Reports, Notes and Correspondence Relating to Alice Lee's D.Sc.

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Draft

Report to the Senate of the University of London

The qualification of Miss Alice Elizabeth Lee for the Degree of Doctor in Science, rests on the employment she has made of the mathematical theory of Correlation, as developed by Prof: Karl Pearson.

She has skilfully utilised the powerful but very laborious methods of that theory, to discuss biological and other problems, and has thereby illustrated the numerous ways in which the modern methods of statistical science may be usefully applied.

This she has done partly in her Thesis, but chiefly as a joint contributor with Prof: Pearson himself, in six memoirs published by the Royal Society, – two in their Philosophical Transactions and four in their Proceedings. In a letter to Mr Galton, Prof Pearson emphatically ascribes a full moiety of the credit of these six memoirs to Miss Alice Lee.

Her claim then, may be considered as roughly equivalent to that of having contributed <u>one</u> paper to the Phil: Trans: <u>two</u> papers to the Proceedings, and of having written another paper of the same order of merit, which is now in MS in the form of a Thesis.

We think that the degree of D. Sc: has been fully earned by Miss Lee.

To be signed

Draft for consideration

for the degree of Doctor in Science

The qualification of Miss Alice Lee rests on the employment she has made of the mathematical theory of correlations, as developed by Prof: Pearson F.R.S.

She has skilfully utilised the powerful but very laborious methods of that theory, to discuss biological & other problems, This she has done partly in her Thesis, but chiefly as a joint contributor with Prof Pearson himself, in six papers published by the Royal Society, two of which are in their Phil: Trans: and four in their Proceedings. In a letter to W. Galton, Prof: Pearson emphatically ascribes a full moiety of the credit of these six memoirs to Miss Alice Lee.

Her claim then may be considered as roughly equivalent to that of having contributed one paper to the Phil: Trans:, two papers to the Proceedings of the R. Soc, and of having written another paper of the same order of merit which is now at present in the form of her Thesis in MS. [All her works deal with subtle and intricate problems in a masterly manner, and elicit conclusions of high biological interest]. It is no small part of their merit that they illustrate numerous ways in which modern methods of statistical science can be usefully applied.

We think that the degree of D. Sc: has been fully earned by Miss Alice Lee.

7.G.

I have seen Miss Lee, and [illegible] referred to your 'Human Skulls' in the Challenger Reports, but do not they more than confirm her assertion p. 29 that "differences of 40 c.m are often obtained in measuring the capacity of a skull by different methods"? The three specimens that you cite of Broca & Schmidt confirm [illegible]; thus

Broca	Schmidt	Diff^ce	Per cent of Schmidt
1000	931	69	74
1500	1409	91	65
2000	1887	113	60

Of course Broca & Schmidt are greatly contrasted examples, on the other hand these are as great as actual differences. Would not Miss Lee's 40 cm be "often" found if the same skull was measured by the different methods now in actual use in different places [illegible]?

I suppose that few of the interesting skulls in different museums, or that have been described by travellers, have been measured by your excellent though of course laborious method but that their diameters have been or could be fairly measured. With these Miss Lee's method would apparently be useful.

As regards the living person, there is no other way as yet proposed so far as I know, of estimating the absolute capacity of the skull, though the mere multiples of height & length & breadth give quite as good relative results.

It seems to me that especial credit of Miss Lee's thesis is one of a series of applications of the new method of statistics (this is its strong point). Regarding these theories the 3 contours of which you speak, could be calculated and a closer approximation made, if the arithmetic labour of obtaining the constants would however be great, Karl Pearson has fully worked out the theory of multiple correlation.

It is true that she is one of the first workers in a field that is not yet recognised as a separate & distinct field of research. Mathematicians are mostly unfamiliar with its fundamental ideas, while there is no [illegible] mathematical elegance in its processes to attract their attention. Ordinary statisticians are deficient in the necessary technical knowledge to apprehend its scope & power, so the importance & power are realised at present by few. Moreover all vagueness of verbal expression disappears, for the

Math: don't know do — neither Statistic f3v.

a misfortune or a credit to her

This is a case in which it seems to me that the U of L wd act with peculiar appropriateness by stamping the work with their approval

Miss Lee is much more than the mere computer fitted to do post graduate Math: work is now Ass: Lect Bedford Coll. is quite concerned with Prof Pearson's work

Human Crania Sir Wm. Turner &c. Challenger Reports 1884

p. 8 The determ: of the capacity of the skull is admittedly one of the most difficult

	Broca	Schmidt	differ	Percent of Schmidt
With shot differences of	1000	931	69	74
	1500	1409	91	65
	2000	1887	113	60

Schmidt made tables to correct Broca's results

p. 9 Sir W. Turner's method

Stop all foramina (except for: mag) with cement & varnishing inside & out with sealing wax varnish Chilled Shot No 8 poured in with stated precautions & similarly at a measure. 2 measures. None accepted that differed more than 10 cm

* much importance is attached to preserving the globular shape of the skull

~~p. 52 Methods of the Novara differ widely~~

p. 124. Comparison of measures of different skulls made by Sir Wm. Turner & Prof Simpson respectively

same	diff < 10 cm	> 10 cm	Total
22	74	23	119

note the skull was stopped & varnished in same way for both

p. 115. — 143 crania are described & tabulated in this Report

Mr P. Lee's enables different estimates to be checked & compared on equal terms

69 : 931 = x : 100 931 / 69000 (74
6517
3830
3724

Skulls
Sir Wm Turner

f4v

f5

July 2

Did not go in to Maths: honours becau
then engaged in teaching. He has done
a great deal ~~do~~ (with Greenwood) of post
graduate work attends Pearsons lectures [and] paper originate on [illegible]
though not claiming to
fully conversant with Pearsons theories
and not a mere computer.

Is assistant lecturer Math & Phys Bedford Coll.

f15

HAMPST[illegible]
5 AM
JU 2[illegible]
99
N.[illegible]

Francis Galton Esq
42 Rutland Gate
S. W.

f IV

Letter from F. Galton

to the Examiners

and their replies

June 23/99

42, RUTLAND GATE, S.W.

Dear Sir,

You may perhaps know that the Senate of the University of London has referred Miss Alice Lee's application for the Doctorate by special exam.ⁿ, — Sir Wm Turner & myself. The Senate has also furnished me with the joint Report & yourself & Dr. Hobson, & we are asked "to confer" with you.

This letter contains all that I myself want to know, perhaps you would kindly forward it through the hands of Dr. Hobson so that I shall receive both your replies & I will forward them to Sir Wm Turner. He may possibly take a sinister course, but as yet I am not in direct communication

with him, but wrote to Edinburgh where
f2v

he may not now be, 2 days ago.

Please tell me whether the first paragraph of your Joint Report is to be taken quite literally? It stands "There is nothing to indicate the share "I had either in the guiding principles of "the work: but the presumption is that "the methods are Prof: Pearson's and that "I may be accredited in the numerical "applications of them much as a computer "would assist an astronomer".

Have you any unwritten corroboration evidence to this view, as might for example have been gained by examining the capacity of the candidate and not being favorably impressed thereby? It is important to have the ground of the above presumption quite clear, because

is ~~the~~ does not at all accord with the view of Prof: Pearson f3
himself, in answer to private inquiries
that I made of him, who thinks that
a full moiety of their joint contributions
is due to Miss Lee.

Of course I should make my Report
not as a Mathematician, but merely
as one interested in Statistics & Anthropology
and familiar with the general outlines
of the higher statistics

Would you kindly return this letter
together with the remarks of yourself
& Dr. Hobson — or rather ask him to do
so; then I will forward all to his
Wm Turner & so save much letter-writing

Very faithfully yours

Francis Galton

Dr. Larmor FRS
St. John's Coll Cambridge

f41

~~ROYAL SOCIETIES CLUB.~~
~~ST. JAMES'S STREET~~,
~~S.W.~~

The Gables
Mount Pleasant
Cambridge
June 28th/99

Dear Sir

I enclose a letter to you from Dr Larmor with reference to Miss Lee's candidature for the D.Sc. degree in the University of London. I approve of what Dr Larmor writes, & desire to add a few words.

In the Regulations for the degree, we as Examiners are directed

to have regard in the first instance to the main Thesis submitted by the Candidate, the other contributions being regarded as collateral evidence. If the Dissertation or Thesis be approved by the Examiners, the Candidate shall be required to present himself for Examination (see Regulations).

We did not approve the main Thesis sent in by the Candidate, & we therefore did not proceed to examine her. We found nothing in the Thesis which appeared to us to establish a prima facie case for granting the degree on the ground of Mathematics.

Technically, that was sufficient ground for refusing the degree; but as a matter of fact we did consider the papers written by the Candidate in conjunction with Professor Pearson. We said in our Report that the presumption was that the methods used in these papers were ~~devised~~ due to Prof. Pearson. In support of this view I may adduce the following considerations.

(1) No undeniably independent Mathematical researches by the Candidate are known to us

(2) The Candidate did not graduate in Honours in Mathematics

(3) These researches were commenced

by Prof Pearson in papers published under his own name alone

(4) Prof Pearson's work has been recognized by the Royal Society by means of a Royal Medal, no such recognition having been given to the Candidate.

In our view to establish a prima facie case for the degree on the ground of Mathematics it would have to be shewn that the Candidate had an important part in devising the Mathematical methods employed in the papers: no amount of assistance rendered to Prof Pearson in the detailed work of carrying out the calculations would be sufficient on the Mathematical side.

Yours faithfully
J. W. Hobson.

24 Mark Street, Portsmouth

June 25. 1898

Dear Sir Galton

With reference to the first paragraph of the D. T. Report, about which You inquire :-

Our first step was to write to the authorities of the University for further information as to what share the candidate had in the joint papers. The answer came that we had all the information available. We had therefore to form the best judgment we could : and I see no reason to doubt its substantial accuracy. The grounds are briefly as follows: I am considering the question as one of mathematical, or general statistical theory, as

f6v

we distinctly reported that we could form no opinion on the Anthropology.

Miss Lee had never (to our knowledge) written any other mathematical papers, of her own, other than computing tables, and had not examinations in the University of London, or elsewhere shown any particular aptitude for mathematical investigation: yet the mathematical theory which is the basis of the joint memoirs is of a refined, complex, and difficult character.

Prof. Pearson has written other such papers along with collaborators other than Miss Lee, in which the general scheme and method is the same.

The earlier memoirs in which this scheme and method is mathematically developed appear under Prof. Pearson's name alone.

If it be granted that the theory of statistics that is involved, belongs to Prof. Pearson, and has been reduced to rules by him, then I ~~claim~~ hold that the simile we used,

"that Miss Lee has assisted in the
numerical applications of them
such as a computer might assist
an Astronomer" is an apt
representation of the facts as regards
the application of statistical theory:
always allowing that Miss Lee
may have had qualifications
for handling the subject matter of
the Statistics, of which we
could not be competent judges.

Under these circumstances we
, judging by the ordinary mathematical standard,
consider, that, even if Miss Lee
turned out to be an excellent
mathematician, yet there was no
mathematical basis for a D.Sc degree
in her work, and that the actual
merits of her many theses must be
judged by a specialist in the subject

matter of which it treats.

And I may add, on my own part, that this conclusion was reached in the face of a general feeling to make the most I could of the writings submitted to us, on the ground that they showed much hard work of a useful kind.

Very faithfully Yours

Harmer

P.S. There is not any necessary contradiction between what I have here written and the opinion which you seem from Prof. Pearson that "a full moiety of their joint contributions is due to Miss Lee".

9. Blenheim Rd. flr
July 4th 1899.

Dear Mr. Galton,

I have looked at-
Sir William Turner's paper
as you suggested —
I cannot see that it in
the least invalidates my
arguments — He gives several
cases of even wider divergence
in results of measurements
on the same skull by different
persons — e.g.

Schmidt	931
Broca	1000
Schmidt	1409
Broca	1500
Schmidt	1557
Broca	2000

He then describes his f1v
method of measurement &
says that he & his Assistant
measured independently &
no result was entered in
which they differed by
more than 10 cm.
This seems to me like
a case of <u>selection</u> —
if I had only entered
results when the calculated
& measured values differed
by some small quantity
which I chose arbitrarily

the results would have
appeared very striking,
but — !
And again it seems to
me to be so much easier
to get a result when you
are trying to get it — I
mean if two people are
trying to prove — their
measurements may quite
likely both do so — When two
students come to the Physics
Laboratory I find sometimes
they wished to ask me
what they ought to get —

f2v

or what is going to happen. I always then make the most absurd statement which comes into my head & I have often heard the results suggested! — They soon learn in this way how indispensable it is to start unbiassed & see for themselves —

But even supposing that Sir William Turner & his Assistant worked in such a way that the danger was greater

f35

out of the question; & that their results were really quite independent & quite unselected, still it does not affect my results — or so it seems to me — for the measures, from which I worked, were not made partly by Sir W. Turner's methods — from the British Association Reports & from what I have gathered from other sources (e.g. Professor Thane told Professor Pearson that divergences of from 30 to

f3v

40 c.c. (in men perhaps) Most skull measurements are liable to the error I have stated — possibly if I had had the advantage of Sir W. Turner's measures of length, breadth, height & skull capacity, my results would have been better. Again I think the personal equation comes in — Professor Pearson, Mr. Yule & I once made a set of experiments — we had 500

f45

bias which we each of us tried to bisect by guess. In the result it was found that one of us went too far to the left about an equal no. of times as too far right — & consequently got a good mean — one of us had a bias to the left & one to the right — I suppose a good experimentalist would have a bias one way rather than wobble;

if he had this bias he f4v
would get a mean out-
of about as much as
any one given measure
& then as the dimensions
always occur in the form
(L - mean L) × const., etc —
this error would not affect
results much — but suppose
he got a good mean tho'
having no definite bias
then there would be more
error in the term
(L - mean L) & as the

f5r

regression coefficients in my formulae (17) (8) are large, even a v. small error in measuring any one dimension would have a fairly large value in the result.

In (9) the regression coefficient is small but then there would be the error of the product L×B×H.

It seems to me that the theory I have set down is the best from a mathematical point of view & that the results are as accurate

of the measurements on which
they are based will allow
that this is all one can
expect –
You spoke of the Barometer
paper, so I am venturing
to send you a review
of it from the Meteorologische
Zeitschrift –
I have the original diagrams
of the Bertyein oscillator
(these are entirely my
own work) I will send
them to you if I may?

f5v

f6

I am entirely grateful to
you for sending me &
allowing me an opportunity
of explaining my position.
your kindness thus makes
me hope you will not
think I am taking a
liberty in saying that
I think of the letter to
which you referred me.

Yours faithfully
Alice Lee.

UNIVERSITY OF LONDON,

BURLINGTON GARDENS, W.

June 22, 1899.

Dear Mr Galton

I send you herewith the Report of the Examiners in Mathematics ~~and some other papers~~.

The Senate has directed me to ask you and your Co-Examiner Sir Wm Turner to confer with the Examiners in Mathematics, (Dr Hobson, F.R.S., The Gables, Mount Pleasant, Cambridge, and Dr Larmor, F.R.S., St John's College, Cambridge) upon the case and also to use such other means examinational or other as may be thought necessary to ascertain the share of the Candidate in the researches submitted in support of her candidature.

She is not a 1st Class B.Sc. Honours candidate, and may be tested in the subjects generally of her claim as well as specially in regard to her Thesis in any way that may be thought proper.

I remain,

Yours faithfully,

F Victor Dickins

Registrar.

Miss Lee's contributions have come in by driblets & I am not sure if you have them all [illegible] you. Please let me know those you have not received.

✓ Thesis
✓ Brain-Variation
✓ Fertility mankind — Abstract & Complete Paper
Variation Cranial — Homocranial Mean
✓ Abstract Paper — Herzian Oscillations
✓ Telegony in Man

only 1 copy then to be sent to Sir W Turner

✓ also Entry Form
× Regulations for Degrees in Science

EXAMINERS' REPORT.

