \$100,000. Should this be done, the Institute of Technology will, for the first time, be in a condition to meet its current expenses out of its annual receipts. Such a result would not avoid the necessity for large additional endowments—first, to secure the school against calamity or reverses of fortune; and secondly, to provide for a continuous future enlargement and improvement of its various services and departments, to meet the ever-growing demands for technical instruction; but it would mark a very important epoch in the history of the Institute of Technology, and would bring an unspeakable relief to the officers and teachers who have so long, in penury and straitness of means, held up the standard of scientific instruction here, amid difficulties and discouragements neither small nor few.

The past year has witnessed the decease of three members of this board. Mr. Charles T. Hubbard had been but for a few months a member of the corporation at the time of his death. The Hon. Marshall P. Wilder was the senior member of the board. Not only was his name embraced in the charter of the Institute, but during the years which preceded the legislative sanction of this enterprise, he was of the small company that labored to arouse public attention to the need of scientific education. Col. Wilder approached the subject rather from the side of agriculture and horticulture, for it is apt to be forgotten that, but for the interposition of the national government in the act of 1862, this institution would have undertaken to promote the agriculture equally with the manufactures of Massachusetts and New England; but his interest in the school did not fail when it was turned from the direction of his own

especial pursuits. During all the remainder of his life, to the long-protracted end, he continued one of the most punctual and attentive members of the board.

It is difficult to find fitting terms in which to speak of the services to the Institute of Mr. Henry B. Rogers. A member of the corporation in the first year of the school, a member of the committee on the school and afterwards of the executive committee, he remained to the last among the wisest of its counsellors, the bravest and firmest of its supporters in every time of doubt and difficulty, the most generous of its benefactors, whether in his own spontaneous and even secret gifts, or through the contributions which his high character enabled him so effectively to solicit from others. A man of antique virtue, inflexible in his integrity and scrupulously opposed to artifice or indirection, yet thoroughly practical, tolerant, and amenable to all considerations of honorable expediency; a man who held his means, his time, his very life in trust for his fellow-men, — Mr. Rogers exemplified a type of citizenship which, we are proud to believe, is more prominent in the civil life of Boston than in that of any other city of the world.

CHAPTER 103, ACTS AND RESOLVES OF 1887.

Resolved, That there be allowed and paid out of the treasury of the commonwealth the sum of one hundred thousand dollars to the corporation of the Massachusetts Institute of Technology, in the manner following: An installment of fifty thousand dollars on the first day of December in the present year, and a final installment of fifty thousand dollars on the first day of December in the year eighteen hundred and eighty-eight; said sums to be applied to the purposes of the Institute. And in consideration of this grant said Institute shall establish and maintain twenty free scholarships, and each senatorial district in this commonwealth shall once in eight years, in such alternate order as the Board of Education shall at the time of the first apportionment of said scholarships determine by lot, be entitled to one scholarship for a period of four years, to be awarded to such candidates as shall be found upon examination to possess the qualifications fixed for the admission of students to said Institute, and who shall be selected by the Board of Education; preference in the award being given to qualified candidates otherwise unable to bear the expense of tuition. In case no candidate appears from a senatorial district, then a candidate may be selected from the State at large to fill such vacancy, who may continue to hold the scholarship annually until a candidate is presented from the senatorial district unrepresented, who shall then be awarded the scholarship for the balance of the time for which said district would originally have been entitled to its benefit. In case a vacancy occurs in any senatorial district after an appointment has been made, then a candidate from the same district shall be selected for the balance of the time for which said district is entitled to its benefit, or in the event of no such candidate appearing, from the State at large, upon the conditions previously set forth: *provided*, that said corporation shall secure, prior to the first payment above authorized, a further sum of one hundred thousand dollars in addition to the funds now held by it and to be applied to the purposes of the said Institute, and shall present satisfactory evidence thereof to the Auditor of the commonwealth. [*Approved June 16, 1887.*]

REMARKS OF THE PRESIDENT OF THE INSTITUTE,

Addressed to the Graduating Class of 1887, May 31.

It is now my pleasant duty, on behalf of the Corporation and Faculty of the Massachusetts Institute of Technology, to present to you the diplomas of your honorable graduation, and to greet you Bachelors of Science.

What we have said in these testimonials we truly and fully mean. All that is here written is to be taken without discount, qualification, forced construction, or academic fiction. These diplomas testify to four years of hard, patient, self-denying, and persistent study and practice, week by week, month after month, in science and in the application of scientific principles to the arts of life. All this is precisely true in the case of each and every one of you.

And on behalf of your teachers, I gladly bear witness to the cheerfulness, courage, and zeal with which you have met the exacting requirements of our curriculum; the fidelity and high sense of honor and duty with which you have borne yourselves through these trying years of laborious study. Those qualities have won the respect and affection of your instructors here; they cannot fail to secure recognition and command confidence in the new lives on which you are entering today.

Fortunate are they who, in opening a new chapter of life, are not required to do what is implied in that ominous phrase, "turning over a new leaf." You are not now called upon to close a career of dissipation, or idleness, or frivolity, or triviality, with good resolutions of amendment and

reformation for the future. Your friends and teachers are not counting the chances that the closer contemplation of life's responsibilities, or perhaps the actual pressure of its burdens, will sober your minds, give you a serious sense of duty, and inspire you for the first time with a strong and controlling purpose. All this has already been done in your case: else you would not now be here.

I would not speak to you as if your characters were altogether formed, your education completed, or the last of the perils that beset life were happily passed. Much, very much, remains; but it is not by turning around in your course, but by following on as you have so well begun, that you are to pursue your voyage and reach the haven of your hopes and rightful ambitions.

It is always a long and weary way which involves the retracing of steps that have gone in the wrong direction, or the making up of time that has been wasted; and I cannot sufficiently congratulate you that you have taken the morning of life, while the heart is buoyant within, the limbs stout and active, and the air around fresh and fragrant, and the sun is yet low in the heavens, to make so strong and stalwart a beginning of your journey. I cannot believe that, as you pause on this eminence, here on your graduation day, and look back and down upon the camps of those who have not yet girded themselves for the march, but are still resting in the comfortable belief that it will do as well to begin life in earnest at twenty-one or twenty-five, you are at all disposed to regret your own early start and the manful exertions to which you have given the dewy hours of morning.

My friends, the point toward which all your studies and exercises have been directed these long years is at length reached; the hour has come for you to say good bye to each other and to your teachers, and with brave and hopeful hearts step over the threshold of the school out into the wide world of action.

