Remarks.

(1) Described by Herschel as a bright extended nebula with two nuclei, the north following one being very faint. In 1848, Lord Rosse observed that the nebula was distinctly spiral, and his drawing represents it as elliptical in shape. The nebula is about $3'$ long and is situated about 2° south of the star λ Leonis. I am not aware that any record of the spectrum has been published.

(2) A star of Group II. Dunér states that the bands 2, 3, 7, 8 are visible, but are rather weak and not very wide. The bands 4 and 5 are very delicate. The star belongs to species 5 of the subdivision of the group, which means that the meteor-swarm of which the "star" is probably composed is somewhat sparse. The bright carbon flutings should therefore be well developed. Bright lines may possibly also be present, if the swarm is not too far condensed.

(3) Konkoly and Vogel both describe the spectrum of this star as a well-developed one of the solar type. The usual differential observations are required.

(4) A star of Group IV. (Vogel). The usual observations of the relative thicknesses of the hydrogen and other lines are required.

(5) A star of Group VI., with a spectrum of extraordinary beauty (Dunér). The spectrum consists of four zones, and all the bands 1-10 are strongly developed. Band 6 is not very dark. The specific differences in stars of this group have not yet been fully investigated. The principal variations so far observed are: (1) the length of continuous spectrum, as indicated by the number of zones visible; (2) the number and intensities of the secondary bands; (3) the intensity of band 6 as compared with bands 9 and 10.

Gould believes this star to be variable, his estimates of the magnitude varying between 4.3 and 6.1. Birmingham's values vary from 4.5 to 6.3. The star appears to be U Hydræ, and, if so, a maximum will be reached about March 18 (*Observatory Companion*, 1890). Espin believes the period to be about 195 days.

As yet, we have no information as to changes of spectrum accompanying changes of magnitude in stars of this group.

A. FOWLER.

THE SOLAR AND THE LUNAR SPECTRUM.—Prof. Langley's second memoir on this subject, which was read before the National Academy of Science in November 1886, has been received. In a previous memoir it was demonstrated that evidence of heat had been found in the invisible spectrum of the sunlit side of the moon, and the experiments indicated that this heat was chiefly not reflected but radiated from a surface at a low temperature. The amount of heat, however, was excessively minute, even when compared with the feeblest part of the solar spectrum known in 1882, yet it was easily recognizable because of the fact that, whereas in the typical solar spectrum heat is greatest in the short wave-lengths, in the typical lunar spectrum heat is greatest in the long wave-lengths.

In this second memoir the results of further observation of the infra-red solar spectrum are given, the newly investigated region being close to that which contains a large part of the lunar heat. The researches considerably extend those previously made. In passing from the visible part of the spectrum into the infra-red region, wider regions of absorption occur. To an eye which could see the whole spectrum, visible and invisible, the luminous part would be, as is well known, interrupted by dark lines, the lower part to 5μ would appear to consist of alternate dark and bright bands, and the part below 5μ be nearly dark, but with feeble "bright" bands at intervals. This appearance is shown in a plate accompanying the memoir. It is noted as a curious fact that the centres of several of the bands or lines are under some conditions found to be shifted to a recognizable extent, and hence their wave-lengths are, within certain limits, variable. This apparent shift is found to be because the absorption does not increase symmetrically with the centre of the band, but more on one side than another, so as to considerably modify the position of greatest absorption.

THE CORONA OF 1889 DECEMBER 22.—The March number of the *Observatory* contains a Woodburytype reproduction of this corona taken by the late Father Perry with a short focus reflector of Mr. Common's, and a note by Mr. W. H. Wesley, assistant secretary of the Royal Astronomical Society, upon its prominent features. Mr. Wesley finds that, as in the eclipse of January 1, 1889, the extension is greatest towards the equatorial

regions, and on the longest exposed plate it can be traced to nearly a diameter from the limb. A wide rift at the north pole, extending 60° or 70° along the limb, contains several fine straight rays similar to the polar rays in 1878 and 1889 January 1, but not so numerous, regular, or distinct. The usual polar rays are scarcely distinguishable at the south pole. A remarkable fact is that the general mass of the corona on the eastern side is considerably broader from north to south than on the western side. This was also the case in 1878. Numerous prominences are seen on the eastern limb, and plates taken near the end of totality show a range of low prominences on the western limb. An interesting feature in the plates taken with the reflector is the photographic reversal of the prominences and the brighter parts of the corona. In the larger exposed negatives the prominences and the corona near the limb are bright instead of dark, whilst the limb itself is bounded by a very definite dark line indicating a double reversal.

