must be determined by a dividing-engine. If a line can be distinctly seen, its wave-length can probably be thus determined with as great accuracy as that of the position of the solar lines on the map of Angström. In the spectrum of *α Bootis* 140 lines are visible between the D and F lines.

The classification of this large number of spectra is a matter of no little difficulty. Slight differences exist in many stars, and certain stars appear to hold an intermediate position, so as to render a rigorous division into classes impossible. On the other hand, many stars appear to have identical spectra. The first step will be to arrange the stars in groups, and then compare the best defined spectra of different groups. A minute discussion and the measurement of wave-lengths will be necessary only in the investigation of a comparatively small number of spectra.

The 28-inch reflecting telescope constructed by Dr. Draper was assigned to the work on faint stellar spectra. During the first six months of the year a careful study was made of this problem, and the difficulties encountered bore evidence of the skill of Dr. Draper in obtaining good results with this telescope. The best method of using this instrument seemed to be a modification of the form first tried by Dr. Draper, — a slit spectroscope from which the slit had been removed. The rays from the mirror were rendered parallel by a concave lens which replaced the objective of the collimator. As this lens had the same focal distance as the objective of the observing telescope, it was not necessary that either should be achromatic. After long trials with this and other forms of apparatus, a spectrum was at length obtained showing good definition. As the results were not better than those described above, and the instrument, from its size, was slow in operation, the experiments have not been carried further.

The Bache telescope described above has proved an extremely convenient instrument for various purposes. Besides the spectroscopic researches already mentioned, several other investigations have been undertaken with it. Owing to its short focal length, it possesses many advantages over photographic telescopes of the usual form. With exposures of an hour and a half, more stars were photographed in the Pleiades than are given in the engraving accompanying the "Annual Report of the Paris Observatory of 1886," although that work was based on photographs taken by MM. Henry with exposures of three hours, and a telescope having an aperture of 13 inches. Nearly twice as many stars were photographed in this region as were visible with the 15-inch telescope of the Harvard College Observatory. The short focus of the telescope also gives it especial advantages for photographing nebulæ. Twelve new nebulæ were thus discovered in a region where but eighteen were known before. Various other investigations, such as a determination of the law of atmospheric absorption, have been undertaken with the aid of this telescope. It has been so persistently used in spectroscopic work that the other researches have been neglected, especially those in which very long exposures were required. Its removal to Peru now cuts it off for some time from such use on the northern stars. Accordingly, Mrs. Draper has procured a similar lens, which is now in the hands of the firm of Alvan Clark & Sons for retouching and mounting. Several important researches will be undertaken with this instrument. Photography is now used in so many departments of astronomy, that a general investigation of the photographic brightness of the stars seems desirable. A plan has been proposed by which a single plate will contain photographs of a number of regions one degree square, but in different portions of the sky. Thus a series of standard faint stars will be photographed, which can all be measured, and reduced to the same scale. One or more photographs of the vicinity of the north pole will be taken on each plate, and thus serve to correct the results obtained on different plates. It is proposed in this way to secure a series of standards of stellar magnitude at intervals of about five degrees. A third lens of similar form, having an aperture of four inches, will be attached to the telescope, with which photographs on a smaller scale, but five degrees square, will be taken simultaneously. These photographs will cover the entire sky, and it is proposed to measure the photographic brightness of all stars of the seventh magnitude, or brighter, which are represented on them. This investigation will have a special value in connection with the photometric measures of the spectra described above. It is hoped also to photograph the entire northern sky by means of the 8-inch telescope, with exposures of an hour. Each plate covers a region nearly ten degrees square, of which the images in the central five degrees square are satisfactorily in focus. One of the regions containing standard stars will appear in the centre of each plate. By such a series of plates the photographic brightness of any stars brighter than the fifteenth magnitude can be determined on a uniform scale. The faintest stars photographed will be nearly a magnitude fainter than the limit proposed by the Astro-photographic Congress, so that all plates included in that work can be reduced to a uniform system. The advantages of such plates for studies of the distribution of the stars and other similar investigations are obvious.

From the above description it appears that the field of work of the Henry Draper Memorial, as now extended, is almost boundless. The problems to be investigated relate to the fundamental laws regulating the formation of the stellar system. Questions of such importance should be discussed on a sufficiently large scale, or the results of the discussion will soon be superseded by a repetition of the work. The liberal provision made for the Henry Draper Memorial permits the investigations to be planned on a scale which is likely to avoid such an undesirable duplication of work.