In the joint papers by Miss Lee and Prof. Pearson there is nothing to indicate the share of each author in the guiding principles of the work: but the presumption is that the methods are Prof. Pearson's and that Miss Lee has assisted in the numerical applications of them much as a computer would assist an astronomer.

The main thesis on the "Calculation of Skull Capacity from the Dimensions - Length, breadth, height," is an application of the same methods as are employed in the joint statistical papers. Assuming the validity of these methods for the purpose in view, there is every presumption that Miss Lee has applied them correctly. But such application by itself does not involve mathematical merit of an order that can count much towards the Doctorate. The Paper must therefore be judged as a contribution to Anthropology.

This report refers to the Thesis and the subsidiary statistical papers. We have not received the subsidiary papers (4) and (5).

Examiners { J. LARMOR.
E. W. HOBSON.

May 5, 1899.

(Karl Pearson) fls (1)

7 Well Road
Hampstead N.W.
June 20, 1899

Dear Mr Galton

Your question is rather a hard one to answer, for I have known miss Lee very intimately for a number of years, and in almost daily working with another one is apt sometimes to emphasise their failings. I will try and say clearly all I know. miss Lee has an immense capacity for work, she is absolutely conscientious and disinterested in all she does.

f1v

quite recently she just, for example on one side, some tables over which she has been working for quite two years & started them all over again because she was not satisfied with the degree of accuracy obtainable from 7 figure logarithmic tables, & has begun again with 10 to 12 figure tables. This is what I call the scientific conscientiousness. She does not shun difficulties & is endlessly painstaking. For years she has devoted her whole leisure to scientific research & this at considerable personal loss and under difficult con-

roundings. Her chief failing is want of expression, she cannot write concisely & show up her points well. I have over & over again suggested to her, as to my other pupils, problems that need working out. She will take one of these up and do thoroughly good work on it, but she will fail to write an effective paper, although quite clear herself as to the significance of the conclusions she has reached. This is the reason that she has continued with joint-papers long beyond her student days. Her energy, care & conscientiousness have been a source of much assistance

4

to me, but the joint papers have really not been quite fair to Her. Take for example the Hertzian oscillator paper now being printed for the Phil. Trans. I suggested that the problem was worth working out in a post. graduate course some five years ago. Mrs Lee took it up & her diagrams were exhibited at a R. S. Soiree, I think four years ago & were favourably noticed for their beauty & scientific value. Well, there the matter stood; she could not or would not write the last. To them & finally I had to do it last Xmas myself. Much the same holds for the Barometer paper, although

my work on that was on the whole more extensive.

In the skull capacity paper I simply suggested that we wanted more knowledge as to the relationship of the parts of the skull & drew attention to the great difficulty of measuring the capacity & how anatomists had failed to give a satisfactory formula. Miss Fawcett & Miss Lee have both been working at the correlation of the parts of the skull & it seems to me that some of their results are of very great importance. I have simply suggested material or given what I had got.

Now here Miss Lee's peculiar characteristics come out, she has been through an immense amount of work in & for this skull paper, but the results are not clearly emphasised and expressed, & have to be sought for by some one knowing the present difficulties of craniometry. Thus she has undoubtedly got a formula which gives capital results in the reconstruction of skull capacity from Length, Height & Breadth, a formula which agrees for both French & Aino & reconstructs mean racial capacity with great exactness & individual exp.

acity with an error probably not greater than 3 to 4 per cent. This is really very remarkable, and I should not hesitate to use it in preference to measuring the capacity of a series of skulls.

Then again the reconstruction of skull capacity on the living is an interesting result. She seems to know & grasp fully what she has reached lately, but her paper (to me) does not sufficiently emphasise what she has accomplished, it is somewhat "unbeholfen".

Hence I am here as on other occasions apt to be vexed by her want of power of expression, and this might prejudice me in giving out what might

to her merits, because I have so often had to fight with it. On the whole I think it is characteristic of most women's work.

She has in my opinion done far more scientific work than most candidates for the D. Sc. She has worked steadily and with real scientific enthusiasm for many years, and as far as our joint papers are concerned, two of them would not have been written but for her work. She started them & provided the material & results & I simply overworked it, tested them and gave to them such form as they have. I think I ought not to say more because I am not unprejudiced, for her style imitates me, and on the

(9) 1752 (3)

other hand I know she has done excellent work. I would merely suggest that you should find out from craniologists the importance of the problems, she has tackled & then see how far she has provided a satisfactory solution.

So far as I personally am concerned I give her full credit for almost all of our joint papers.

I should very much like the plan of the reaction time apparatus. I may not be able to put it in hand at once, but I shall do so sooner or later, as I find

the needful workers & funds.
Horace Darwin had a plan
in hand for me some two years
ago, but it was too expensive
& when my apparatus grant
was withdrawn I had to
put it on one side. My
impression then was that
a simpler & more economical
form ought to be & would
be sooner or later devised.
If I am at Bedford College
Conversazione would you like to
be introduced to Miss Lee?
She does not know you
are an examiner. The Registrar
has only written to say that
the thesis & paper had

Ken referred to special examiners.
That is a great step forward
after reference to formerly mathematical
examiners.

Please excuse the form & haste
of this, as I am labouring
under some mental strain due
to a received unfavourable
report of my wife's health.
I shall only be too delighted
if Miss Lee gets her degree,
but just as I should have
refused directly to examine
her, so I cannot indirectly
judge one, with whose strong
& weak points I am so
very familiar. I should not
have judged my own work
adequate for the Darwin medal.

Yours always sincerely
Karl Pearson

Penrose July 4/99

f75

Hampden Farm House
Great Missenden
Bucks.

July 4
1899

My dear Mr Galton

I was up in
Town again yesterday for
a committee to select
Waldon's successor, and
found Miss Lee at work
in my instrument room.
She told me of her interview
with you and of Sir W.
Turner's strictures on her
paper. She is a difficult
very nervous person and I
think liable to underrate

her own work and knowledge.
meantime I looked at Sir
William Turner's Challenger
paper. Between ourselves it
is of small value. I am
already familiar with the
methods of Broca & Schmidt.
Schmidt's method makes
a difference of 100 calcic ent.
occasionally on Broca's, and
there is no reason to suppose
that Schmidt's correction
would be found acceptable!
Both give results very
divergent from what would
be obtained with Hunman's
Calais sand. The fact is

that all these sorts of measurement will have to be considered in future by men trained in the physical laboratory rather than by medical men. I further asked my anatomy colleague, Professor Keane, as to the matter and he replied that different men using their own methods will make 20 to 40 cubic cms difference in their estimate. We found ourselves that three men watching the way in which they each did a measure of the capacity could after a number of trials agree for a series a skulls to 10 to 15 cms^3 or less. But this is quite a different thing to

different observers using their own methods coming with in 30 cms^3 of each other. Sir W. Turner cannot have had experience of our 5000 to 6000 years old Naqada skulls or he would know that shot is impossible, it would smash them to pieces, they are so fragile. In many cases the skull is far too broken to fill at all. The very fact that the Frankfurter Verständigung leaves the method of determining skull capacity unfixed, shows that the majority of German craniologists still

Pearson. July 4/99 f9r (2

consider the matter sub
judice & are not prepared
to accept Broca or Broca-
Schmidt. Miss Lee's method
does not replace the ordinary
method of filling to find
capacity, but it supplements
it and enables an estimate
to be formed when that
method is inapplicable
e.g. when the skull is
incomplete, too fragile or
on the rising head. To my
mind Ranke is out and
away the most thorough
and careful of modern
craniologists. Now the fact
that Miss Lee can deduce

his average for the Alt-Baiern skulls ♂ & ♀ from the Ainos or the Ainos from his Alt-Baiern results seems to me a very wonderful bit of work. Next men like the late Professor Marshall have discussed at length (Journal of Anatomy, I have no reference here) various formulae for reconstructing skull-capacity from external measurement and have reached nothing like Miss Lee's accuracy. In fact formulae of this

kind cannot be obtained without the theory of multiple correlation, and such a theory comes wholly new & unexpectedly upon a man like Sir William Turner, who has worked purely on the lines of 50 years ago.

The last point I would make is the question of correlation between skull capacity and intellectual ability. I have looked at Miss Lee's data & work again and am pretty confident that the actual skull capacity predicted by her or the living subject cannot be

subject to more than 40 cms³ error
say 3 p.c error. This amount
of error will not alter the
broad lines of her classification
of school girls, university professors
& anatomists. Sir William
Turner's as well as my
skull capacity must be
such that we are somewhere
about the bottom of the
list, and brain weight
generally must be roughly
proportional to skull capacity.
Her results then either show
we are very inferior people
or else are in keeping with
Bischoff's very large series
of brain-weights, which

July 4/99 file (3)

gave no correlation between intellectual capacity and weight of brain. I am fully prepared to accept the former conclusion, but what I am not prepared to accept is the argument, that because Sir William Turner is at the bottom of the list, the method is incorrect. You may give him 40 cms³ more and you will not materially improve his position! The main factor (if I remember rightly) is the vertico-auricular height & of course this is not in

evidence at all when persons are judged by size of hat, or rarely when they are judged by general appearance. Some of the biggest headed men I have ever seen are those Buckinghamshire farmers, but we must go back to Hampden to find them producing a genius!. If you have the opportunity talk the thing over with Dr. Garson, who seems to me to grasp the importance of correlating the parts of the skull. Between ourselves I should

hardly expect a man of the old school of anatomists like Sir William Turner to do so.

Do you know this part of the world or its wonderful "out of the world" ways at all? We have taken an unoccupied farm here, which has not had a tenant for some time and we are trying to shake down into summer quarters. My children were shown by a village lad a young cuckoo in a hedge sparrow's nest, and have been feeding it on cake for some days past. Today

there is great grief for it
has departed for another
shrine.

Yours always sincerely
Karl Pearson

24 June

f1r

6, Eton Terrace,
Edinburgh.

Dear M. Galton

I have received your letter also Miss Lees Thesis & other papers - I am now reading the Thesis & hope to send my report on it early next week - I am not likely to be in London

again for a little time,
but shall be glad to
hear the date when
you leave home, so
that I may know
up to what day I
might see you in
case I should have

to go to town —

Believe me

Yours truly

H Clay

f31

29 June 1899

6. Eton Terrace
Edinburgh.

Dear Mr. Galton

I now enclose a memorandum on Miss Lees Thesis. It is written from the point of view of an Anthropologist who is not a mathematician - You wished me to write freely and I have put down the difficulties which I

have experienced in
accepting her methods
as giving sufficient
data for the estimation
of internal capacity -

The memorandum
is not intended as my
report on the Thesis for
the Senate of the University.

but for your consideration
& as a help perhaps
in the conversation
which you propose to
have with her -
I should like you
to put the points to
her which I have
raised, and you will
doubtless kindly advise
me as to her replies -
They may perhaps

remove my difficulties -
If we could come to
a decision before you
leave town it would be
appreciable to do so -

Believe me
Very truly Yrs
Mumey

For the consideration of W. Galton.—

Memorandum.

I have received Miss Lees' Thesis on reconstruction of Skull capacity and several reprints of papers published in conjunction with Professor Pearson. Not being a mathematician, I am unable to criticise or form an opinion on the formulae which are given. I assume that as the joint papers with Professor Pearson have been published by the Royal Society they have received the favourable judgment of competent persons as to the methods employed. I restrict myself therefore, to the consideration of the Thesis on the reconstruction of cranial capacity.

I suppose that everyone who has conducted an extensive series of cranial measurements has thought of the possibility of a method of determining the capacity of a skull from data provided by external measures, and that of the living head from such measures as are possible during life. I know this has often been in my mind. If a cranium were a rectangular box with the opposite walls parallel to each other and with all the walls of equal thickness, there would not, I apprehend, be much difficulty in obtaining a formula to determine the capacity of the box from measures of length, breadth and height. The cranium presents however a much more complex problem, its surfaces are irregularly curved, and the areas between the six points selected for the measures of length,

breadth and height, vary materially in the degree of curvature in different skulls. One can conceive two skulls equal in length, breadth and height, in one of which the area between the points of measurement may be much more ~~convex~~ curved externally than in the other, so that the capacity in it should give a corresponding increase, which could not possibly be shown by a method in which the dimensions are taken in straight lines drawn between no more than six points, and where the irregularities in curve between these points are not taken into consideration. Again the outer and inner surfaces of the cranial bones are not parallel to each other, the diploë between the two tables of a bone varies in thickness in different regions, and also in the forehead the outer table is projected forwards, by the development of the frontal air-sinuses between it and the inner table in the region where the maximum length is taken, and thus add to the external length, with no commensurate addition to the capacity.

The possibilities of error arising in the calculations seem therefore to be considerable, and to subtract materially from the value of the method pursued in the Thesis. It has always seemed to me that the data for reconstruction of capacity could be much more precisely obtained from measures which followed the curvature of the surfaces of the cranium, e.g. the horizontal circumference, the longitudinal circumference and the vertical transverse circumference, but a method for the solution of the problem from this mode of examination is not before us in the Thesis.

If the method pursued by Miss Lee is not sufficient to meet the difficulties presented by the skull after death, neither does it I think give us the requisite data for determining the internal capacity in the living head. For the ear-height which she takes for the vertical diameter, does not give the maxium height of the skull, though it is the diameter best available in the living head.

Miss Lee in discussing the comparative merits of the formulae 8 and 9 states on p.29 the lowest mean error, and speaks of differences of 40c.cm. as being often shown by different methods of measuring the internal capacity. No craniologist, however, could accept as even approximately accurate measurements of capacity in which in an individual skull differences of 40c.cm. were obtained in the methods employed. When water is used for taking the capacity, an exact measurement can be obtained. When a method of gauging and cubing is employed, such as I have described in my Challenger Report, 1884, a skull may be repeatedly measured and found to correspond with the measurement made with water, or to have a limit of variation of no more than 10c.cm. Errors therefore which range from 36.05 (formula 8) to 55.4 (formula 9) are so much beyond the range of variation attained by exact methods of measuring the actual capacity, that calculations of capacity based on the mathematical formulae given in the Thesis do not seem to me to be of practical moment.

8th July

6, Eton Terrace,
Edinburgh.

Dear Mr. Galton

I have signed the revised Report & return it for your signature - I understand that you will forward it to the Registrar after University. I shall return to him the several papers

appertaining to Miss
Lees' candidature –

Believe me
Very truly yrs
H Turner

6 Eton Terrace. Edinburgh
5 July - 1899.

Dear M. Galton

I duly rec^d your packet with letter of 29th June, also your letter of 3^d July.

I do not wish you to think that I am unmindful of the time, Labour & thought bestowed by Miss Lee both independently & in conjunction with Professor Pearson on the problems which she has sought to solve -

I am prepared to join with you in signing a Report ~~in favour of~~ recommending the University to confer on her the degree of Doctor of Science - I am however desirous not to commit myself as concurring with the method described in her Thesis as solving the problem of determining the internal capacity of the cranium from external measurements - Hence while I agree with the general mode of expression in your draft report I consider the sentence which I have included in brackets is too strong and I should be pleased if you could modify it -

I quite recognised that anthropologists have obtained variable results by the use of different methods of measuring the internal capacity of the cranium, & that the variation of 40 c.cm. by the employment of Miss Lee's formula was no more & indeed not so much as has been got by certain experimental methods. But the point I wished to emphasise was this, that an exact method does not give a variation of more than 10 c.cm., and that the value of her mathematical formula is to be tested by comparing it with an exact method, & not with methods, some of which are so inexact that one would not even think of resorting to them -

I would ask therefore if you could see your way to make some modification in the sentence I have referred to so that the Report may be sent in to the Senate as the expression of our joint opinion

Believe me

Very truly yrs

Wm Turner -

P. S. I return the letters which you sent for my perusal, also the draft report. I shall be obliged if you will advise me if the printed memoirs & the Thesis are to be returned to the Registrar of the University —

W.