THE NEBULAR HYPOTHESIS.—Mr. Herbert Spencer contributed an essay on Laplace's famous theory to the *Westminster Review* for July 1858. With the assistance of Mr. Thynne Lynn, a new edition of this essay has been prepared and distributed amongst leading astronomers at home and abroad.

The revised calculations bring out more strongly than ever Mr. Spencer's views of the nebular hypothesis, and in particular the portion referring to Mars. When the essay first appeared the density of this planet was taken as 0.95, but recent and more exact determinations show the value to be much too high, and taking this into account the fact comes out that to agree with Mr. Spencer's views Mars should have from one to four satellites as it has since 1877 been known to have.

Olbers's theory that the asteroids are fragments of an exploded planet is favoured, and the genesis of the thirteen short-period comets is found in the same catastrophe. It is needless to say that the theory is defended in a most masterly manner, although the arguments against its acceptance are overwhelming.

NEBULA, GENERAL CATALOGUE No. 4795.—The Journal of the Liverpool Astronomical Society for December 1889, which has just been issued, contains a note by Mr. W. E. Jackson on this nebula, R.A. 22h. 24m., N.P.D. $111^\circ 24'$. It is described in the General Catalogue as "Remarkable, pretty faint, very large, extended or binuclear." Mr. Jackson has carefully observed the nebula several times, and finds that there are several stars involved, although no mention of them is made in the Catalogue, and that there is a strong suspicion of others beyond the reach of his 6 inch Grubb telescope. A sketch of the appearance accompanies the note.

A NEW ASTEROID.—Minor planet (283) was discovered by Prof. Luther (Hamburg) on February 24.

CAMBRIDGE ANTHROPOMETRY.

ABOUT two years ago the results were published, in the Journal of the Anthropological Society, of the first batch of measurements taken at Cambridge. These comprised rather more than 1100 cases. During the last two years a nearly equal number have been obtained, and it therefore becomes important to compare the results yielded by these distinct batches.

The measurements proposed by Mr. Galton, and adopted by the Cambridge Committee, were the following:—(1) A test for the eyesight. The extreme distance at which a man could read "diamond type" (viz. the print employed in the little pocket Common Prayer-books) was noted with each eye separately; the figures given in our tables indicate the mean of the two. It may be remarked that, as this instrument would only record up to 35 inches, and as about ten per cent. of the men could read at this distance, it is certain that many could have seen further. The arithmetical mean, therefore, though good enough for our present purposes, is here less scientifically appropriate than the "median." (2) A test of the muscular strength of the arms when employed in an action similar to that of pulling a bow. Two handles, connected at a convenient distance apart, are pulled away from each other against the pressure of a spring. (3) A test of the power of "squeeze" of each hand separately. In this case two handles stand a short distance apart, and are then pressed towards each other against the action of a spring. The figures here given denote the mean of the two results. (4) Measurement of the size of the head. This is taken in three different directions, viz. from front to back, between the two

sides, and upwards from a line between the eye and the ear. The product of these three measurements is what is given in the annexed tables as "head-volumes." It need hardly be said that these numbers do not assign the actual magnitudes of the heads; but they do all that is wanted for our purpose, viz. they are *proportional* to these magnitudes, on the assumption, of course, that the average shape of the head is the same throughout. (5) A test of the breathing capacity. The volume of air, at ordinary pressure, that can be expired is measured by the amount of water displaced from a vessel. The result is given in cubic inches. (6) The height; deducting, of course, the thickness of the shoes. (7) The weight, in ordinary indoor clothing. This is assigned, in our tables, in pounds.

As regards the persons measured, they are exclusively students—that is, undergraduates, with a small sprinkling of bachelors and masters of arts. Nine-tenths of them were between the ages of 19 and 24 inclusive. Statisticians will understand the importance of this fact in its bearing upon the homogeneity of our results; since a comparatively small number of measurements, in such cases, will outbalance in their trustworthiness a very much larger number which deal with miscellaneous crowds.