EXAMINATION AND EDUCATION.[1]

FOR many years I have watched the examinations of young men in our colleges, with reference to the award of prizes and honors, and also with reference to the terms of admission to college and the conditions of bestowing academic degrees. The conclusions to which I have come are these: —

Daily marks, jotted down by the instructor at the close of an exercise, help him to form an accurate notion of the fidelity of his scholars and of their intellectual growth; but it is usually best for him to keep these marks private, and simply for his own guidance, lest by showing the record to his pupils he should accustom them to the notion that work is over when they have learned the lesson, solved the problems, or written the exercises acceptably. He must not teach them to read for marks, — an odious habit.

Examinations held at frequent intervals, say once a month, three or four times a year, or at the end of a certain obvious block of work, especially if preceded by a brief and spirited review, are as serviceable to the scholar as to the teacher. The true condition of a class can thus be ascertained and recorded. The scholar or his advisers can be informed whether or not he excels, is passable, or is deficient. The good students are thus encouraged to better work: the poor students are warned before it is too late to recover their standing.

Yearly examinations accustom the scholar to hold on to the knowledge that he has acquired. If rightly conducted, they remind the pupil that he must carry in his mind the general principles and the fundamental facts of the subject he has studied. A good examiner will put very different questions at an annual examination from those he would set at the end of a month's study. He will endeavor to ascertain whether the subject taught has been mastered by the individuals examined, not whether every detail can be instantly recalled.

Special examinations at marked epochs in an education — such as admission to college, competition for prizes, and the attainment of a degree — encourage young men to put forth their highest and best efforts, to make strong exertions, to overcome great difficulties. As an important part of the business of life is the overcoming of obstacles, so a good school or college should train its pupils to meet and master tasks that are hard. The well-trained youth will not shrink from such difficulties as he must encounter when he becomes a physician, a lawyer, a statesman, a teacher, an engineer, a philanthropist, an editor, a man of business; in short, when he takes an active part in the affairs of life.

In selecting men for high stations, for appointments by the government, or for college fellowships, or for the position of teachers, other tests than those of an examination must be employed. Evidence that the candidate has exact knowledge, and that his knowl-

[1] A contribution by President D. C. Gilman of Johns Hopkins University to he American Supplement to the Nineteenth Century for March.

edge can be readily and clearly communicated, may indeed be indispensable, and this may be ascertained by examination. But to judge of the general ability of a candidate, of his fidelity, his adaptation to a given position, the probability of his growth, his skill as a "re-searcher," his originality of mind, his perseverance, other tests must be employed than those of an examination-paper. Good judgment, based upon a knowledge of human nature, must be called in.

The advantage of allowing teachers to be the examiners of their classes is obvious: they know what has been taught, and how, and they can say what the scholar ought to remember. At the same time, the advantage of calling in examiners who have not taught the class is also obvious. Pupils are thus reminded that they are expected to know a subject, not a certain part of a text-book. For example: they are to know how to read Cicero, and not to present six orations; they are to read German books, not to say that they have read "Marie Stuart;" they are to know their algebra, their physics, their chemistry, botany, and so on. Probably for the best pedagogical discipline, the board of examiners should be made up partly of the actual teachers of a class, partly of competent, sensible outsiders.

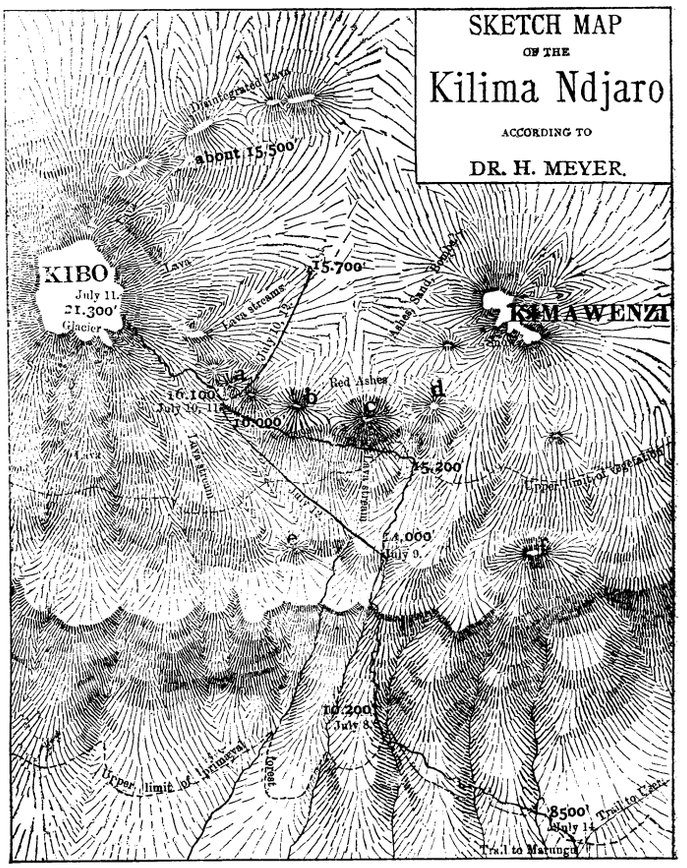
While there is reason to believe that the lower schools of the country suffer from too many or too poor examinations, I doubt whether the colleges rely too much upon their examinations. Some instructors have but vague ideas of the purpose of examinations, and consequently may employ imperfect methods of examining. Examiners are as likely to be at fault as examinations.