Alice Lee
~~Sir Wm. Turner~~ 1899
about Miss Alice Lee
& other papers thereto

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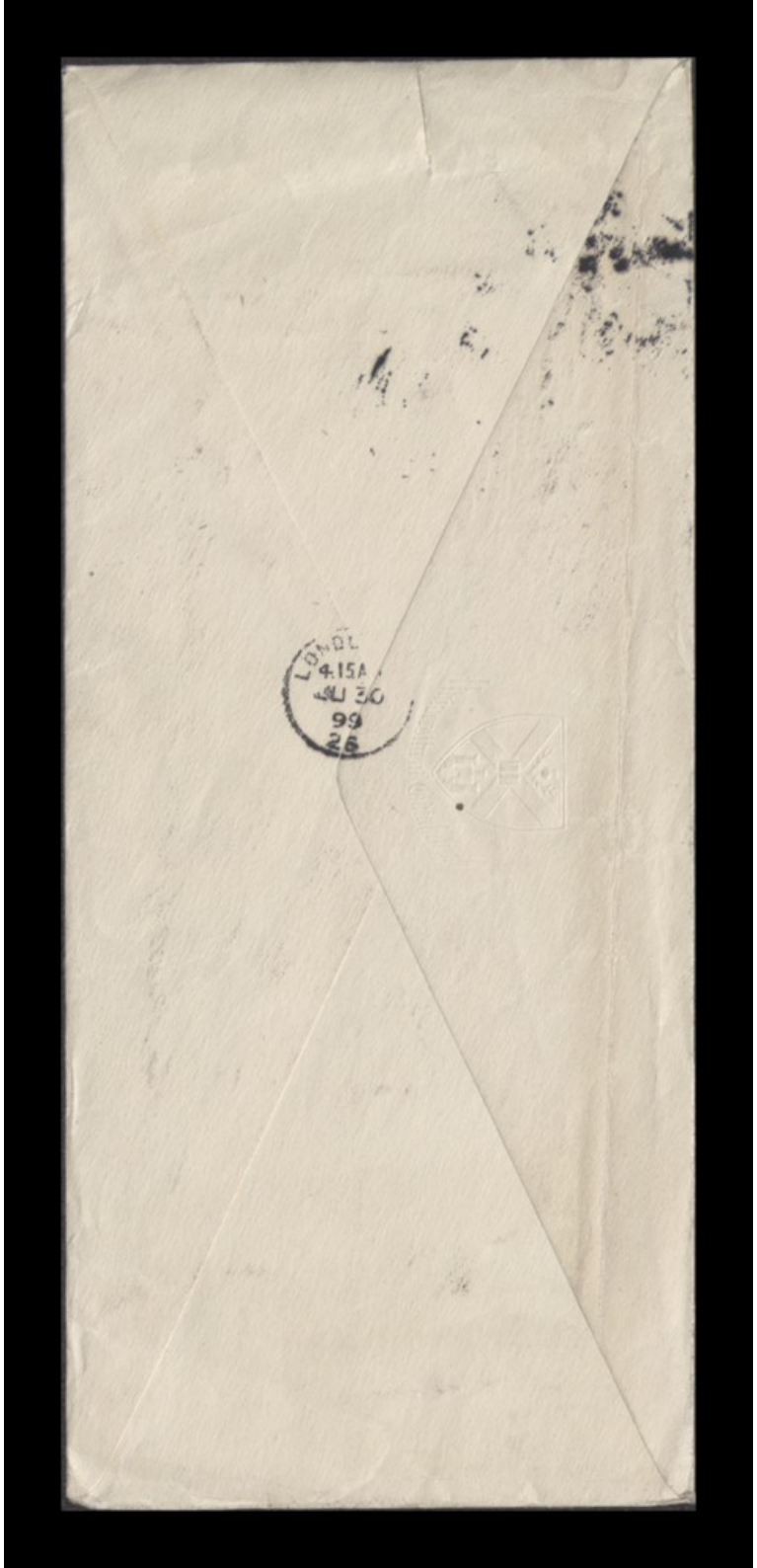
Francis Galton Esqr
42 Rutland Gate
London - S.W.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f/r

University of London.

University and Collegiate Courses

in

SOCIOLOGY AND COGNATE SUBJECTS.

Session 1904–05.

September, 1904.

C.
S.M. 7.03.

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University of London.

SOCIOLOGY AND COGNATE SUBJECTS.

The following University and Collegiate Courses in Sociology and Cognate Subjects, approved by the Senate and conducted by Appointed and Recognised Teachers and by Non-recognised Teachers at Schools of the University, will be held during the Session 1904–05.

These Courses are intended for Students taking Sociology (the Comparative Study of Social Institutions) as one of the alternative subjects under Section 5 of the Course for the Honours Degree in Philosophy; for Students taking the subject of Sociology (Psychology, Ethnology and the Comparative Study of Social Institutions) as part of the Course for the Honours Degree in Economics; and for others who are studying the subject independently of a Degree Course.

University Lectures in Sociology to be given under the Martin White Benefaction at the London School of Economics.

1904–05.

[*Admission will be free to the first Lecture in each term of each of the University Courses in Sociology.*]

WESTERMARCK, E. A., Ph.D.		SOCIOLOGY.	
	A	Lectures	1st & 2nd Terms. T. & Th., 3–4. Beginning Oct. 11th and Jan. 17th. 40 Lectures.
		For Syllabus *see* p. 6.	
	A 1	Seminar	Th., 4–5. Beginning Oct. 11th and Jan. 17th. 20 hours.
		[Term Fee for Lectures and Seminars, £1 11*s.* 6*d.* Fee for 2 Terms, £2 12*s.* 6*d.*]	
Haddon, A. C., M.A., Sc.D., F.R.S.	**B**	ETHNOLOGY—TROPICAL AND SUB-TROPICAL PEOPLES OF AFRICA, ASIA, AND AUSTRALASIA.	
		Lectures	F., 3–4.
		Seminar	F., 4–5.
			Beginning Oct. 14th, Jan. 13th, and May 5th.
		For Syllabus *see* p. 7.	
		[Term Fee, £1 1*s.* Sessional Fee, £2 2*s.*]	
Hobhouse, L. T., M.A.	**C**	COMPARATIVE ETHICS.	M., 3–5. Beginning Oct. 17. 8 Lectures.
		For Syllabus *see* p. 8.	
		[Fee, £1 1*s.* Free to members of the Sociological Society.]	
Hearn, Lafcadio, Professor of English in the University of Tokio.	**D**	JAPANESE CIVILISATION.	3rd Term.
		Details to be announced later.	

The printing of a Teacher's name in heavy type indicates University recognition of the Teacher at the particular Institution in the particular subject against which the name in question appears. The names of Teachers appointed by the University are printed in italics.

Advanced Courses in Subjects Cognate to Sociology.

NOTE.—*Advanced Students are recommended to attend one or more of the following Courses of Lectures :—*

University College.

Hicks, G. Dawes, M.A., Ph.D., Lit.D.	**T** & **Z** 2	ADVANCED ETHICS.	1st Term. T. at 3. Beginning Oct. 11th. 3rd Term. T. & Th. at 3.

Royal Holloway College.

Solomon, J., M.A.	**N**	EVOLUTION IN ETHICS. (Open to Women only.)	2nd Term.

University College.

Pollard, A. F., M.A.	**B** 4	CONSTITUTIONAL HISTORY.	F. at 11 & 12. Beginning Oct. 7th.

Bedford College.

Allen, J. W., M.A.	**E** 1	HISTORY OF POLITICAL IDEAS.	3rd Term, W. at 4.15. Beginning May 3rd.

London School of Economics.

Dickinson, G. Lowes, M.A.	**E** 2	POLITICAL IDEAS. The History of Political Ideas in connection with the History of Europe and the United States. [Sessional Fee, £1 5s.]	M. at 6.

Royal Holloway College.

Robinson, Margaret W. Hayes, Hon. Sch. Mod. Hist. (Oxford).	**B**	POLITICAL AND SOCIAL HISTORY OF GERMANY.	F., 10-11.

University College.

Macdonell, Sir John, C.B., M.A., LL.D.	**A**	COMPARATIVE AND INTERNATIONAL LAW	T. at 5. Free. Beginning Oct. 25th.

London School of Economics.

KNOWLES, Mrs. (LILIAN), Hist., Tripos, Law Tripos.	**y** 1	GENERAL ECONOMICS. [Sessional Fee, £2 5s.]	W. at 6. F. at 4 or 7.
SARGENT, A. J., M.A.	**y** 5	GENERAL ECONOMICS. [Term Fee, 11s.]	1st Term, T. at 6.
CANNAN, EDWIN, M.A., LL.D.	**z** 1	GENERAL ECONOMICS. General Economics, including the History of Economic Theory. (A two years' Course ; 30 Lectures in each year.) [Sessional Fee, £1 5s.]	T. at 4 or 7.
BOWLEY, A. L., M.A.	**z** 1	METHODS AND APPLICATIONS OF STATISTICS. [Sessional Fee, £1 5s.]	Th. at 6.

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Bedford College.

Tims, H. W. M., B.A., M.D., C.M.	**A**	ANTHROPOLOGY.	3rd Term, M. at 4.15.

[Term Fee, £1 1*s.*]

King's College.

Caldecott, Rev. A., D.D., M.A.	**Z** 1	HISTORICAL RELIGIONS.	Times to be arranged.
Loch, C. S., B.A.	**A**	ECONOMICS IN RELATION TO SOCIOLOGY.	W., 6–7.

[Term Fee, £1 1*s.*]

Social theory and obligation in relation to Economic Science. The self, the family ; the State ; Society. Social reciprocity and economic exchange. Points of contact in Economic Science and Sociology. Some of these points considered in special reference to the use, exchange and taxation of land at different stages of thought and development, *e.g.*, in parts of India, and in France and England after 1815.

Wesleyan College, Richmond.

Geden, Rev. A. S., M.A.	**Z** 1	COMPARATIVE RELIGION.	T., 12-1.

Elementary Courses in Subjects Cognate to Sociology.

[NOTE.—*Elementary Students are recommended to take one of the Courses in Logic, Psychology and Ethics of which details are given in the Calendar, Vol. II., pp.* 332–334.]

London School of Economics.

CANNAN, EDWIN, M.A., LL.D.	**Y** 3	THE PRINCIPLES OF ECONOMICS.	M. at 6.

[Sessional Fee, £1 5*s.*]

King's College.

Loch, C. S., B.A.	**B**	ECONOMICS AND SOCIAL ORGANISATION.	W., 2-3.

[Term Fee, £1 1*s.*]

Bedford College.

Hurlbatt, Ethel, Final Hon. Mod. Hist. (Oxford).	**A**	POLITICAL ECONOMY.	1st & 2nd Terms. M. & W., 11–12.

General Course including Industrial History.

[Term Fee, £2 12*s.* 6*d.*]

Birkbeck College.

Armitage-Smith, G., M.A.	**z** 1	ECONOMICS.	F., 7.30–9.30.

Descriptive, Analytical, and Historical Economics.

[Term Fee, 8*s.*]

University College.

FOXWELL, H. S., M.A. and Sanger, C. P., M.A., Late Fellow of Trinity Coll. (Camb.).	**Y** 2	THEORY OF VALUE AND THE DISTRIBUTION OF WEALTH.	1st Term. T. & Th., 6–7.
	Y 4	ECONOMIC HISTORY. From 1760–1860.	2nd Term. T. & Th., 4–5.

London School of Economics.

KNOWLES, Mrs. (LILIAN), Hist. Tripos, Law Tripos (Camb.).	**C**	ECONOMIC HISTORY OF GREAT BRITAIN SINCE 1485. First Year Students. [Sessional Fee, £1 5s.]	30 Lectures. W. at 6 & F. at 7.
		Second Year Students. [Sessional Fee, £2 5s.]	Th. at 4 or 7.
		Third Year Students. [Sessional Fee, £1 5s.]	F. at 6.
SARGENT, A. J., M.A.	**Z** 5	ECONOMIC HISTORY OF THE GREAT POWERS IN THE NINETEENTH CENTURY.	W. at 4 & 6, or W. at 6 & 7. 30 Lectures.
		[Sessional Fee, £2 5s.]	

University College.

Yule, G. Udney.	**Z** 6	STATISTICS.	W. at 5.30.
	A	RESEARCH WORK.	W. at 6.30.
	B	STATISTICS.	F. at 5.30.
		[Fees:—**Z** 6, £2 2s. 0d.; **A**, £1 1s. 0d.; **B**, Public.]	

London School of Economics.

MACKINDER, H. J., M.A.	**Z** 1 & **E** 4	HISTORICAL GEOGRAPHY.	1st Term. F. at 6.
		The Geographical Factor in History.	
		[Term Fee, 11s.]	

University College.

Lyde, Lionel W., M.A.	**Y**	COMMERCIAL GEOGRAPHY.	M., 4.30–5.30.

London School of Economics.

MACKINDER, H. J., M.A.	**Y** 1	COMMERCIAL GEOGRAPHY.	Th. at 6.
		[Sessional Fee, £1 5s.]	

Birkbeck College.

Chisholm, George G., M.A., B.Sc.	**y** 1	COMMERCIAL GEOGRAPHY.	W. at 6.30.
		[Term Fee, 8s.]	

University College.

Neill, J. W., Fellow of the University of Calcutta.	**A**	INDIAN LAW.	T. & Th. at 10.30.
	B	HINDU LAW AND USAGE. MAHOMMEDAN LAW.	T. & Th. at 2.
		[For A & B.—Sessional Fee, £10 10s. Term Fee, £4 4s.]	

Syllabus of the University Lectures in Sociology.

A. Lectures on Sociology.

By Dr Westermarck. (*See* p. 2.)

Sociology, the science of social phenomena. The characteristics of social phenomena as distinguished from biological and psychological phenomena. Sociology in its relations to Biology and Psychology. The principle of evolution applied to Sociology. The theory of natural selection stated and explained. Its bearing on social phenomena. The varieties of social phenomena. The essential characteristics of a society. Animal and Human societies. The origin of Human societies. The formation, scope, and coherence of a society largely dependent on biological and psychological facts, especially on (1) nutrition, and (2) the instinct of self-preservation and altruistic sentiments. Gregariousness and altruistic sentiments. Human societies based on the principles of local contiguity and blood-relationship. The family, clan, tribe, nation. The systems of maternal and paternal descent. The origin and function of the family. The relationships between parents and children. The *patria potestas*. The origin and function of marriage. Social regulations as to the limits within which marriages may be contracted (exogamous and endogamous rules). The modes of contracting marriages; marriage by capture, marriage by purchase, the marriage portion. The forms of marriage. The duration of marriage, and the customs and laws referring to divorce. The relation between husband and wife. The position of women. The institution of slavery. Its origin and distribution. The relations between master and slave. The disappearance of slavery and serfdom in Europe. The negro slavery. (The economic aspect of slavery will not be discussed in detail.) Social rules referring to the conduct of men towards members of their own society. Rights and their psychological origin. Customs and laws as rules of conduct. The origin and function of punishment. The chief theories of the object of punishment examined. Responsibility, moral and legal. Internal and external aspects of conduct in connection with the question of responsibility (accident, dolus, culpa, &c.). Agents under intellectual disability (children, lunatics, &c.). The punishment of animals and inanimate things (cf. the English deodand). The right of life. The influence of class distinction on the right of life. The system of blood-revenge. The system of compensation. Capital punishment. The duel as a social institution and the wager of battle. Suicide in the eyes of custom and law. Mutual aid. Charity as a social and a religious duty. The right of property. Acquisition by occupation, by use and work, by inheritance. The right of

honour and the rules of politeness. Sincerity and good faith. The origin and development of patriotism. Social relationships between members of different societies. The state of war. The evolution of rules relating to war. The social position of strangers. The custom of hospitality. Relations to the dead. Ancestor-worship and its social importance. Religion in its social aspects. Totemism. National religions and universal religions. Religious worship. Prayer. Sacrifice. Human sacrifice. Asceticism. Oaths. Ordeals. The right of sanctuary. Magic and its influence on social relationships.