But it is not so much to the above characteristics that I wish to direct attention here as to one in respect of which our University offers an almost unique opportunity. No previous attempt, it is believed, has ever been made to determine by actual statistics the correlation between intellectual and physical capacities. What, however, with the multiplicity of modern examinations, and the intimate knowledge possessed by many tutors about the character and attainments of their pupils, this could here be effected to a degree which could not easily be attempted anywhere else. By appeal to these sources of information, the students were divided into three classes (here marked as A, B, and C), embracing respectively (1) scholars of their College, and those who have taken, or doubtless will take, a first class in any tripos; (2) those who go in for honours, but fall short of a first class; and (3) those who go in for an ordinary degree, to which class also are assigned those who fail to pass. It is not for a moment pretended that such a classification is perfect, even within the modest limits which it hopes to attain. Very able men may fail from indolence or ill-health, and very inferior ones may succeed through luck or drudgery. But it must be remembered that we only profess to deal with averages, and not with individuals, and on average results such influences have little power. There are probably few cricket or football clubs in which one or more men in the second eleven or fifteen are not really better than some in the first, but no one supposes that the second team would have much chance of beating the first. All that is maintained here is that our A, B, C classes, *as classes*, stand out indisputably distanced from each other in their intellectual capacities. The average superiority of one over the next is patent to all who know them, and would be disputed by very few even of the men themselves.

The plan adopted has been to classify the A, B, C men separately, arranging each of these in sub-classes according to their age. On the last occasion about 1100 were thus treated, and it is very important to observe that the new batch (of about 1000) independently confirms the conclusions based on the previous set. Space can scarcely be afforded for these tables separately, so I only give here the results of grouping the entire two sets together. But as a matter of evidence, it must be insisted upon that the two separate tables tell the same tale.

The following, then, are the results of thus tabulating the measurements of 2134 of our students:—

TABLE I.
Class A (487).

No.	Age.	Eyes.	Pull.	Squeeze.	Head.	Breath.	Height.	Weight.
10	18	21.3	75.8	75.3	235.8	244.0	68.13	142.6
42	19	22.6	75.3	80.9	242.9	255.5	69.04	148.0
99	20	23.7	81.2	83.5	242.8	252.7	69.00	152.1
104	21	23.6	81.6	82.8	242.1	255.2	68.82	152.3
94	22	24.6	83.9	87.1	244.3	257.2	68.71	154.0
48	23	21.9	82.0	84.2	242.9	262.8	69.11	149.7
33	24	23.6	84.9	84.0	245.9	261.5	68.90	154.8
57	25	23.0	80.9	82.7	247.2	251.0	68.59	154.6
Average..	23.4		81.5	83.5	243.6	255.6	68.85	152.5

Class B (913).

38	18	24.4	77.4	82.1	236.7	235.0	68.92	148.5
136	19	25.4	78.7	80.3	238.0	249.8	68.78	149.7
280	20	24.0	82.5	84.2	237.3	255.1	69.08	153.5
212	21	23.5	83.7	83.7	235.5	257.2	68.84	153.0
136	22	24.6	84.7	85.3	239.2	257.2	69.17	153.3
54	23	22.7	81.5	83.5	234.4	259.0	69.31	154.0
21	24	26.1	90.6	87.4	245.5	261.5	68.93	157.7
36	25	22.6	85.8	86.1	237.1	264.5	68.83	157.2
Average..	24.1	83.2	84.4	237.3	254.9	69.00	152.8	

Class C (734).

32	18	24.4	82.4	83.7	234.2	238.0	68.68	156.0
98	19	24.8	81.8	83.6	231.4	250.0	69.10	152.9
185	20	24.8	83.5	82.8	235.0	252.7	69.03	153.6
163	21	23.7	86.1	84.5	239.6	258.1	69.23	156.0
123	22	24.4	89.5	86.6	236.8	255.5	68.79	155.4
57	23	23.8	88.1	87.2	238.5	256.4	68.97	156.2
26	24	25.4	87.4	86.1	239.3	244.0	68.35	156.0
50	25	24.0	82.5	84.2	243.2	247.5	68.24	154.2
Average..		24.4	85.2	84.5	236.8	252.9	68.93	154.8

These tables may be looked at from two points of view, which would commonly be called the practical and the theoretical. By the former, to speak in the more accurate language of statistics, I understand any conclusions to be involved which do not recognize distinctions of less than about 4 or 5 per cent. of the totals in question. Looked at with this degree of nicety, the main fact that the tables yield is, that there is no difference whatever (with a single exception, to be presently noticed) between the physical characteristics of the different intellectual grades. Whether in respect of height, weight, power of squeeze, eyesight, breathing capacity, or head-dimensions, there is no perceptible distinction. There *are* differences, of course, but to say whether or not these are of any significance requires an appeal to the theory of statistics and to tests beyond the reach of the "practical" standard.