It would surely be well for every board of examiners to consider what object they have in view; e.g., is the object to ascertain whether the class as a whole has been well taught? The authorities of a school or college sometimes require this information, and of course an examiner who is not the teacher must be enlisted. Is the object to select those who are most deserving of an honor or prize? If so, sharp test-questions are requisite. Is it to ascertain whether a scholar is capable of going forward with a proposed course of study? If so, a fair, general paper, supplemented if possible by oral questioning, is desirable. Is it to grade a class? Then there should be a paper which every one ought to be able to answer, so as to pass, but with riders, so that the superior scholars may show their attainments, and win the rank which is their due. The highest talents will thus be drawn out, while inferior ability will not be discouraged.

But the subject is quite too complex for a brief discussion, and I fear that I have already filled the space that you offer me.

ASCENT OF THE KILIMA NDJARO.

MR OTTO F. EHLERS made an interesting ascent of the Kilima Ndjaro in company with Dr. Abbott, an American naturalist who had been collecting for upwards of a year in the country round Tavita. The "Proceedings of the Royal Geographical Society" gives the following sketch of this ascent: The travellers left Marangu with a party of thirty men. The first camp was pitched at the foot of a small crater almost due south of the eastern peak, Kimawenzi, at an altitude of about 9,800 feet. On the following day Herr Ehlers made an excursion to Kimawenzi, and reached a height of about 16,400 feet; any further ascent of this remarkable jagged mountain seemed to him impossible. The same day the travellers saw three specimens of a new species of antelope. The two following days were spent in collecting plants and searching for a suitable camping-place, where the majority of native followers might remain, while the travellers proceeded up the mountain. A spot was chosen to the west of their last camping-ground, at an altitude of about 10,500 feet. From here the two travellers started with five men, and provisions for four days, taking a northerly direction up the saddle between Kibo and Kimawenzi. After some hours' marching, they discovered that they had made the same mistake Dr. Meyer had in 1887, and were proceeding in a direct line to the summit of the lower eastern peak. Being at this moment overtaken by a snow-storm, they pitched their camp at an altitude of about 15,500 feet. On the following morning, which broke bright and clear, they set out in a westerly direction over the newly fallen snow, proceeding along the northern edge of the line of lava hills mentioned by Dr. Meyer, whose route lay along their southern side. After much toilsome marching, snow having commenced to fall again, the natives were compelled to return, leaving the two travellers to push on to their last camping-ground (Nov. 17). The morning of the 18th was exceptionally clear, and an early start was made over the hard-frozen snow. At seven o'clock they found themselves at an altitude of 16,200 feet, about the middle of the eastern side of the summit. Instead of attempting to ascend from this side, as Dr. Meyer had done, they proceeded in a north-westerly direction over lava-streams and rocky bowlders to the northern side of Kibo. Unfortunately, at this point Dr. Abbott completely broke down, and Herr Ehlers pushed on alone. Keeping to the east of a mighty lava-stream, he pushed his way over sand, ashes, and rubble, covered with the freshly fallen snow, and after repeated halts, but without suffering at all from the rarity of



the atmosphere, he arrived at 10 o'clock at the ice-wall which completely encircles the actual summit, and the scaling of which at this point was impossible. He consequently proceeded along this wall of ice for some distance, in the hope of finding a point at which it could be surmounted, but after a time was compelled to retrace his steps, owing to a steep fall in the ground. Descending the summit a little, he contrived, by much toilsome climbing, to get round to the north-east side of the summit; and here, from a point of some little elevation, he obtained a comparatively wide view over the summit. He could discover nothing in the form of a crater: the mass of snow and ice lay before him in a succession of gentle undulations. This is somewhat remarkable, in view of Dr. Meyer's account of the crater of the summit. He does not give the exact height attained, as he prefers to wait until the instruments used have been tested, but states that it exceeds 19,600 feet. The descent was made by a somewhat different route, in a direct course to the south-east. At an altitude of 16,400 feet the track of an elephant was observed in the snow, also those of buffaloes and antelopes. Here also he found the last traces of vegetation. The return to Marangu occupied three days.