B. Lectures on Ethnology.

By Dr Haddon. (*See* p. 2.)

The object of this Course of Lectures is to describe the main characteristic human societies that occur in the tropical and sub-tropical regions of the Old World, to trace their evolution and to indicate some of the probable factors that have influenced them. A Term will be devoted to each Continent. The Lectures will begin with the simplest societies in the Continent under consideration and work up to the highest, and the influence of one society upon another will be indicated. Each social group will, as far as possible, be treated from the aspects of environment (physical and biological), occupation, property, family, social structure, government, religion, and expansion. The Course will illustrate the scope and method of the Descriptive Sociology of the Nature-Folk and Low Culture-Folk as regarded from the point of view of the Ethnologist.

Africa.—*Nomad Hunters:* Bushmen, Pigmies; *Agriculturalists:* True Negroes; *Agriculturalists and Cattle-breeders:* Zulus, Abyssinians, &c.; *Pastors:* Peoples of Sahara and its borders; *Pastors as Masters of Agriculturalists:* Felahs and Hausas. The Sociological History of Africa.

Asia.—*Nomad Hunters:* Veddahs, Andamanese, Saki, and Semang, Punans; *Agriculturalists who also hunt:* Indonesians; *Agricultural Communities:* Gardeners, Rice and Grain Growers; *Cattle-keepers:* Todas; *Traders.* The Sociological History of India and Borneo.

Australasia. — The physical conditions of Australia: climate, scarcity of water, deserts, plains, tropical and temperate forests. Flora and fauna. The Australians, physical and psychical characteristics. The effect of the environment on the occupations of the aborigines. Totemism in Australia. The clan system and its modifications. The evolution of marriage. The transition from mother-right to father-right. Property.

The organisation of various tribes, class, and territorial organisation. Suggestions as to some of the causes that have retarded the social evolution of the Australians as a whole and of certain tribes in particular.

The geographical extent and chief physical and biological conditions of Melanesia. The Melanesians, physical and psychial characteristics. The occupations of the people. Vestiges of totem clans in Melanesia. Marriage and the family. Property consists of garden ground, house lots, and personal possessions. Stages in the evolution of mother-right into father-right. Secret societies in Melanesia, description of various societies, their possible origin, the good and the harm they do, their decline. Various forms of political organisation in different islands.

The geographical extent and chief physical and biological conditions of Polynesia. The characteristics of the Polynesians and their wanderings. The occupations of the people. Marriage and the family. Property. Traces of more primitive conditions. Dominance of religion, power of the priests. Government in some places more patriarchal and democratic than monarchial, in others more organised and centralised. The religious chief and the civil chief, or king, of Tonga.

Summary of the stages of social evolution reached in Australia and Oceania before contact with Europeans. The effects of this contact upon typical peoples of these areas. Arrested development. Extermination. Social and industrial education.

C. Lectures on Comparative Ethics.

By Mr L. T. Hobhouse. (*See* p. 2.)

The place of Ethics in Sociology. Relation of Ethical conceptions—

(*a*) to Social organisation.
(*b*) to religion.

The question of ethical progress and methods of determining it. Ethical conceptions of different peoples illustrated by (1) laws and customs concerned with marriage and the position of women; (2) the administration of justice; (3) intertribal and international relations, laws and customs of war and conquest; (4) slavery, serfdom and distinctions of class and caste; (5) property, communal and private.

UNIVERSITY OF LONDON.

REGULATIONS

RELATING TO DEGREES

IN

SCIENCE,

(As regards the Intermediate Examination, for 1899 only.)

All Communications must be addressed "To the Registrar of the University of London, Burlington Gardens, London, W."

March 1st, 1899.

Candidates shall be examined for a Pass *or* Honours in any three subjects[1] selected by themselves out of the following four subjects of examination, viz.:—(1) Mathematics, (2) Experimental Physics, (3) Chemistry; and for a Pass only in (4) Botany and Zoology. In (4) the written Examination shall be conducted by separate papers in Botany and Zoology, and failure in either of these parts of the subject shall entail failure in the whole subject.

Candidates may also be examined for Honours in Botany *or* in Zoology separately, *or* in both Botany and Zoology, in which latter case they shall not take the Pass Papers in (4).

Every Candidate must state upon his Form of Entry the subject or subjects (if any) in which he desires to be examined for Honours.

No Candidate may take both the Pass and the Honours Papers in the same subject, but every Candidate must take the Pass Papers in those of his selected subjects in which he does not offer himself for Honours.[2]

A Candidate who enters for, but fails to obtain, Honours in any of his selected subjects, may be recommended by the Examiners for a Pass in any of those subjects, if they are satisfied that he has shown such a competent knowledge thereof as is required by the Regulations for the Pass Examination.[3]

The Examiners will make no report upon the Examination for Honours of a Candidate who has failed in any part of the Pass Examination.[4]

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[1] To be specified on the Form of Entry.

[2] Except that a Candidate may take (*a*) either (4) Pass Botany and Zoology together, or (*b*) in lieu of (4) Honours Botany and Zoology together, *or* (*c*) Pass Botany and Zoology together, and Honours Botany *or* Honours Zoology.

[3] Candidates must bear in mind that the standard of attainment for the Honours Examination is much higher than that for the Pass Examination, and they should therefore exercise due caution in making their choice,—to which they will be required to adhere.

[4] Any Candidate desiring to take advantage of the Intermediate Examination in Science as a qualification for entry to the Degree Examinations both in Science and in Medicine, must apply for and return a Conjoint Entry-Form, stating his intention to proceed to a Degree in Medicine, and must present himself for examination in the following three subjects at the Intermediate Examination, viz.: Experimental Physics, Chemistry, Botany and Zoology. He shall pay one Fee of 5*l.* for both the Intermediate Science and the Preliminary Scientific Examinations thus taken together. The Candidate who shall pass in the above three subjects shall be credited with a Pass in both the Intermediate and the Preliminary Examinations. The Candidate who shall fail in any subject shall be treated as having failed at the Intermediate Examination in Science; but the Candidate who shall pass in either of the sections of the Examination corresponding to the two sections of the Preliminary Scientific shall be treated in all respects as a Candidate entering for the whole of the Preliminary Scientific and passing in either of those sections.

EXAMINATION FOR A PASS.

PURE MATHEMATICS (Two Papers).

ARITHMETIC.

The ordinary Rules of Arithmetic.
Vulgar and Decimal Fractions.
The Rule of Three, and its Applications.
Simple and Compound Interest.
Present Value, Discount, and Annuities.
Extraction of the Square Root.

ALGEBRA.

The ordinary Rules of Algebra.
Reduction and Manipulation of Algebraical Fractions.
Ratio, Proportion, and Variation.
Permutations and Combinations.
Arithmetical and Geometrical Progressions.
Simple and Quadratic Equations.
Determination of Common Factors.
The Theory of Indices.
The nature and use of Logarithms.

GEOMETRY.

The Relations and Properties of Similar Rectilinear Figures.
The Elementary Properties of the Plane, including those of the Angles made by Planes with Right Lines and with each other.
The Elementary Properties of the Sphere, including those of the Great and Small Circles on the Surfaces of Spheres.
The Mensuration of the simpler Plane and Solid Figures, including that of the Circle, the Sphere, the Cylinder, and the Cone.
Elements of Coordinate Geometry, in Rectangular and Polar Coordinates, as far as the Equations and Properties of the Right Line and Circle.

TRIGONOMETRY.

The different Measurements of Angles, and the ordinary relations of their Trigonometrical Ratios.
The Elementary Formulæ connecting the Trigonometrical Ratios of two or more Angles.
The Solution of the several cases of Plane Triangles, including the determination of their Areas.
The determination of the Heights and Distances of Inaccessible Objects.

MIXED MATHEMATICS (One Paper).

[*The questions put under this head will be such as may be answered by simple mathematical methods.*]

The Composition, Resolution, and Equilibrium of Concurrent Forces.
The Composition, Resolution, and Equilibrium of Parallel Forces.
The Centres of Gravity of Rigid Bodies.

The Mechanical Powers.
The Measures of Velocity, Acceleration, and Force.
The Accelerations of Masses under the action of Forces.
The Laws of Rectilinear Motion.
The Rectilinear Motion of Particles under the action of Gravity.

EXPERIMENTAL PHYSICS (Two Papers).

[*The following Syllabus is intended to indicate the general scope and character of the Examination without being exhaustive of all parts of the subject. Candidates are expected to show a general acquaintance with the apparatus by which the elementary principles of Physics are illustrated and applied.*]

General Properties of Solids, Liquids, and Gases.

Relation between volume and pressure in Gases.
Diffusion in Liquids and Gases.

Heat.

Definition of Temperature. Construction and use of Instruments for the measurement of Temperature.
Expansion of Solids, Liquids, and Gases with rise of Temperature. Convexion in Fluids.
Quantity of Heat. Specific Heat.
Change of State. Latent Heat. Vapour Pressure. Boiling-point.
Dew-point. Formation of Cloud, Fog, and Dew.
Conduction. Definition of Thermal Conductivity.
Radiation: its Emission, Propagation, Reflexion, Refraction, and Absorption: its relation to Light.

Sound.

The production of Sound by vibrating sources, and its transmission through material media in the longitudinal wave form.
The features of the waves corresponding to Loudness and Pitch.
Experimental determination of the Velocity of Sound in Air. Echoes. Effect of change of Temperature on the Velocity.
Determination of Frequency by simple methods.
Experimental investigation of the Fundamental Vibrations of Strings by means of the Sonometer.
Experimental investigation of the Vibrations of Air in Pipes by Resonance to Tuning Forks. Organ Pipes. Position of Nodes and Antinodes.

Optics.

Laws of Propagation of Light. Measurement of Velocity. Laws of Reflexion and Refraction. Photometry.
Reflexion at Plane and Spherical Surfaces, and the formation of Images.

Refraction at Plane Surfaces and by Prisms. Minimum deviation. Chromatic dispersion.

The formation of Images by single Lenses. Long and Short Sight and their correction by Lenses.

The combination of two Lenses to form a simple Telescope or Microscope.

MAGNETISM AND ELECTRICITY.

Properties of Magnets. Simple phenomena of Magnetism and of Magnetic Induction.

The Magnetic Field : Lines of Force.

The Earth as a Magnet.

The simpler phenomena of Electrified Bodies. Conduction and Insulation. Electrification by Friction and by Induction (Influence).

Quantity of Electrification. The two kinds of Electrification produced or destroyed in equal amounts.

Distribution of Electrification on Conductors.

Electric Field : strength of Field.

The Inverse-Square Law of Electric Force.

Potential. Capacity. Energy of Charge.

Electric Discharge.

Electric Current. The various Cells. Accumulators.

Magnetic Field of Current ; Magnetic measurement of Current Galvanometers.

Electromotive Force. Difference of Potential. Resistance.

Ohm's Law : Volt ; Ohm ; Ampere.

Heating and chemical effects of Currents. Thermo-electricity.

Identification of Current with Electric Discharge.

Action on Current Circuits in a Magnetic Field.

Electromagnetic Induction : Faraday's Law ; Lenz's Law Induction Coil.

ENERGY.

The Transformations of Energy. All Transformations according to fixed rates of exchange. The Mechanical Equivalent of Heat and modes of determination. The Conservation of Energy.

Practical Examination.

[*The following Scheme is not exhaustive, and is intended merely to show the general nature of the exercises at the Practical Examination. The Examiners are not precluded from setting other exercises and practical problems illustrative of the principles set forth in the Syllabus.*]

Length measurements by Millimetre Rule.

Eye-estimation of Tenths of a Division.

Use of Vernier, Linear and Angular.

Determination of Areas and Volumes by measurement of Linear Dimensions.

Use of the Balance, weighing to one centigramme.

Determination of Volumes by weighing in Water.
Specific Gravities of Solids, Powders, and Liquids.
Use of the Hydrometer.
Verification of Boyle's Law.
Reading the Barometric Height.
Determination of the Centre of Gravity of a Plate.
Use of Atwood's Machine.
Time of swing of a simple Pendulum, and verification of the formula $t \propto \sqrt{l}$.
Determination of Velocity of Sound in a Tube by Resonance with a Fork.
Use of the Sonometer.
Use of Thermometers, and determination of fixed points.
Simple methods of determining Specific Heat and Latent Heat of Fusion.
Determination of Dew-point.
Use of simple Photometers.
Focal lengths of concave Mirrors.
Focal lengths of convex Lenses.
Arrangement of two Lenses to make simple forms of Telescope, Microscope, and Magic Lantern.
Arrangement of a Slit, Lens, and Prism to get a pure Spectrum.
Tracing the path of a Ray of Light through a block of Glass and deduction of Refractive Index.
Tracing the lines of force in the neighbourhood of a Magnet.
Mode of making a simple Electro-magnet.
Gold-leaf Electroscope and its use to find the sign of a given charge.
Mode of setting-up common Voltaic Cells. Modes of joining-up Cells.
Determination of the signs of the terminals of a Cell.
Use of simple Galvanometers.
Measurement of Resistance by Substitution.
Simple experiments on Induced Currents.

CHEMISTRY (Two Papers).

Laws and conditions of Chemical Action.
Equivalents. Atomic Weights. Molecular Weights. Avogadro's hypothesis and relation of Gas Density to Molecular Weight. Other methods of determining Molecular Weight.
Relation of specific Heat of solid Elements to Atomic Weight.
Gaseous and Liquid Diffusion.
Electrolysis.
Theories of Solution.
Exothermic and Endothermic Reactions.
Dissociation.
Spectrum Analysis.

A general knowledge of the properties of the Elements with a view to their classification. The Periodic System.

The ordinary methods of preparation, and the chief properties of the following Elements and their principal compounds :—Hydrogen, Oxygen, the Halogens, Sulphur, Nitrogen, Phosphorus, Arsenic, Boron, Carbon, and Silicon.

The preparation, properties, and relations to one another of the following compounds of Carbon :—Marsh Gas, Ethylene, Acetylene ; Methyl and Ethyl Alcohols ; Formic, Acetic, and Oxalic Acids ; Cyanogen and Cyanides. Nature of Substitution. Synthetical production of Carbon Compounds from their Elements ; Classification of Carbon Compounds in homologous series. Constitutional formulæ.

Chief sources, preparation, and properties of the common Metals, and the preparation and properties of their more important Oxides, Hydroxides, Sulphides, and Salts.

N.B.—Candidates will be expected to give evidence in their answers that they have witnessed simple experiments illustrative of these subjects, and that they are familiar with the appearance of the commoner elements and their important compounds.

Practical Examination.

[*Candidates will be expected, as far as possible, to understand the nature of the chemical changes involved in the tests they employ for the identification of chemical substances, and to represent these changes by equations.*]

Identification of the common Elements and their important compounds either in the solid or liquid state, or in solution.

Simple volumetric analysis with standard solutions of Acids, Alkalis, and Potassium Permanganate.

ZOOLOGY AND BOTANY.

Zoology (One Paper).

The fundamental facts and laws of Biology, as exhibited in the following types :—Amœba, Paramœcium, Hydra, Anodonta, Lumbricus, Astacus, Amphioxus, Scyllium, Rana, Lepus.

The Candidate will be expected to show a practical knowledge of the general structure of each of the Animal types above specified, and an elementary knowledge of (1) the chief Biological Laws which the structural phenomena illustrate ; (2) the phenomena of Sexual and Asexual Reproduction, of Parthenogenesis, Heredity and Variation ; (3) the structure and properties of the Cell, and the general characters of the Tissues, including Epithelia, Blood, Lymph, Nervous, Muscular, Connective and Skeletal Tissues ; (4) the Segmentation of the Ovum the Frog, Fowl, and Rabbit ; the metamorphosis of the Frog and the development of the Fowl as far as the fourth day of incubation, treated in an elementary way.

Practical Examination.