The one exception is in the power of "pull." I called attention to this two years ago; but, with the bulk of statistics at that time at our command, I felt somewhat doubtful as to its real significance. But there can scarcely be any doubt as to the non-casual nature of a difference of power between the A and C classes amounting to 4.6 per cent., when this difference displays itself between the averages of such large numbers as 487 and 734 respectively. At least, if there were any doubt, it would be removed by another mode of displaying the results, to explain which a brief digression must be made. In the preceding tables the primary division into three classes was based on intellectual differences. Let us make, instead, one based on physical differences. Let the first class, in respect of each kind of measurement, embrace "the best in ten"; in other words, select the top 200, or thereabouts, in each separate list. Such a table will show, for one thing, the extent to which one kind of physical superiority is correlated with another; and also, by reference to the triposes and tutors' information, it will show how these classes are composed in respect of their A, B, C constituents. The following is such a table, arranged to show how such "first classes" in one physical department stand in relation to the principal other such departments.

TABLE II.

Comparative Excellence in Different Physical Capacities.

	Eyes.	Pull.	Squeeze.	Breath.	Height.	Weight.
1st Class, Eyes	34.6	86.6	83.5	263.2	69.40	157.1
" Pull	25.4	113.0	93.9	280.2	69.82	167.3
" Squeeze	24.2	96.5	103.7	278.7	70.45	170.1
" Breath	24.9	94.3	92.4	320.5	71.19	167.3
" Height	25.3	88.0	90.4	286.7	73.25	171.5
Average student..	24.1	83.5	84.2	254.5	68.94	153.4

I shall call attention hereafter to certain conclusions furnished by this table as to the correlation of these various physical characteristics. At present they are only appealed to in confirmation of the fact alluded to above. It is rather curious that, when we sort out these first classes into their A, B, C constituents, we find that, with the same single exception, the distribution is about what it would be on a chance arrangement. That is, the men of exceptional height or breathing capacity are just as likely to be found amongst the A's as amongst the B's or C's. This is the case even with the eyesight. The first class here was confined to men who could read distinctly the small print (diamond) employed, at a distance of at least 35 inches; with the additional restriction that the weaker eye of the two could read the same at 33 inches. Of such men there were 196 out of 2134. Now had these been taken indiscriminately from the three classes A, B, C, the most likely proportions would have been respectively 44, 84, and 68. The actual numbers were 46, 88, and 62. But when we select in the same way a first class (consisting of 182) of the strongest "pullers," we find that whereas A, B, C, should contribute respectively 41, 78, and 63, they actually contribute 28, 78, and 83. Taken in connection with our previous results, the conclusion seems inevitable that this particular kind of physical superiority is, to a certain extent, for some reason or other, hostile to intellectual superiority.

The question *why* this is so is one which it is not easy to answer with confidence, but the following suggestion may be offered. The action of "pulling" is the only one in the above list of physical tests which is much practised in any popular games: it obviously is so in rowing, whilst in cricket a similar set of muscles appear to be exerted. But no known game appears much to practise our "squeezing" power; and, as regards the height, weight, breathing, and seeing powers, probably any form of exercise which keeps a man in good health offers sufficient scope for development. It would therefore seem to meet all the observed facts if we suppose that our hard-reading men take amply sufficient exercise to develop their *general* physical powers fully up to the same relatively high standard found amongst the others; but that the non-reading men, or a certain proportion of them, are rather apt to devote themselves to certain kinds of exercise which develop a proportional superiority in one special muscular development.

I should not have directed so much attention to this second table if it were not that such considerations have a very direct bearing upon a question of importance at the present day. As some readers of this journal probably know, it has been seriously discussed, in influential quarters, whether it is not advisable to take some account of physical qualifications in our Civil Service or other State examinations.¹ By this, we may presume, is not to be understood any mere *pass* examination. The necessity of some test of that kind may be taken for granted, and would naturally be secured by a medical certificate. Something much more serious than this may plausibly be defended, and on the following grounds.