The Candidate must be prepared to examine microscopically, to dissect, and to describe specimens or parts of the Animals[1] comprised in the foregoing Syllabus, with the exception that for the skull of Lepus will be substituted that of Canis.

Botany (One Paper).

The elements of the Morphology and Physiology of the Flowering Plant (both Angiospermous and Gymnospermous). The leading modifications in the structural plan of the Flower. The leading types of Fruits. The modes of dispersal of Seeds.

The structure and properties of the Cell; the various modes of Cell-formation. The anatomy of Foliar Organs, Stems, and Roots; the histology and development of the Tissues of which these are composed; the functions of these Organs and Tissues.

The minute structure and the development of the Reproductive Organs of Angiosperms and Gymnosperms. The phenomena of Pollination and Fertilization; the development of the Embryo; the formation, structure, and germination of the Seed.

The life-history of the Flowering Plant.

The life-history of *Selaginella*.

The structure and life-history of a Fern.

The structure and life-history of *Fucus* and *Spirogyra*.

The structure, physiology, and life-history of *Agaricus*, *Pythium*, *Saccharomyces* and Bacilli.

Practical Examination.

Each Candidate must be prepared to examine microscopically, to dissect and to describe specimens or parts of the Plants[1] comprised in the foregoing Syllabus.

Candidates shall not be approved by the Examiners unless they have shown a competent knowledge in all of the three subjects selected by them out of the following four subjects of the Examination, viz.:

1. Pure and Mixed Mathematics;
2. Experimental Physics;
3. Chemistry;
4. Botany and Zoology.

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[1] The List of Animals and of Plants may be changed from time to time, but two years' notice of any change will always be given.

EXAMINATION FOR HONOURS.

Any Candidate who presents himself at the INTERMEDIATE EXAMINATION IN SCIENCE for examination *in three subjects* (See Note 1 on page 3), may be examined for Honours at the same Examination in (1) Mathematics, (2) Experimental Physics, (3) Chemistry, (4) Botany, and (5) Zoology; unless he has previously obtained the Exhibition in Mathematics at the INTERMEDIATE EXAMINATION IN ARTS, in which case he shall not be admissible to the Examination for Honours in that subject; or unless he has previously obtained an Exhibition at the PRELIMINARY SCIENTIFIC EXAMINATION in any of the subjects (or parts thereof) which are common to it with the INTERMEDIATE EXAMINATION IN SCIENCE, in which case he shall not be admissible to the Examination for Honours in that subject or part.

MATHEMATICS

Algebra.
Theory of Equations.
Plane Trigonometry.
Spherical Trigonometry.
Pure and Coordinate Geometry of two Dimensions, up to and including the properties of the Conic Sections.
Differential Calculus.
Integral Calculus.
Statics of Material Particles, of Rigid Bodies, of Flexible Cords, and of Elastic Beams.
Kinetics of Material Particles.
Hydrostatics of Gravitating Fluids.

For this Examination four Papers shall be set on the days appointed in the Order of Examinations.

EXPERIMENTAL PHYSICS.

The subjects of the Pass Examination treated more fully.

Practical Examination.

[*The following Scheme is not exhaustive, and is intended merely to show the general nature of the exercises at the Practical Examination. The Examiners are not precluded from setting other exercises (including such as may be given at the Pass Examination) and practical problems illustrative of the principles set forth in the Syllabus.*]

Use of Micrometer Wire Gauge.
Use of the Spherometer.
Use of the Accurate Balance, with corrections for displacement of Air.

Determination of Internal Volumes.
Use of the Volumenometer.
Calibration of Tubes.
Reading and correcting the Barometer.
Determination of Young's modulus for a Wire.
Measurement of Surface Tension by means of Capillary Tubes.
Determination of the Intensity of Gravity by simple Pendulum and simple Conical Pendulum.
Determination of Frequency by a Siren.
Verification of the Laws of Transverse Vibrations of Strings.
Determination of Velocity of Sound in Rods by Kundt's Tube.
Determination of Wave-length in Air in Tubes by Resonance.
Determination of Co-efficient of Liquid Expansion.
Expansion of Air at constant pressure.
Pressure-increase of Air at constant volume.
Determination of Specific Heat
Determination of Latent Heat of Water.
Determination of Latent Heat of Steam.
Determination of Vapour Pressure.
Determination of Vapour Density.
Determination of Dew-point.
Determination of Melting-points.
Determination of comparative illuminating power by Photometers.
Measurement of focal lengths of Mirrors and Lenses and of combinations of Lenses.
Estimation of magnifying power of telescopic arrangement of Lenses.
Determination of Refractive Index of Solids and Liquids.
Comparison of Magnetic Moments.
Comparison of strength of Magnetic Field at two points by vibration.
Determination of the Axis of a Magnetised Body.
Absolute measure of current by Galvanometer of known radius in a given field.
Verification of an Ampere-meter by Electrolysis.
Measurement of Heat developed by Current, and Verification of Joule's Law.
Measurement of Resistance of Wires.
Comparison of Electromotive Forces.

For this Examination two Papers shall be set and a Practical Examination held on the days appointed in the Order of Examinations.

CHEMISTRY.

Chemistry treated more fully than at the Pass Examination.

Practical Examination.

The subjects of the Pass Examination treated more fully. Candidates may be required to make simple Chemical preparations according to instructions given at the time of Examination.

For this Examination two Papers shall be set and a Practical Examination held on the days appointed in the Order of Examinations.

ZOOLOGY.

The Typical Structure and mode of Development, with the chief deviations from each, of every class in the Animal Kingdom.

Candidates may also be tested practically by description of the whole or parts of skeletons and skulls and by dissection of animals selected from the following lists, as well as by further examination in the subjects prescribed for the Practical part of the Pass Examination :—

Practical Examination.

Skeletons and Skulls for Description.

Galeus. Salmo. Chimæra. Protopterus. Rana. Monitor. Chelone. Columba. Echidna. Lepus. Canis (skull only). Sus (skull only). Felis tigris (skull only). Ovis (skull only). Platyrrhine Monkey (skull only). Catarrhine Monkey (skull only). Homo.

Animals for Dissection.

Hydra. Tubularia. Aurelia. Alcyonium. Lumbricus. Nereis. Sipunculus. Hirudo. Anodonta. Mya. Helix. Haliotis. Sepia. Lepas. Asellus. Astacus. Carcinus. Periplaneta. Apis. Pieris. Scolopendra (appendages only). Ascaris. Ciona. Amphioxus. Raia. Rana. Columba. Lepus.

For this Examination two Papers shall be set and a Practical Examination held on the days appointed in the Order of Examinations.

BOTANY.

Anatomy and Histology.

The structure and properties of the cell, and of the various kinds of tissues : the processes of cell-formation : the morphology and the development of the tissues : the structure of various members and organs of the body.

Morphology.

The plant-body and its members : their development and their various modifications. The life-history of plants.

Special Morphology and Taxonomy.

The morphological and physiological characteristics of the groups enumerated below, and the affinities of the larger groups.

SPERMOPHYTA (Phanerogamia).

ANGIOSPERMÆ.

Dicotyledones.

Ranunculaceæ, Papaveraceæ, Cruciferæ, Caryophyllaceæ, Geraniaceæ, Leguminosæ, Rosaceæ, Umbelliferæ, Caprifoliaceæ, Rubiaceæ, Compositæ, Primulaceæ, Ericaceæ, Solanaceæ, Scrophulariaceæ, Labiatæ, Boraginaceæ, Polygonaceæ, Urticaceæ, Euphorbiaceæ, Amentiferæ.

Monocotyledones.

Orchidaceæ, Liliaceæ, Amaryllidaceæ, Irideæ, Gramineæ.

GYMNOSPERMÆ.

Coniferæ.

PTERIDOPHYTA.

Lycopodinæ.

Filicinæ, Eusporangiatæ and Leptosporangiatæ (including the Rhizocarpeæ).

Equisetinæ.

BRYOPHYTA.

Musci. Hepaticæ.

THALLOPHYTA.

ALGÆ.

Rhodophyceæ. Phæophyceæ. Chlorophyceæ.

FUNGI.

Basidiomycetes. Uredineæ. Ascomycetes. Phycomycetes.

Lichenes.

PHYSIOLOGY.

The processes and mechanisms of metabolism, growth, and reproduction: the organs and their functions: the influence of external conditions upon metabolism and growth.

Practical Examination.

Each Candidate must be prepared (1) to dissect and examine, microscopically or otherwise, any plants or parts of plants; (2) to refer to their appropriate systematic position plants or parts of plants comprised in the foregoing Syllabus; (3) to describe specimens in technical language.

For this Examination two Papers shall be set, and a Practical Examination held on the days appointed in the Order of Examinations.

The Examinations, Pass and Honours, will occupy three weeks.

At Two o'clock on Wednesday in the second week after that in which the Examination closes, the Registrar shall publish (*a*) a List of the Candidates entered for the Pass Examination only who have passed, arranged in two Divisions; (*b*) a List of the Candidates who have passed an Examination for Honours in one or more subjects, arranged by the Examiners in the several Departments under their

respective heads in three Classes, and in Alphabetical order in each class ;—and (*c*) a List of the Candidates who have failed to obtain Honours, but are recommended for a Pass.

As soon as the Reports of the Examiners shall have been approved by the Senate, a Pass Certificate signed by the Registrar shall be delivered to each Candidate whose name is on the Pass List ; and an Honours Certificate shall be delivered to each Candidate whose name is on the Honours List in respect of each subject in which he shall have obtained Honours.[1]

If in the opinion of the Examiners any Candidate of not more than Twenty-two years of age at the commencement of the Examination, who shall have passed either the INTERMEDIATE EXAMINATION IN SCIENCE or the INTERMEDIATE EXAMINATION IN ARTS shall possess sufficient merit, the Candidate who shall distinguish himself the most of all the Candidates who shall have passed either of the said Examinations, and who were not more than Twenty-two years of age at the commencement of the Examination, in *Mathematics*, shall receive an Exhibition of Forty Pounds per annum for the next Two Years, payable in quarterly instalments (it being intended that one Exhibition only shall be given among all the Candidates, although some of such Candidates may have passed the INTERMEDIATE EXAMINATION IN SCIENCE and others the INTERMEDIATE EXAMINATION IN ARTS) ; provided that on receiving each instalment he shall declare his intention of presenting himself at the DEGREE EXAMINATION within Two Academical Years[2] from the time of his passing the INTERMEDIATE EXAMINATION, whether in Arts or in Science, as the case may be.

If in the opinion of the Examiners any Candidate of not more than Twenty-two years of age at the commencement of the Examination, who shall have passed either the INTERMEDIATE EXAMINATION IN SCIENCE or the PRELIMINARY SCIENTIFIC EXAMINATION, shall possess sufficient merit, the Candidate who shall distinguish himself the most of all the Candidates who shall have passed either of the said Examinations, and who were not more than Twenty-two years of age at the commencement of the Examination, in *Experimental Physics*,[3] the Candidate who shall distinguish

[1] The Reports cannot be laid before the Senate until towards the end of October ; and the Certificates will, in the absence of any request to the contrary, be posted to the addresses given by the Candidates on their Forms of Entry.

[2] See the Note on page 36.

[3] The Exhibition in Experimental Physics, having been provided by the liberal endowment of the late Dr. Arnott, will be entitled "The Neil Arnott Exhibition."

himself the most of all the Candidates who shall have passed either of the said Examinations, and who were not more than Twenty-two years of age at the commencement of the Examination, in *Chemistry*, the Candidate who shall distinguish himself the most of all the Candidates who shall have passed either of the said Examinations, and who were not more than Twenty-two years of age at the commencement of the Examination, in *Botany*, and the Candidate who shall distinguish himself the most of all the Candidates who shall have passed either of the said Examinations, and who were not more than Twenty-two years of age at the commencement of the Examination, in *Zoology*, shall each receive an Exhibition of Forty Pounds per annum for the next Two Years, payable in quarterly instalments (it being intended that one Exhibition only shall be given in each case among all the Candidates, although some of such Candidates may have passed the INTERMEDIATE EXAMINATION IN SCIENCE and others the PRELIMINARY SCIENTIFIC EXAMINATION); provided that on receiving each instalment he shall declare his intention of presenting himself either at the B.SC. EXAMINATION within Two Academical Years[1] from the time of his passing the INTERMEDIATE EXAMINATION IN SCIENCE, or at the INTERMEDIATE EXAMINATION IN MEDICINE within Three Academical Years from the time of his passing the PRELIMINARY SCIENTIFIC EXAMINATION, as the case may be.

Under the same circumstances, the First and Second Candidates for Honours in Experimental Physics shall each receive a Neil Arnott Bronze Medal.[2]

ORDER OF THE EXAMINATIONS AT THE INTERMEDIATE EXAMINATION IN SCIENCE.[3]

First Week.

	Pass.	Honours.
MONDAY.		
Morning, 10 *to* 1. *Afternoon*, 2 *to* 5.	Chemistry.....	Chemistry.

[1] See the Note on page 36.

[2] Candidates who in any year from 1880 to 1896 inclusive have passed the Intermediate Examination in Science, and Candidates who in or after 1897 shall have passed in the following subjects at that Examination, viz., Experimental Physics, Chemistry, Botany and Zoology (but see Note 4, p. 4), will be allowed to proceed to Degrees in Medicine without passing the Preliminary Scientific Examination; and Exhibitioners who, in or previously to July 1896, have passed in the Mathematics of the Intermediate Examination in Science as well as the Preliminary Scientific Examination, or after that date shall pass the Intermediate in the above subjects, will fulfil their declaration by proceeding, within the specified periods, either in Science or in Medicine.

[3] Changes in the details of this Order may become necessary, but in all cases will be notified in the Time-table sent to Candidates with the Form of Entry.

	Pass.	Honours.
TUESDAY.		
Morning, 10 *to* 1. *Afternoon*, 2 *to* 5.	Experimental Physics.	Experimental Physics.
WEDNESDAY.		
Morning, 10 *to* 1.	Botany.	
Afternoon, 2 *to* 5.	Zoology.	
THURSDAY.		
Morning, 10 *to* 1.	Arithmetic and Algebra.	Mathematics.
Afternoon, 2 *to* 5.	Geometry and Trigonometry.	
FRIDAY, *Morning*, 10 *to* 1.	Mixed Mathematics.	

First and Second Week.

FRIDAY, SATURDAY, and MONDAY.
10 *to* 1 ; 3 *to* 6. Practical Biology.

TUESDAY and WEDNESDAY.
Commencing at 10 A.M. Practical Chemistry. Practical Physics.

THURSDAY.
Morning, 10 *to* 1. *Afternoon*, 2 *to* 5. ..... Mathematics.

FRIDAY (*with* THURSDAY, *if requisite*).
Morning, 10 *to* 1. *Afternoon*, 2 *to* 5. ..... Practical Chemistry.

SATURDAY.
Morning, 10 *to* 1. *Afternoon*, 2 *to* 5. ..... Botany.

Third Week.

MONDAY.
Morning, 10 *to* 1. *Afternoon*, 2 *to* 5. ..... Practical Botany.

TUESDAY, *at* 10 ..... Practical Physics.

WEDNESDAY.
Morning, 10 *to* 1. *Afternoon*, 2 *to* 5. ..... Zoology.

THURSDAY.
Morning, 10 *to* 1. *Afternoon*, 2 *to* 5. ..... Practical Zoology.

B.Sc. EXAMINATION. (For 1899 and 1900.)

The B.Sc. EXAMINATION shall take place once in each year, and shall commence on the Fourth Monday in October.

Every Candidate for this Examination shall be required to have passed the INTERMEDIATE EXAMINATION IN SCIENCE at least One Academical Year[1] previously.

[1] See the Note on page 36.

Every Candidate who enters for a Pass in all his subjects, or for Honours in Mathematics only, must, on or before September 18th, apply to the Registrar for a Form of Entry, which must be returned on or before September 25th, accompanied by a satisfactory Certificate of Good Conduct, and by the proper Fee.[1] Every Candidate for Honours in any subject other than Mathematics must return his Form of Entry on or before August 1st.

Every Candidate entering for the first time must pay a Fee of Five Pounds to the Registrar. If a Candidate withdraws his name, or fails to present himself at the Examination, or fails to pass it, the Fee shall not be returned to him; but he shall be allowed to enter for any subsequent B.Sc. EXAMINATION upon payment, at every such entry, of an additional Fee of Two Pounds Ten Shillings, provided that he comply with the Regulations in the preceding paragraph.[2]

Candidates shall be examined in any three[3] which they may select out of the prescribed eight subjects of the Examination.[4] They shall be examined for a Pass or for Honours in any one or more of the subjects chosen.

No Candidate taking Pass Papers only shall pass who shall not obtain such proportion of the aggregate marks in the three subjects selected by him, and also such proportion (but lower) of the total marks in each of such subjects taken separately, as shall satisfy the Examiners.

Every Candidate must state upon his Form of Entry the subject or subjects (if any) in which he desires to be examined for Honours.

No Candidate may take both the Pass and the Honours Papers in the same subject, but every Candidate must take the Pass Papers in those selected subjects in which he does not offer himself for Honours.

A Candidate who enters for, but fails to obtain, Honours in any of his selected subjects may be recommended by the Examiners for a Pass in any of those subjects, if they are satisfied that he has shown such a competent knowledge thereof as is required by the Regulations for the Pass Examination.[5]

The Examiners will make no report upon the Examination for Honours of a Candidate who has failed in any part of the Pass Examination.

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[1] These times and conditions must be *strictly* observed.

[2] A Certificate of Good Conduct need not again be produced.

[3] See also p. 29 as to Honours Candidates, on certain conditions, being examined in *two* subjects only.

[4] These must be specified in the Form of Entry.

[5] See Note 3 on page 4.

I. PURE MATHEMATICS (Three Papers).

ALGEBRA.

Theory of Indices, Radicals, and Surds.
Binomial Theorem.
Theory of Logarithms and Exponentials, with the Exponentia and Logarithmic Series.
The graphical representation of simple algebraic functions.
Applications of the preceding subjects.

TRIGONOMETRY.

Ordinary Formulæ connecting the Sides and Angles of Spherical Triangles.
Solution of the several cases of Spherical Triangles including the determination of their Areas.

GEOMETRY.

The Properties of the Conic Sections, by Pure and Coordinate Geometry.

DIFFERENTIAL CALCULUS.

Differentiation of Functions of a Single Variable.
Taylor's and Maclaurin's Theorems, with their Applications.
Theory of Maxima and Minima for Functions of a Single Variable
Applications to Tangents and Normals of Plane Curves.

INTEGRAL CALCULUS.

Integration of Functions of a Single Variable in finite terms.
Reduction of Integrals of Functions of a Single Variable. Applications to Rectification and Quadrature of Plane Curves.

II. MIXED MATHEMATICS (Three Papers).

DYNAMICS.

Composition, Resolution, and Equilibrium of Moments.
Equilibrium of Rigid Bodies, of Jointed Bars, and of Flexible Cords.
Equilibrium of Incompressible Fluids, and of Solids floating in Gravitating Fluids.
Principle of Virtual Velocities, with its Applications.
Elementary Laws of Friction, and of Resistance to Rectilinear Motion in Fluid Media.
Composition and Resolution of Velocities and Accelerations.
Uniform Motion in a Circle, Harmonic Vibration, and Centrifugal Force.
Curvilinear Motion of a Particle, free or constrained, under the action of Gravity, of Central Force, or of any Forces.
Vibrations of a simple Pendulum under the action of Gravity.
Impact of uniform Spheres against fixed Planes, and against each other.
Moments of Inertia of Rigid Bodies with respect to Fixed Axes.
Uniform Rotation of Rigid Bodies about Fixed Axes.
Rotation of Rigid Bodies about Fixed Horizontal Axes under the action of Gravity.
Theory of Mechanical Work, and of Energy, Actual and Potential.

OPTICS AND ASTRONOMY.

Geometrical Optics so far as required for the elementary theory of telescopes, excluding Aberration and Achromatism.
Points, Lines, Planes, and Circles of the Celestial Sphere.
Phenomena depending on the Earth's Rotation round her Axis.
Phenomena depending on the Earth's Revolution round the Sun.
Phenomena depending on Change of Place on the Surface of the Earth.
Determination of Place and Time on the Surface of the Earth.
Parallax—diurnal and annual: causes, effects, and determination of.
Refraction and Aberration: causes, effects, and determination of.
Precession and Nutation: causes, effects, and determination of.
Kepler's Laws of Planetary Motion, and their consequences.
Determination of the Magnitude and Figure of the Earth, of the Extent and Form of the Lunar Orbit, and of the Dimensions and Configuration of the Solar System.
Determination of the particulars of Eclipses, Solar and Lunar, and of Transits of the Interior Planets across the disk of the Sun.

III. EXPERIMENTAL PHYSICS (Two Papers).

The subjects prescribed for the INTERMEDIATE PASS EXAMINATION, with the addition of the following; the whole being treated Mathematically, as well as Experimentally, so far as the Mathematics of the INTERMEDIATE PASS EXAMINATION are applicable:—

GENERAL PHYSICS.

Motion in a Circle. Simple Harmonic Motion.
Simple, Conical, and Torsional Pendulums.
Kinetic Energy and Work. Moment of Inertia. Kinetic Energy of a rotating body.
Torsional Vibration of a body.
Compound Pendulum, and its use to measure the intensity of Gravity.
Young's Modulus Simple Elasticity treated experimentally.
Friction.
Viscosity of Liquids and Gases.
Surface Tension. Laplace's Law.

SOUND.

Representation of Longitudinal Waves by displacement curves.
Distribution of Velocity and Pressure in the waves.
Experiments on the Velocity of Sound in Air.
Calculation of Velocity from Elasticity and Density.
Quality of Sound. Harmonic Tones of Strings and Air Columns.
Longitudinal Vibrations of Rods.
Determination of Frequencies. Ratios of the frequencies of the more important intervals.
Effect on Pitch due to Motion of the Source, of the Receiver, and of the Medium.

Resonance.

Reflexion of Waves. Stationary Waves.

Simple cases of Interference of Sound. Beats.

HEAT.

The methods which have been used to determine the most important Thermal Constants, and the chief results which have been obtained.

The Theory of Exchanges.

The Laws of Thermodynamics. Carnot's Cycle. Efficiency of Reversible Engines. Thermodynamic Scale of Temperature.

Quantity of Heat required for Isothermal Expansion. Change of Temperature with Adiabatic Change of Volume. Ratios of Elasticities and of Specific Heats.

Effect of Pressure on the Melting-points and Boiling-points.

Liquefaction of Gases : the Critical State.

OPTICS.

Wave nature of Light.

Simple cases of Interference of Light. Fringes.

Optical description of the Eye.

Optical Instruments : Sextants, Lenses, Microscopes, Telescopes, Spectrometers.

Achromatic combinations.

The Wave Theory. Explanation of Reflexion and Refraction.

Diffraction by Slits and Gratings.

Polarization. Properties of Polarised Light. Polarization by Reflexion and Refraction.

Double Refraction. Calc-spar ; Nicol's Prism ; Tourmaline.

Coloration of thin Crystalline Plates in Parallel Pencils between Polarizer and Analyser.

Rotation of the Plane of Polarization. Polarimeters.

MAGNETISM AND ELECTRICITY.

Magnetic Moments, and methods of comparing them.

The methods of determining Magnetic Declination, Dip, and Horizontal Force.

Alterations in the values of the Magnetic Elements with Time and Place.

Magnetic properties of various substances. Magnetic Permeability and its measurement.

Effect of Temperature on Magnetisation and on Permeability.

Theory of Electrical Condensers of simple Geometrical forms.

Specific Inductive Capacity and its measurement.

Electrometers. Theory of the Attracted Disc and Quadrant Electrometer.

The definition of the principal Electro-magnetic Units; the methods of measurement and of verifying the laws expressing the relations between them.

The definition of the principal Electrostatic Units and their relations to the units of the Electro-magnetic system.

Effect of Temperature on Electric Resistance.

Electrolysis.

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Practical Examination. (One day.)

[*The following Scheme is not exhaustive, and is intended merely to show the general nature of the exercises at the Practical Examination. The Examiners are not precluded from setting other exercises (including such as may be given at the Intermediate Pass and Honours) and practical problems illustrative of the principles set forth in the Syllabus.*]

Use of Wire Gauge, Linear Callipers, Spherometer and Cathetometer, Reading Microscope, and Planimeter.

Use of the Accurate Balance, with the various corrections.

Determination of Internal Volumes.

Determination of Specific Gravities.

Determination of Young's Modulus for a given Wire by stretching and for a Rod by bending.

Determination of the Modulus of Torsion.

Measurement of Surface Tension by means of Capillary Tubes.

Determination of the Intensity of Gravity by simple and conical Pendulum.

Determination of frequency of Vibration of the Siren.

Verification of the Laws of Transverse Vibrations in Strings.

Determination of Velocity of Sound by Kundt's Tube.

Coefficient of Liquid Expansion.

Expansion of Air at Constant Pressure.

Increase of pressure of Air at Constant Volume.

Specific Heat by Calorimeters.

Newton's Law of Cooling.

Determination of Latent Heat of Water and Steam.

Measurement of Vapour Pressure.

Estimation of Dew-point.

Radiation from a Body at various Temperatures above its surroundings.

Comparison of Conduction of Heat along Rods of Metals and through Slabs of Bad Conductors.

Measurement of Focal Lengths of Mirrors and Lenses and of their combinations.

Determination of Magnifying Power of combinations of Lenses.

Use of Spectrometer.

Determination of Refractive Index of Solids and Liquids.

Measurement of Wave-lengths by Gratings.

Polarization of Light by Reflexion and Measurement of Polarizing Angle.

Comparison of Magnetic Moments.

Comparison of Horizontal Forces.

Measurement of Dip.

Absolute measurement of current by Galvanometer of known radius in a given field.

Verification of a Galvanometer by Electrolysis.

Verification of Joule's Law of the Heating Effect of Current

Comparison of Resistances.

Comparison of Electromotive Forces by the Potentiometer.

IV. CHEMISTRY. (Two Papers.)

[*Candidates will be expected to show a general knowledge of all the following sub-divisions of the subject, as well as of the chief experimental processes employed in the science.*]

1. HISTORY OF CHEMISTRY.—The progress of Scientific Chemistry from the time of Boyle to the present day, including—the Doctrine of Phlogiston, and the researches on which the Anti-phlogistic system was founded; the Atomic Theory; the Theory of Types; the establishment of the modern system of Atomic Weights; and the origin of the Doctrine of Valency and of modern constitutional formulæ.

2. PHYSICAL CHEMISTRY.—The Kinetic Theory of Gases; the properties of Solutions; Electrolysis; the relations of the physical properties of substances to their chemical nature, with special reference to the rotation of the Plane of Polarization, to Refraction and Dispersion, Crystalline Form, Atomic and Molecular Volume, Emission and Absorption Spectra.

   The law of Mass-action; the Velocity of Chemical Change; and the relations of Chemical Energy to Heat.

3. GENERAL THEORETICAL CHEMISTRY treated more fully than at the Intermediate Examination, together with the principles of chemical classification, including the Periodic System.

4. CHEMISTRY OF CARBON COMPOUNDS.—The preparation, properties, and transformations of the chief series of open and closed Chain Carbon Compounds, including the principal series of Hydrocarbons, Cyanides, and Nitriles, the Alcohols, Phenols, Amines, Amides, and the chief vegetable Alkaloids, Ethers, Aldehydes, Ketones, Acids, and their more important derivatives

Practical Examination. (One day.)

Candidates will be expected to be practically conversant with the principal operations of Experimental Chemistry, and to be familiar with well established laboratory processes, especially those included under the following heads:—

1. QUALITATIVE ANALYSIS, including analysis of mixtures of mineral substances, and identification by chemical and physical tests of commonly-occurring Carbon compounds.

2. QUANTITATIVE OPERATIONS including methods of estimating Metals and other Inorganic Substances; determination of Carbon, Hydrogen, Nitrogen, Sulphur, Phosphorus, Chlorine Bromine, and Iodine, in Carbon Compounds; observations of Melting and Boiling Points; determination of Molecular Weights by Freezing and Boiling Point methods and by Vapour Density; elementary Gas Analysis.

3. Preparation of Pure Substances or separation of the constituents of mixtures by chemical and physical processes.

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V. BOTANY (Three Papers).

Anatomy and Histology.

The Cell: its structure and modifications; the various processes of Cell-formation.

The Tissues and Tissue-systems: their distinctive characters and development.

The Structure of the Vegetative Organs.

The Structure and Development of the Reproductive Organs.

Morphology.

The life-history of Plants; alternation of generations and other forms of polymorphism.

The Plant-body and its members; the symmetry, development, and principal modifications.

Special Morphology and Taxonomy.

The characteristic morphological, histological, and physiological features, and the relationships of the main sub-divisions of the Vegetable Kingdom; as also the affinities and the features of special importance, morphological or otherwise, of the smaller groups of plants enumerated below.

The more general facts of Geographical Distribution.

SPERMOPHYTA (Phanerogamia).

Angiospermæ.

Dicotyledones.

Ranales. Ranunculaceæ, Nymphæaceæ.

Parietales. Papaveraceæ, Cruciferæ, Violaceæ.

Caryophyllales. Caryophyllaceæ.

Malvales. Malvaceæ, Tiliaceæ.

Geraniales. Linaceæ, Geraniaceæ, Rutaceæ.

Rosales. Leguminosæ, Rosaceæ, Saxifragaceæ, Crassulaceæ.

Umbellales. Umbelliferæ.

Caprifoliales. Caprifoliaceæ, Rubiaceæ.

Asterales. Valerianaceæ, Dipsaceæ, Compositæ.

Ericales. Ericaceæ.

Primulales. Primulaceæ.

Polemoniales. Boraginaceæ.

Solanales. Solanaceæ.

Personales. Scrophulariaceæ, Orobanchaceæ.

Lamiales. Labiatæ.

Chenopodiales. Polygonaceæ, Chenopodiaceæ.

Amentiferæ. Salicaceæ, Betulaceæ, Corylaceæ, Cupuliferæ

Euphorbiales. Euphorbiaceæ.

Monocotyledones.

Orchidales. Orchidaceæ.
Narcissales. Iridaceæ, Amaryllidaceæ.
Potamales. Butomaceæ, Alismaceæ, Naiadaceæ.
Palmales. Palmaceæ.
Arales. Aroideæ.
Liliales. Liliaceæ, Juncaceæ.
Glumales. Cyperaceæ, Gramineæ.

GYMNOSPERMÆ.

Cycadaceæ, Coniferæ.

PTERIDOPHYTA.

Lycopodinæ. Selaginelleæ, Lycopodiaceæ.
Filicinæ. Leptosporangiatæ, Eusporangiatæ.
Equisetinæ. Equisetaceæ.

BRYOPHYTA.

Musci.
Hepaticæ.

THALLOPHYTA.

Algæ. Rhodophyceæ, Phæophyceæ, Chlorophyceæ, Cyanophyceæ.
Fungi. Basidiomycetes, Æcidiomycetes, Ascomycetes, Phycomycetes.
Lichenes.
Schizomycetes.
Myxomycetes.

PHYSIOLOGY.

Nutrition: the food-materials of plants; the forms in which they are absorbed, and the sources from which they are obtained; absorption.

The distribution of the absorbed water and food-materials; root pressure; transpiration.

The metabolic processes; the products of metabolism; respiration.

Growth and Movement: their phenomena and mechanism; irritability, and the transmission of stimuli.

Reproduction: the phenomena of sexual and asexual reproduction; cross- and self-fertilisation; apospory; apogamy; parthenogenesis. Mechanisms for the preservation and dispersal of reproductive cells and seeds.

THE THEORY OF EVOLUTION.