In most of the examinations of any magnitude with which the State is concerned, it may be taken as a fact of experience that the number of selected candidates bears some moderate ratio to that of those who compete. If two hundred men are found to go in and try, it will seldom be the case that there were very many more or less than fifty vacancies. Supply and demand, in a country in the present social and economic condition of England at any rate, will generally obviate any extreme disproportion between the two quantities. Now it is well known that where many aims of any kind are made at an object the so-called "law of large numbers," or "law of error," comes into play. At the two ends of our list of competitors the discrepancies in their performances will be very great. But, for a wide range on both sides of the middle, the differences will be comparatively small. A glance at any one of the lists, which are published in the papers from time to time, of the selected candidates for the army, with the number of marks gained by each, will illustrate this. Near the top the difference between one candidate and the next may be measured by hundreds of marks, whilst towards the bottom of the selected candidates (*i.e. towards the middle of the competitors*) the difference will be given in tens only, or even in units. So marked is this tendency that any well-informed statistician could often give a very shrewd guess, from the mere inspection of such a list, as to the number

of candidates who had failed to pass, and whose names therefore were not mentioned.

Now, this being so, it follows that the differences between, say, the last 20 per cent. who succeeded, and the first 20 per cent. who failed, are extremely slight, *in respect of the qualities thus tested*. Might it not then be wise to take account of some other quality, and what better could be found than the physical? If by sacrificing little or nothing of mental superiority we can gain a good deal of physical superiority, there is much to be said in favour of such a final appeal. If, for instance, we accepted, in the first instance, 20 per cent. more than we wanted to retain, and then subjected the whole number to some physical test, for which a moderate amount of marks were assigned, the men finally excluded would at worst necessarily be those who were only just admitted on the customary plan, and those finally admitted would at worst necessarily be those who otherwise would only just have been rejected.

There is not space here to discuss fully any such proposal, but if any scheme of this kind is ever introduced its justification must rest on considerations such as those displayed in our second table. One or two results may be pointed out. In the first place, it must be insisted that the whole merit of any such scheme rests upon the assumption that mental superiority may be considered as perfectly "independent" (in the mathematical sense) of physical. This we find is *not* quite the case as regards the "pulling" power, but is the case as regards every one of the other qualities here displayed. If we set much store upon tall men, or upon men with good eyes, we may rest assured that little or nothing will be sacrificed in the way of mental results by giving reasonably good marks for such excellence. Again, it may be remarked to what extent these different kinds of physical superiority are correlated. It appears that great superiority in any one kind of physical power is accompanied by considerable superiority in every other. It is a striking fact that in only one of the thirty subdivisions there indicated, do we fail to find the "first class" man, in any one department, standing above the average man in every department.

This being so, it is rather for the physiologist, or for the man of affairs, to select the particular physical test which is likely best to serve the public interest. So far as mere statistics are concerned, I should give the preference to the *breathing power*. For one thing, this appears, in my judgment, to be correlated, on the whole, with a higher general physical superiority than is the case with the other qualities. I apprehend also that good breathing power could not readily be "crammed," so to say, by attendance at a gymnasium, and by aid of professional advice and direction, as can be done to some considerable extent in the case of muscular power.

It has been already remarked that high excellence in one physical capacity seems correlated with decided superiority in all the others. This is evident from a glance at the tables. But it deserves notice that *equally* high excellence is not by any means implied. The chance of a man who is in one of these physical first classes being also in another such class is not very much more than what it would be if the two capacities were distributed at random. As a matter of fact, four men only out of the entire number are in every one of these first classes. As between the exertions of muscular strength apparently so closely similar as those of pulling and squeezing, it is found that only 44, out of the total of 195 in the latter, also secured a place in the former; whereas a purely chance distribution might have been expected to secure as many as about 20. As between the corresponding selections, of about equal numbers, from the best in respect of eyesight and breathing, it appears that not more than 30 obtain a place in both classes.

Turn now to some of the less obviously certain conclusions. Comparing the "head-volumes" of the students, two facts claim notice, viz. first, that the heads of the high-honour men are distinctly larger than those of the pass men; and, second, that the heads of all alike continue to grow for some years after the age of 19.

The actual amount of difference as between the A and C students is, of course, small. On our scale it is just about 7 inches—that is 3 per cent. on the real size of the head. Is this small difference to be regarded as significant? The answer can only be given by an appeal to the theory of statistics, which yields the following conclusions.