Practical Examination (One day).

Each Candidate must be prepared (1) to dissect and to examine, microscopically or otherwise, any plants or parts of plants; (2) to refer to their appropriate systematic position plants or parts of plants comprised in the foregoing schedule; (3) to describe

specimens in technical language; (4) to show a practical acquaintance with the methods and apparatus used for demonstrating the main facts of the physiology of plants.

VI. ZOOLOGY.

(Three Papers).

Two Papers shall relate to the following two paragraphs generally, and one to the third paragraph:—

The fundamental facts and laws of Zoology, including the principal facts of structure and development in the Animal Kingdom, as illustrated by all the great groups, viz., Protozoa, Porifera, Cœlentera, Platyhelminthes, Nemertini, Nemathelminthes, Chætognatha, Rotifera, Polyzoa, Brachiopoda, Annelida, Arthropoda, Mollusca, Echinoderma, Enteropneusta, Tunicata, Cephalochorda, Vertebrata.

The histology and development and the range of form of each group; the general Biological Laws of Variation, Heredity, Adaptation, and Distribution. These subjects will be treated in an elementary manner.

The third paper shall deal with some small group of Animals,[1] selected by the Candidate from a list to be published from time to time,[2] notice being given two years before any change in the list is made. The questions shall relate not only to the structure and development of members of the group, but also to their classification and distribution in space and time; to the principal facts of variation and inheritance characteristic of the group; its "natural history" (bionomics); and to the application to the group of theories of evolution.

Practical Examination (One day).

1. Demonstration of the main features of skeletons, or parts of skeletons, selected from the following groups:—
   Foraminefera, Radiolaria, Cœlenterata, Echinodermata, Polyzoa, Brachiopoda, Mollusca, Arthropoda.
2. Demonstration of the main facts of Vertebrate Osteology, and reference of skeletons, or parts of skeletons, to their proper order; dissection or other demonstration of the structure of the following animals, in addition to the types prescribed for the Intermediate Examination:—
   Common types of freshwater Protozoa; Monocystis, a calcareous Sponge, Tubularia, Obelia, Aurelia, Actinia (or some other "Sea Anemone"), Asterias, Lineus, Dendrocœlum, Nereis, Hirudo, Sipunculus, Flustra, Ascaris, Tænia, Distoma, Periplaneta, Apus, Carcinus, Helix, Sepia, Ciona, Gadus, Lacerta, Columba.

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[1] The Candidate must state upon his Form of Entry the group he selects.
[2] The groups for 1899 will be—Hydrozoa, Mollusca Gasteropoda, Polychæta

3. Demonstration and description of the structure of specimens from the Candidate's selected group, with reference of specimens or parts of specimens to their systematic position within the group.

VII. ANIMAL PHYSIOLOGY (Two Papers.)

Chemical Composition of Food. The quantities and kinds of Food required to balance the losses of the economy.

The several processes to which the Food is subjected in Digestion.

Absorption in general; chyliferous and lymphatic Absorption.

The Blood, its organic and chemical constitution; phenomena and mechanism of Circulation.

Respiration, its mechanical and chemical actions; effects of its suppression.

Temperature of the Body; production and regulation of Animal Heat.

Secretion and Excretion; construction and operation of Secreting Apparatus. Chemical composition and amount of the Urinary, Cutaneous, and Pulmonary excretions.

Muscular and other Contractile substance; phenomena presented by acting Contractile substance.

Nutrition, Growth, and Reparation.

The Mechanism of Locomotion, Voice, and Speech.

Constitution and Functions of Nervous system. Distinction of Motor and Sensory Nerves or Nerve-fibres. Phenomena presented by Nerves in action. Influence on Contractile Tissue.

Functions of Brain, Spinal Cord, and Ganglia. Sensation, Voluntary motion, Reflex Action. Inhibitory Action. Influence of Nervous System on Heart and Blood-vessels, and on Secreting organs.

Organs of the Senses and their functions.

Reproductive Organs and their functions.

Changes produced in the Ovum by impregnation. Outline of the Development of the Embryo and its Envelopes. Nutrition of the Fœtus. Changes which occur at Birth in the Fœtus and in the Parent. Lactation.

Changes which take place with Age in the Proportions of the Body; in the Skeleton; in the Dentition; and in the Reproductive apparatus.

Differences between Man and Woman other than in the Reproductive Organs.

Senile Decay.

Somatic and Molecular Death.

Practical Examination (One day).

(1) Examination and description of Microscopical Specimens of Animal tissues and organs; (2) preparation of Microscopical Sections, &c. of Animal tissues and organs; (3) exercises in the Chemistry of

albumen and its allies, milk, the digestive juices and their actions, blood, urine, and glycogen ; (4) practical demonstrations with the most important Apparatus used in studying the Physiology of muscle, nerve, the circulatory and respiratory systems, and the organs of sense.

VIII. GEOLOGY AND PHYSICAL GEOGRAPHY

(Two Papers).

Candidates will be examined in the leading details of this subject, in general accordance with the outline indicated in the following Syllabus :—

(*a*) The principal contours of the Earth's Surface, above and below the level of the ocean, and its dominant physical characteristics in various regions.

(*b*) The Constitution and Materials of the Earth, so far as known. The mineral composition and structural characteristics of the rocks commonly called Igneous.

(*c*) The composition of the Water of the ocean and of inland seas ; the tides, currents, circulation, and other phenomena of such waters.

(*d*) The composition of the Atmosphere : the chief air currents ; their effects, and other leading facts relating to atmospheric movement and circulation. Climate and the laws of Rainfall.

(*e*) Agents of Change operating from Within the earth's surface, and their results ; such as the bending, folding, and fracture of rocks ; the producing of cleavage and foliation ; the formation of rocks commonly called metamorphic ; the upheaval and depression of the earth's surface ; and the process of mountain-making. Earthquakes, volcanoes, and mineral veins.

(*f*) The Agencies of Change operating from Without the earth's surface.

The action of Water, chemical and mechanical ; its various modes of earth-sculpture, and the formation of detrital rocks, such as sand, clay, &c. ; together with its reconstructive action generally, and the structures of stratified rocks.

The work, destructive and constructive, of Living Organisms ; such as results in the formation of coal, limestone, &c.

(*g*) The more important details of the Stratigraphy of Great Britain and Ireland, viewed in relation to the past physical geography of the region.

(*h*) The present distribution of the more important Life-groups and its bearing on the past history of the earth. The chief facts of the earth's ancient life-history.

Practical Examination (One day).

Identification and description of Specimens of the principal Rocks, and of the Fossils characteristic of the leading stratigraphical subdivisions (*e.g.* the Wenlock Limestone, or the London Clay). Preparation of Geological Maps and Sections, and demonstration of the meaning and application of Models.

EXAMINATION FOR HONOURS.

Any Candidate who presents himself at the B.Sc. EXAMINATION for examination in three of the eight subjects thereof, may be examined for Honours at the same Examination in any one or more of the subjects selected,[1] not being a subject in which he presents himself for a Pass. But a Bachelor of Arts who passes the B.Sc. EXAMINATION (See Note 1, page 3), and who has previously obtained a Scholarship at the B.A. EXAMINATION in Mathematics, Pure and Mixed, shall not be admissible to the Examination for Honours in that subject.

A Candidate for Honours may, at his option, be examined in *two only*[1] out of the eight subjects of the Examination by means of the Honours Papers in one of such selected subjects and the Pass (or Honours) Papers in the other, provided that no such Candidate shall pass who shall not obtain First Class Honours in one subject and First Division (Pass) proportion of marks (or be classed in Honours) in the other subject.

MATHEMATICS.

The Honours subjects of the Intermediate Examination in Science carried to a higher development.
Higher Coordinate Geometry of Two Dimensions.
Coordinate Geometry of Three Dimensions.
Differential Equations.
Dynamics of Rigid Bodies and of Systems of Bodies.
Vibrations of Flexible Cords.
General Equations of the Equilibrium and Motion of Fluids.
Propagation of Sound by Plane and Spherical Waves.
Geometrical Optics.
Spherical Astronomy.

For this Examination six Papers shall be set on the days appointed in the Order of Examinations.

CHEMISTRY.

For this Examination two Papers shall be set, and a Practical Examination[2] (two days) be held on the days appointed in the Order of Examinations.

Practical Examination.

Qualitative Analysis as specified for the Pass Examination, and Quantitative Analysis, including estimation of Carbon and Hydrogen, Nitrogen, Sulphur and the Halogens in organic compounds; determinations of Vapour-density.

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[1] The subjects must be specified in the Form of Entry.

[2] The necessary apparatus (but not platinum apparatus of any kind, or foil or wire) will be provided by the University.

Note.—At the above and following Examinations Candidates will be required, immediately before each Examination, to submit the record of their Laboratory-work duly certified by the Teacher, if any, whose course they may have attended.

Experimental Physics.[1]

For this Examination three Papers on the principles and methods of Physics shall be set, and a Practical Examination (two days) be held on the days appointed in the Order of Examinations.

Botany.[1]

For this Examination four Papers shall be set, and a Practical Examination (one day) held on the days appointed in the Order of Examinations. The Examination shall comprise Botany in all its branches, including the History of Botany, the Geological History of Plants, and their general Biology (Bionomics), and shall, in part, relate to a special subject to be selected by the Candidate from a list of three subjects to be prescribed two years in advance.[2]

Zoology.[1]

For this Examination four Papers shall be set, and a Practical Examination (one day) held on the days appointed in the Order of Examinations. The Examination shall comprise Zoology in all its branches, including Palæontology, and shall, in part, relate to a special group of animals to be selected by the Candidate[3] from the current list of groups prescribed for the Pass Examination.

Physiology.[1]

For this Examination two Papers shall be set, and a Practical Examination (one day) held on the days appointed in the Order of Examinations.

Geology and Physical Geography.[1]

For this Examination two Papers shall be set, and a Practical Examination (one day) held on the days appointed in the Order of Examinations.

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[1] See *Note* on Laboratory records above.

[2] The Honours Candidate must state his subject on his Form of Entry. The subjects for 1899 and 1900 will be the Histology and Morphology of Vascular Tissues; the Morphology and Affinities of the Chlorophyceæ; the Natural History of the Flower.

The subjects for 1901 and until further notice will be:—(1) The Morphology of the Sporangium in Vascular Plants. (2) The Physiology of Carbon assimilation in plants that possess chlorophyll and in plants that are devoid of it. (3) The morphology, affinities, and general biology of Amentales, (*i.e.*, the first eight "Reihe" of Archichlamydiate Dicotyledons, as enumerated in Engler's "Syllabus der Pflanzenfamilien," 1898 edition) with special reference to the species native or frequently cultivated in the British Islands.

[3] The Candidate must state upon his Form of Entry the subject selected by him. See Note 2, page 26.

The Examination, Pass and Honours, will occupy Five weeks.

At Two o'clock on Friday in the week next after that in which the Examination closes the Registrar shall publish (*a*) a List of the Candidates entered for the Pass Examination only who have passed, arranged in two Divisions ;—(*b*) a List of the Candidates who have passed an Examination for Honours in one or more subjects, arranged by the Examiners in the several Departments under their respective heads in three Classes, and in Alphabetical order in each Class ;—and (*c*) a List of the Candidates who have failed to obtain Honours, but are recommended for a Pass.

A Diploma under the seal of the University, and signed by the Chancellor, shall be delivered at the Public Presentation for Degrees to each Candidate who has passed the Examination.

If in the opinion of the Examiners any Candidate of not more than Twenty-three years of age at the commencement of the Pass Examination, who shall have passed either the B.Sc. EXAMINATION or the B.A. EXAMINATION, shall possess sufficient merit, and the Candidate whoshall distinguish himself the most of all the Candidates who shall have passed either of the said Examinations, and who were not more than Twenty-three years of age at the commencement of the Pass Examination, in *Mathematics*, shall receive Fifty Pounds per annum for Three Years, with the style of UNIVERSITY SCHOLAR ; it being intended that one Scholarship only shall be given in each case among all the Candidates, although some of such Candidates may have passed the B.Sc. EXAMINATION and others the B.A. EXAMINATION.

If in the opinion of the Examiners any Candidate of not more than Twenty-three years of age at the commencement of the Pass Examination, who shall have passed the B.Sc. EXAMINATION, shall possess sufficient merit, the Candidate who shall distinguish himself the most of those who were not more than Twenty-three years of age at the commencement of the Pass Examination, in *Experimental Physics*, the Candidate who shall distinguish himself the most of those who were not more than Twenty-three years of age at the commencement of the Pass Examination, in *Chemistry*, the Candidate who shall distinguish himself the most of those who were not more than Twenty-three years of age at the commencement of the Pass Examination, in *Botany*, the Candidate who shall distinguish himself the most of those who

were not more than Twenty-three years of age at the commencement of the Pass Examination, in *Zoology*, the Candidate who shall distinguish himself the most of those who were not more than Twenty-three years of age at the commencement of the Pass Examination, in *Physiology*, and the Candidate who shall distinguish himself the most of those who were not more than Twenty-three years of age at the commencement of the Pass Examination, in *Physical Geography and Geology*, shall each receive Fifty Pounds per annum for the next Two Years, with the style of UNIVERSITY SCHOLAR.

ORDER OF THE EXAMINATIONS AT THE B.SC. EXAMINATION.[1]

	Pass.	Honours.
First Week.		
MONDAY.		
Morning, 10 *to* 1. *Afternoon*, 2 *to* 5.	Chemistry	Chemistry.
TUESDAY.		
Morning, 10 *to* 1. *Afternoon*, 2 *to* 5.	Botany	Botany.
WEDNESDAY.		
Morning, 10 *to* 1.	Botany	Botany.
Afternoon, 2 *to* 5.	———	
THURSDAY.		
Morning, 10 *to* 1. *Afternoon*, 2 *to* 5.	Zoology.....	Zoology.
FRIDAY.		
Morning, 10 *to* 1.	Zoology	Zoology.
Afternoon, 2 *to* 5.	———	
SATURDAY.		
Morning, 10 *to* 1. *Afternoon*, 2 *to* 5.	Pure Mathematics	Pure Mathematics.
Second Week.		
MONDAY.		
Morning, 10 *to* 1.	Pure Mathematics	Pure Mathematics.
Afternoon, 2 *to* 5.	Mixed Mathematics	Mixed Mathematics.

[1] Changes in the details of this Order may become necessary, but in all cases will be notified in the Time-table sent to Candidates with the Form of Entry.

	Pass.	Honours.
TUESDAY.		
Morning, 10 *to* 1. / *Afternoon*, 2 *to* 5.	Mixed Mathematics.	Mixed Mathematics.
WEDNESDAY.		
Morning, 10 *to* 1. / *Afternoon*, 2 *to* 5	Experimental Physics.	Experimental Physics.
THURSDAY.		
Morning, 10 *to* 1. / *Afternoon*, 2 *to* 5.	Physiology	Physiology.
FRIDAY.		
Morning, 10 *to* 1. / *Afternoon*, 2 *to* 5.	Geology.....	Geology.
SATURDAY.		
Morning, 10 *to* 1.	.....	Experimental Physics.

Third Week.

MONDAY.		
Morning, 10 *to* 1. / *Afternoon*, 2 *to* 5.	Practical Chemistry.	
TUESDAY.		
Morning, 10 *to* 1. / *Afternoon*, 2 *to* 5.	Practical Chemistry.	
WEDNESDAY.		
Morning, 10 *to* 1. / *Afternoon*, 2 *to* 5.	Practical Chemistry.	
THURSDAY.		
Morning, 10 *to* 1. / *Afternoon*, 2 *to* 5.	Practical Botany	Practical Botany.
FRIDAY.		
Morning, 10 *to* 1. / *Afternoon*, 2 *to* 5.	Practical Zoology	Practical Zoology.
SATURDAY.		
Morning, 10 *to* 1. / *Afternoon*, 2 *to* 5.	Practical Physiology...	Practical Physiology.

Fourth Week.