I must premise that the figures given here as average head-volumes were thus obtained. The average was taken of each of the three separate head-measurements (in the three directions

¹ See Mr. Galton's paper on this subject at the last meeting of the British Association.

already explained) of each sub-class of students—*e.g.* of those of the A class who were 19 years of age; these three were then multiplied together, and the product resulting (in the case in question, 242.9) was entered in the table. What we have, therefore, is not strictly the mean of the products, but the product of the means. Theoretically, I apprehend, the former should have been preferred; but as the extra labour entailed would have been very great, and as the difference, when dealing with large numbers of cases and small amounts of divergence, is extremely small, I have been content with the latter. It may be added that the actual computation was made in both of these ways for a sample number of cases, and the insignificance of the difference for our purposes of comparison was statistically verified.

What theory directs us to do is of course to begin with determining the probable error of the individual head-volumes of the men generally. This is found to be, on the scale in question, about 17 inches. The usual formula for the difference between the means of 734 and of 487 would then assign to this difference

a probable error of $17 \times \sqrt{\frac{1}{734} + \frac{1}{487}}$, viz. nearly one inch.

The actual observed difference, of nearly 7 inches, thus lies enormously outside the bounds of probability of production from mere statistical chance arrangement. But in this calculation there is a source of error omitted to which attention was directed not long ago by a correspondent in *NATURE*, viz. the actual errors (in the literal sense of that rather unfortunate technical term) committed by the observer, or involved in the mechanism of the instrument. Two years ago I had taken it for granted that these were insignificant; and, had it been otherwise, the materials at our disposal would hardly have enabled us to make the due allowance. But, as the correspondent pointed out, the error is by no means to be neglected, and we have now the means of fairly estimating it. A considerable number of men have been measured five or six times, and some even oftener, whilst one man, who seems to have had a morbid love of this physical inspection, has actually had his various dimensions and capacities tested no less than eighteen times during the course of some three years. These cases have furnished a fair basis of determination. They show that these personal errors are certainly greater than they should be (they seem to arise in part from a certain looseness in the machine, which will be remedied in future), amounting in certain extreme cases to as much as even half an inch on the single measurement, and therefore to much more in what appears here as a "head-volume." The resultant "probable error" from this fresh source of disturbance amounts to about five (cubic) inches. Those unfamiliar with probability may perhaps be staggered by such an admission, but they may be assured that the healing tendency of the averages of large numbers is very great, and that the results remain substantially unaffected. The problem appears to be simply one of the superposition of two independent sources of error, and may be stated thus: Given a large number (over 2000) of magnitudes, with a mean of 239, and a "probable error," about this mean, of 17; and assume that these magnitudes are inaccurately measured with a further probable error of 5 inches (as seems to be the fact), what is the probable error of the divergence between the two averages obtained respectively from 734 and 487 of these results? The answer is still a little less than one inch. It is, that is to say, an even chance that the two averages will not differ by more than this; and it is, consequently, thousands to one that they will not differ by so much as seven inches. The conclusions, therefore, previously drawn, lose little of their force.

It seems to me almost as certain that the size of the head continues to increase up to at any rate the age of 24. This will be made clear by looking at the following diagram, which is drawn to show the sum of the figures of the head-measurements as contained in Table III.

As regards the comparative physical endowments, in the other respects, of the different classes of students, there does not seem to be much to say. The differences—sometimes one way and sometimes the other—between them in respect of height, weight, breathing, and squeezing power, are so small as to be statistically insignificant, averaging only about 1 per cent. That the first-class honour men, however, have slightly inferior eyesight seems established, especially when we bear in mind that each batch of about 1000 cases tells the same tale; the only evidence telling the other way is the fact, already adverted to, that when a class comprising "the best in ten," as regards eyesight, is

selected from the whole number, we do not find any appreciable intellectual selection to be thereby entailed.

An equally trustworthy basis of comparison is found by observing the distribution of the short-sighted men. Let us take as the limit of what shall be termed "short sight" the inability to read the diamond print with both eyes at a distance greater than ten inches. Adopting this test, we find that the A, B, C classes furnish respectively 14, 11, and 11 per cent., indicating a very small difference between them.

The general conclusion to be drawn here seems, then, to be this. With the single exception of eyesight—and this to a very slight extent—it does not appear that intellectual superiority is in the slightest significant degree either correlated with any kind of natural physical superiority or inferiority, or that it tends incidentally to produce any *general* superiority or inferiority. I emphasize the word "general" in the last clause in order to allow for the difference shown in respect of pulling power. It seems probable, as has been already suggested, that the superiority of the non-honour men does not point to the slightest superiority of their general bodily development—as would be indicated perhaps if it displayed itself in respect of their height, weight, or breathing capacity—but is solely brought about by greater muscular exercise in the pursuit of certain athletic games.

So much as regards the first and second tables. As regards the third—which is arranged in order to show the development

TABLE III.

Physical Development of Students from 18 to 25.
A, B, C combined (2134).

No.	Age	Eyes.	Pull.	Squeeze.	Head.	Breath.	Height.	Weight.
80	18	24.0	79.2	81.9	235.6	237.3	68.72	150.8
276	19	24.8	79.3	81.6	236.4	250.8	68.93	150.5
564	20	24.2	82.6	83.6	237.5	253.9	69.05	153.3
479	21	23.6	84.0	83.8	238.3	257.0	68.96	154.1
353	22	24.6	86.2	86.2	239.7	256.6	68.91	154.2
159	23	22.8	84.0	85.0	238.4	259.4	69.12	153.5
80	24	24.8	88.4	85.6	243.6	255.8	68.73	156.0
143	25	23.3	82.7	84.1	243.3	253.2	68.53	155.1

of the physical powers between 18 and 25—there is very little to be said, as statistics of this character offer no particular novelty. Such merit, therefore, as this may possess must depend mainly on the homogeneity of the class of men concerned. As indicated at the commencement of this paper, this homogeneity is equivalent to a considerable increase in the total numbers where more heterogeneous materials are dealt with. They appear to indicate that the physical powers, as a whole, culminate at the age of 22 or 23, and thence begin to steadily decline. Too much stress, however, must not be laid upon the rate of decline here, since the last subdivision is of a somewhat less homogeneous character than the others. For one thing, the men of twenty-five really include those also who are *over* that age, though these are relatively but few. Again, whilst the men up to 24 remain (for all statistical purposes) identically the same individuals, with a year or two more added on to their

age, it would probably be found that a not insignificant proportion of those marked as 25 were men who were already older when they came into residence.
J. VENN.

ABOUT eighteen months ago a brief memoir of mine—"Head Growth in Students at the University of Cambridge"—read before the Anthropological Institute, was published in *NATURE* (vol. xxxviii. p. 15). The means obtained by Dr. Venn, of the "head-products" of Cambridge students between the ages of nineteen and twenty-five were there thrown into the form of a diagram, and discussed. The head-product, I may again mention, is the maximum length of the head, $\times$ its maximum breadth, $\times$ its height above the plane that passes through the following three points: 1 and 2, the apertures of the ears; 3, the average of the heights of the lower edges of the two orbits. I drew curves that appeared to me to approximately represent the true average rate of growth, and deduced from them the following conclusions, in which I have now interpolated a few words in brackets, not because any criticism has been founded on their omission, but merely as a safeguard against the possibility of future misapprehension.

(1) Although it is pretty well ascertained that in the masses of the population the brain ceases to grow after the age of nineteen, or even earlier, it is by no means so with University students.

(2) That men who have obtained high honours have had [on the average] considerably larger brains than others at the age of nineteen.

(3) That they have [on the average] larger brains than others, but not to the same extent, at the age of twenty-five; in fact, their predominance is by that time diminished to [about] one-half of what it was.

(4) Consequently, "high honour" men are presumably, as a class, both more precocious and more gifted throughout than others. We must therefore look upon eminent University success as [largely due to] a fortunate combination of these two helpful conditions.

These conclusions have been latterly questioned by two of your correspondents, partly on the ground of discordance among the data, and partly on that of insufficient accuracy of the individual observations. To this I replied, that materials had since been accumulating, and that a second batch of observations, about equally numerous with those in the first, were nearly ripe for discussion, and that I thought it better to defer discussion until these had been dealt with; then, their agreement or disagreement with the first batch would go a long way towards settling the doubt.

This second batch of observations has now been discussed by Dr. Venn on exactly the same lines as the first one, and I give the results of both in the annexed diagram. The data from the

first batch, which formed the basis of the above-mentioned memoir, are here shown by dots with little circles round them; those from the second batch by crosses.