MONDAY.		
Morning, 10 *to* 1. / *Afternoon*, 2 *to* 5.	Practical Physics.	
TUESDAY.		
Morning, 10 *to* 1. / *Afternoon*, 2 *to* 5.	Practical Physics.	
WEDNESDAY.		
Morning, 10 *to* 1. / *Afternoon*, 2 *to* 5.	.....	Practical Chemistry

	Pass.	Honours.
THURSDAY.		
Morning, 10 *to* 1 } *Afternoon*, 2 *to* 5. }	.....	Practical Chemistry.
FRIDAY.		
Morning, 10 *to* 1. } *Afternoon*, 2 *to* 5. }	.....	Practical Physics.
SATURDAY.		
Morning, 10 *to* 1. } *Afternoon*, 2 *to* 5. }	.....	Practical Physics.
Fifth Week.		
MONDAY.		
Morning, 10 *to* 1. } *Afternoon*, 2 *to* 5. }	Practical Geology	Practical Geology.

DOCTOR OF SCIENCE.

The Examination for the Degree of DOCTOR OF SCIENCE shall take place annually within the first twenty-one days of June.

No Candidate shall be admitted to the Examination for the Degree of D.Sc. until after the expiration of Two Academical Years[1] from the time of his obtaining the Degree of B.Sc. in this University.

Every Candidate must, *before the end of March*, apply to the Registrar for a Form of Entry, which must be returned not later than *April 1st*, accompanied by the proper Fee.

Every Candidate entering for the first time must pay a Fee of Ten Pounds to the Registrar. If a Candidate withdraws his name or fails to present himself at the Examination, or fails to pass it, the Fee shall not be returned to him; but he shall be allowed to enter for any subsequent D.SC. EXAMINATION upon payment, at every such entry, of an additional Fee of Five Pounds, provided that he comply with the Regulations in the preceding paragraph.

Every Candidate for the Degree of D.Sc. shall, upon the above-mentioned Form of Entry, state in writing the special subject within the purview of the Faculty of Science, as set out in the Programme of the B.Sc. Examination, upon a knowledge of which he rests his qualification for the Doctorate; and together with the Form of Entry he shall transmit (*a*) a Dissertation or Thesis,[2] printed, "type-written," or published

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[1] See the Note in page 36.

[2] At least six copies must be transmitted.

in his own name, treating scientifically some special portion of the subject so stated, embodying the result of independent research, or showing evidence of his own work, whether conducted independently or under advice, and whether based on the discovery of new facts observed by himself, or of new relations of facts observed by others, or, generally, tending to the advancement of Science: and (*b*) any printed contribution or contributions to the advancement of Science published independently or conjointly which he may desire to submit in support of his Candidature.

If the Dissertation or Thesis be approved by the Examiners, the Candidate shall be required to present himself at the University upon such day or days within the first twenty-one days of June as may be notified to him, and shall be further tested either orally or practically or by printed papers, or by all of these methods, at the discretion of the Examiners, with reference both to the special subject selected by him and to the Thesis. But in case the Examiners shall, upon examination of the Dissertation or Thesis and of the other contribution or contributions to the advancement of Science submitted by the Candidate, hold the same to be generally or specifically of such special excellence as to justify the exemption of the Candidate from any further test, he may be so exempted, provided that the Report of the Examiners shall set forth the fact and the grounds of such exemption.

Any Candidate who, at any previous B.Sc. Examination, shall have been awarded First Class Honours in the subject for which he presents himself at the D.Sc. Examination, shall be exempted from examination in that subject, but not from examination upon the Thesis.

Candidates who did not obtain First Class Honours at their B.Sc. Examination shall, for the purpose of obtaining the D.Sc. qualification only, be admissible to any subsequent B.Sc. Examination for Honours on procuring and returning a Form of Entry and paying the Fee for the D.Sc. Examination, on or before August 1st; but Candidates so entering shall in no case appear upon the B.Sc. Honours List for the Year.

[Candidates for the Degree of D.Sc. will be expected to be so fully conversant with the Branch of Science they profess as to be able, if required, to satisfy any test of their acquirements in that Branch that it may be thought expedient to apply.]

In the course of the month following the Examination the Registrar shall publish a List of the Candidates who have passed, and shall report to the Senate upon each case

separately. Each such Report shall state (*a*) The Subject of the Dissertation or Thesis submitted by the Candidate; (*b*) A list of his other original contributions (if any) to the Advancement of Science; (*c*) A concise statement of the grounds upon which he is recommended by the Examiners for the Degree.

A Diploma under the Seal of the University and signed by the Chancellor shall be delivered at the Public Presentation for Degrees to each Candidate who has passed.

Note.—By the term "Academical Year" is ordinarily meant the period intervening between any Examination and an Examination of a higher grade in the following year; which period may be either *more* or *less* than a Calendar year. Thus the interval between the *Intermediate* Examination in Science and the *Degree* Examination of the next year is about fifteen months; whilst the interval between the B.Sc. Examination and the D.Sc. Examination of the next year, is less than eight months. Nevertheless, each of these intervals is counted as an "Academical Year."

SCHOLARSHIPS AND PRIZES.

1.—The Granville Scholarship.

The late Chancellor, the Earl of Derby, having given to the University the sum of 2,000*l.* for the foundation of a Prize or Scholarship in memory of his predecessor, the late Earl Granville, the income of this fund will be applied in the award of a Scholarship to be called the "Granville Scholarship," such Scholarship to be awarded at those times only when the funds shall allow of the amount of the Scholarship being not less than 100*l.*

In 1898 this fund was augmented by the sum of 275*l.* 0*s.* 6*d.*, being the balance of the "Lord Granville Memorial Fund."

The Granville Scholarship will be awarded to such one (or more when the funds suffice) of the Candidates for the Doctorate of Science in Mathematics, Physics, or Chemistry, who shall obtain the Degree, and whose thesis (or theses) shall in the opinion of the majority of the Examiners in the above three subjects evince such distinguished merit as to be deserving of the Scholarship and show the most originality and general excellence

2.—The Sherbrooke Scholarship.

The late Lord Sherbrooke having in his lifetime given to the University the sum of 1,000*l.* to be used at the discretion of the Senate, the Senate has determined that the income of the fund shall be applied in the award of a Scholarship, to be called the "Sherbrooke Scholarship," to be awarded in the same manner and upon the same terms and conditions as the Granville Scholarship, but in respect of the Doctorate of Science in Botany, Zoology, Physiology, or Geology.

3.—The Derby Prize.

The late Chancellor, the Earl of Derby, having bequeathed to the University the further sum of 2,000*l.* for the foundation of a Prize, Exhibition, or Scholarship, as the Senate may determine, the income of this fund will be applied in the award of a Prize to be called the "Derby Prize," such Prize to be awarded in and after 1896 to the Candidate, if of sufficient merit, who shall distinguish himself the most of those who were not more than twenty-three years of age at the commencement of the Pass Examination at the B.A. Examination for Honours in *History*. [See Regulations relating to Degrees in Arts, page 27.]

PROVINCIAL EXAMINATIONS.

These Examinations are appointed by the Senate from time to time, upon the application of any City, Institution, or College desiring to be named as a local centre for one or more Examinations; and are carried on simultaneously with the Examinations in London, under the supervision of Sub-Examiners also appointed by the Senate.

Candidates wishing to be examined at Provincial centres must give notice upon their Forms of Entry to the Registrar of the University, who will then make all necessary arrangements.

Besides the University Fee, a Fee usually varying from 1*l.* to 2*l.* is charged by the local authorities, and must be paid *at the local centre* immediately before the commencement of the several Examinations.

The answers of the Candidates at the Provincial Examinations are reviewed by the Examiners at the same time as the Answers of the Candidates examined in London; and a List of the Candidates who have passed at each Provincial Examination is published, at the time fixed by the Regulations, at the place where such Examination has been held.

1899.

The June Matriculation Examination will be held at—

Aberystwith:—University College;
Bangor:—University College;
Bedford:—The Modern School;
Birmingham:—The Mason University College;
Bristol:—University College;
Cardiff:—College and Technical Buildings, Dumfries Place;
Cheltenham (for Ladies only):—The Ladies' College;
Edinburgh:—The Heriot-Watt College;
Epsom:—The Royal Medical College;
Leeds:—The Yorkshire College;
Liverpool:—St Edward's College;
Liverpool:—University College;
Manchester:—The Owens College;
Newcastle-on-Tyne:—Rutherford College;
Nottingham:—University College;
Plymouth:—The Technical Schools (Communications to be addressed to I. S. Hawker, Esq., B.A., J.P., Mutley House, Plymouth);
Sheffield:—University College;
Southampton:—The Hartley College.

1899—*continued.*

The INTERMEDIATE EXAMINATIONS IN ARTS AND IN SCIENCE[1] and the PRELIMINARY SCIENTIFIC EXAMINATION[1] of July will be held at—

Aberystwith :—University College ;
Bangor :—University College ;
Birmingham :—The Mason University College ;
Bristol :—University College ;
Cardiff :—University College ;
Cheltenham (for Ladies only) :—The Ladies' College ;
Epsom :—The Royal Medical College (Prel. Sci. Papers only) ;
Glasgow :—The Training College, New City Road ;
Leeds :—The Yorkshire College ;
Liverpool :—University College ;
Manchester :—The Owens College ;
Newcastle-on-Tyne :—Rutherford College ;
Nottingham :—University College ;
Plymouth :—The Technical Schools (See June Matriculation, above) ;
Sheffield :—University College.

The B.A. EXAMINATION will be held at—

Aberystwith :—University College ;
Bangor :—University College ;
Birmingham :—The Mason University College ; (with some B.Sc. Papers ;)
Bristol :—University College ; (with some B.Sc. Papers ;)
Cardiff :—University College ; (with some B.Sc. Papers ;)
Glasgow :—The Training College, New City Road ; (with some B.Sc Papers ;)
Leeds :—The Yorkshire College ; (with some B.Sc. Papers ;)
Liverpool :—University College ;
Manchester :—The Owens College ;
Newcastle-on-Tyne :—Rutherford College ; (with some B.Sc. Papers ;)
Nottingham :—University College ; (with some B.Sc. Papers ;)
Plymouth :—The Technical Schools.

1900.

The JANUARY MATRICULATION EXAMINATION will be held at—

Birmingham :—The Mason University College ;
Bristol :—The Merchant Venturers' Technical College ;
Cardiff :—College and Technical Buildings, Dumfries Place
Glasgow :—The Training College, New City Road ;
Leeds :—The Yorkshire College ;
Newcastle-on-Tyne :—Rutherford College ;
Nottingham :—The High School ;
Plymouth :—The Technical Schools (See June 1899) ;
Portsmouth :—The Grammar School.

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[1] The Practical Examinations in Chemistry are conducted at the Provincial Centres ; but all Candidates must attend at the University for Practical Physics and Biology.

1900—*continued.*

The JUNE MATRICULATION EXAMINATION will be held at—

Aberystwith :—University College ;
Bangor :—University College ;
Birmingham :—The Mason University College ;
Bristol :—University College ;
Cardiff :— University College ;
Edinburgh :—The Heriot-Watt College ;
Leeds :—The Yorkshire College ;
Liverpool :—St Edward's College ;
Liverpool :—University College ;
Manchester :—The Owens College ;
Newcastle-on-Tyne :—Rutherford College ;
Nottingham :—University College ;
Plymouth :—The Technical Schools (See June 1899) ;
Sheffield :—University College.

The INTERMEDIATE and PRELIMINARY EXAMINATIONS[1] of July will be held at—

Aberystwith :—University College ;
Birmingham :—The Mason University College ;
Bristol :—University College ;
Cardiff :—University College ;
Glasgow :—The Training College, New City Road ;
Leeds :—The Yorkshire College ;
Liverpool :—University College ;
Manchester :—The Owens College ;
Newcastle-on-Tyne :—Rutherford College ;
Nottingham :—University College ;
Plymouth :—The Technical Schools ;
Sheffield :—University College.

And the B.A. EXAMINATION at—

Aberystwith :—University College ;
Birmingham :—The Mason University College; (with some B.Sc. Papers ;)
Bristol :—University College ; (with some B.Sc. Papers ;)
Cardiff :—University College ; (with some B.Sc. Papers ;)
Glasgow :—The Training College, New City Road ; (with some B.Sc. Papers ;)
Leeds :—The Yorkshire College ; (with some B.Sc. Papers ;)
Liverpool :—University College ;
Manchester :—The Owens College ;
Newcastle-on-Tyne :—Rutherford College ; (with some B.Sc. Papers ;)
Nottingham :—University College ; (with some B.Sc. Papers ;)
Plymouth :—The Technical Schools.

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[1] *See* Note on page 38.

EXAMINATIONS IN 1899–1900.

The following are the Dates at which the several Examinations in the University of London for the year 1899–1900 will COMMENCE:—

MATRICULATION.—Monday June 12, 1899; and Monday January 8, 1900.

BACHELOR OF ARTS.—Intermediate, Monday July 10; B.A., Monday October 23.

MASTER OF ARTS.—Monday June 5.

DOCTOR OF LITERATURE.—Tuesday December 5.

SCRIPTURAL EXAMINATIONS.—Tuesday November 21.

BACHELOR OF SCIENCE.—Intermediate, Monday July 10; B.Sc., Monday October 23.

DOCTOR OF SCIENCE.—Within the first twenty-one days of June.

BACHELOR OF LAWS.—Intermediate and LL.B., Tuesday January 2, 1900.

DOCTOR OF LAWS.—Tuesday January 16, 1900.

BACHELOR OF MEDICINE.—Preliminary Scientific, Monday July 10, 1899, and Monday January 15, 1900; Intermediate, Monday July 3, 1899, and Monday January 15, 1900; M.B., Monday May 1, and Monday October 30, 1899.

BACHELOR OF SURGERY.—Tuesday December 5.

MASTER IN SURGERY.—Monday December 4.

DOCTOR OF MEDICINE.—Monday December 4.

BACHELOR OF MUSIC.—Intermediate and B.MUS., Monday December 18.

DOCTOR OF MUSIC.—Monday December 18.

ART, THEORY, AND HISTORY OF TEACHING.—Tuesday December 12.

UNIVERSITY OF LONDON.

FRANCIS GALTON RESEARCH FELLOWSHIP IN NATIONAL EUGENICS.

A Research Fellowship has been founded by Mr Francis Galton, F.R.S., to promote the Study of National Eugenics, *i.e.*, the study of the agencies under social control that may improve or impair the racial qualities of future generations either physically or morally.

The Fellowship is established on the following conditions :—

(1) The value of the Fellowship is £250 per annum ; it is tenable for one year in the first instance, and for two subsequent years on favourable Report from a Special Committee at the end of the first and second year's tenure respectively.

(2) The endowment not absorbed by the stipend of the Francis Galton Research Fellow, amounting to about £250 per annum, will be placed at the disposal of the Committee for the purpose of aiding his work, subject to the general approval of the Senate.

(3) The duties of the Fellow will be to devote the whole of his time to the study of Eugenics, subject to the approval and under the general direction of the Committee. In particular he will be required :—

(*a*) To acquaint himself with statistical methods of enquiry, and with the principal researches which have been made in Eugenics, and to plan and carry out further investigations thereon.

(*b*) To institute and carry on such investigations into the history of classes and families as may be calculated to promote the knowledge of Eugenics.

(*c*) To prepare and present to the Committee, though not necessarily for publication, an annual Report on his work ; and to give from time to time, if required or approved by the Committee, short Courses of Lectures on Eugenics, and in particular on his own investigations thereon.

(*d*) To prepare for publication at such times and in such manner as may be approved by the Committee (and at least at the end of his tenure of the Fellowship), a Memoir or Memoirs on the investigations which he has carried out.

Applications for the above Fellowship must be sent in duplicate, accompanied by copies in duplicate of not more than three testimonials, and must reach the University not later than November 10th, 1904. Additional references may be given.

ARTHUR W. RÜCKER,
Principal.

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