To the best of my judgment, the conclusions that were reached before are now confirmed. No person can, I think, doubt that the swarm of the A dots, and that of the C dots, are totally distinct in character. I have avoided drawing curves through either of them, lest by doing so the effect of the marks, when standing alone, should be overpowered, and it might be prejudiced. In their place, small arrow-heads are placed outside each diagram, to indicate the direction of the stretched thread that seemed most justly to represent the general trends of the

two swarms of dots. Then, for the sake of convenient comparison, lines corresponding to these threads have been placed on the third diagram. It must, however, be understood that I have supposed the lines to be drawn straight, merely for convenience. In making my own final conclusions, I should take into account not only what the swarms of dots appear by themselves to show, but also the strong probability that the rate of head-growth diminishes in each successive year, and I should interpret the true meaning of the dots with that bias in my mind.
FRANCIS GALTON.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, February 6.—Dr. W. J. Russell, F.R.S., in the chair.—The following papers were read:—Observations on nitrous anhydride and nitric peroxide, by Prof. Ramsay, F.R.S. The author recommends as the best method of preparing pure nitrogen peroxide that the deep blue-green liquid, supposed to be a mixture of this oxide with nitrous anhydride, which is obtained by condensing the products of the interaction of arsenious oxide and nitric acid, be added to a solution of nitric anhydride in nitric and phosphoric acids, prepared by adding phosphoric anhydride to well-cooled nitric acid; after agitating the mixture, the upper layer is decanted and distilled. He assumes that the two oxides interact according to the equation: $N_2O_3 + N_2O_5 = 2N_2O_4$. The melting-point of the peroxide was found to be $10^{\circ}14$, in agreement with Deville and Troost's statement. The depression of the freezing-point caused by one part of chloroform in 100 parts of the peroxide was $0^{\circ}35$, and by one part of chlorobenzene $0^{\circ}37$; the molecular depression is therefore 41° . The heat of fusion, W , of the peroxide, calculated from this number and the observed fusing-point, by Van't Hoff's formula $W = \frac{0.02T^2}{t}$, where T is the

freezing-point of the solvent in absolute degrees and t the molecular depression, is 33.7 cal.; a direct determination gave 32.3 cal. To determine the molecular weight of nitrous anhydride, a known quantity of nitric oxide was passed into the peroxide, and the depression of the freezing-point determined. Assuming that an amount of nitrous anhydride equivalent to the nitric oxide was formed, the results gave the values of 80.9 , 92.7 , and 81.0 against 74 , the value corresponding with the formula N_2O_3 . The author was unsuccessful in freezing nitrous anhydride even at -90° by means of liquefied nitrous oxide. It was found to be soluble in this liquid, and it was further observed that as evaporation took place nitric oxide gas was given off together with the nitrous oxide; it would therefore appear that N_2O_3 is unstable even at the very low temperature at which nitrous oxide is liquid. In the discussion which followed the reading of the paper, Mr. Pickering pointed out, with reference to Prof. Ramsay's determination of the heat of fusion of nitric peroxide, that observations on substances which exercise an appreciable influence on each other cannot safely be used in deducing the heat of fusion. Thus in the case of mixtures of water and sulphuric acid, solutions containing 29.5 , 18.5 , 8.6 , 1.0 , and 0.07 per cent. of acid, gave respectively the values 37.4 , 58.3 , 79.9 , 74.9 , and 56.3 as the heat of fusion of water, instead of 79.6 . In reply to Mr. Wynne, who remarked that nitric oxide alone should interact with nitric anhydride in the way attributed to N_2O_3 , Prof. Ramsay stated that he had not examined the action of nitric oxide on nitric anhydride.—Note on the law of the freezing-points of solutions, by Mr. S. U. Pickering.—The action of chromium oxychloride on nitrobenzene, by Messrs. G. G. Henderson and Mr. J. M. Campbell.—Studies on the constitution of the tri-derivatives of naphthalene; No. 1, The constitution of β -naphthol- and β -naphthylaminedisulphonic acids R. and G.; naphthalenemetadisulphonic acid, by Prof. H. E. Armstrong, F.R.S., and Mr. W. P. Wynne. After alluding to the great theoretical importance of a study of the tri-derivatives of naphthalene, the authors draw attention to the necessity of determining the constitution of those tri-derivatives which are employed technically in the manufacture of azo-dyes in order that the dependence of colour and tinctorial properties on structure may be determined; and especially is this the case, since all are not equally valuable— β -naphtholdisulphonic acid G. (Gelb), like Bayer's β -naphtholmonosulphonic acid, interacting but slowly