UNIVERSITIES OF MANCHESTER, LIVERPOOL, LEEDS, SHEFFIELD AND BIRMINGHAM

Joint Matriculation Board

General Certificate of Education

PHYSICS. PAPER II

ADVANCED

FRIDAY 8 JUNE 1951, 2-5

Answer **six** *questions including:*

(*a*) **four** *from* SECTION (1);

(*b*) **two** *from* SECTION (2).

Answers to Sections (1) and (2) must be written in different answer-books.

The books must be marked clearly either SECTION (1) *or* SECTION (2) *and handed in to the Supervisor separately.*

Candidates should wherever possible show by their answers that they have seen or themselves performed experiments on the subjects they are discussing.

For full credit it is not sufficient to obtain correct results to numerical questions; the principles involved and their bearing on the question must be clearly stated.

(*Assume that the acceleration due to gravity is 981 cm. per sec. per sec.*)

Section (1)

Answer **four** *questions from this section.*

1. Describe the optical system of a simple prism spectrometer. Illustrate your answer with a diagram showing the paths through the spectrometer of the pencils of rays which form the red and blue ends of the spectrum of a source of white light. (Assume in your diagram that the lenses are achromatic.)

The prism of a spectrometer has a refracting angle of 60 degrees and is made of glass whose refractive indices for red and violet light are respectively 1·514 and 1·530. A white light source is used and the instrument is set to give mimimum deviation for red light. Determine (*a*) the angle of incidence of the light on the prism, (*b*) the angle of emergence of the violet light, (*c*) the angular width of the spectrum.

2. Define *lumen*, *foot-candle*. The recommended average illumination for proof reading is 20 foot-candles. Express this in lumens per square metre assuming that 1 ft.=30·5 cm.

Explain why special ' daylight illumination ' is often installed in drapers' shops.

The horizontal top of a desk measures 4·5 ft. by 3·0 ft. and a 300 C.P. lamp is situated 5·0 ft. vertically above one corner. Calculate the illumination, due to light received directly from the lamp, on the desk at the middle of the long side opposite this corner.

3. Define *susceptibility*, *permeability* and state the relation between them.

Describe briefly how you would test a small rod to find if it is diamagnetic, paramagnetic or ferromagnetic. Draw intensity of magnetization graphs for each type of material and comment on their special features.

4. Describe and explain an experiment to demonstrate the change in the capacity of a parallel plate condenser produced by inserting a sheet of dielectric between the plates.

Derive the expression for the energy stored in a condenser of capacity C when a potential difference V is applied across its plates.

A parallel plate condenser in air has a capacity of 300 e.s.u. Calculate the change in energy of the condenser when the space between the plates is filled with an insulator of dielectric constant 5, (*a*) if the potential difference between the plates is kept constant at 2 e.s.u., (*b*) if the charge on the plates is kept constant at 600 e.s.u. State the unit in which the results are expressed.

5. Describe an experiment for determining the variation of the resistance of a coil of wire with temperature.

An electric fire dissipates 1 kilowatt when connected to a 250v. supply. Calculate to the nearest whole number the percentage change that must be made in the resistance of the heating element in order that it may dissipate 1 kilowatt on a 200v. supply. What percentage change in the length of the heating element will produce this change of resistance if the consequent increase in the temperature of the wire causes its resistivity to increase by a factor of 1·05 ? The cross-sectional area of the wire may be assumed constant throughout the calculation.

6. Describe with the aid of diagrams (*a*) a transformer and (*b*) an induction coil. Explain the action of each.

Draw diagrams to show, in a general way, how the voltage output from each of these appliances varies with the time.

SECTION (2)

(Answers to be written in a separate answer-book.)

Answer **two** *questions from this section.*

7. Give an account of **two** of the following:

(*a*) Primary and secondary rainbows.

(*b*) Winds near the surface of the earth.

(*c*) The colour of the cloudless sky (i) at mid-day, (ii) at sunset, (iii) at a great height above the earth's surface.

8. Comment on the following statements:

(*a*) The loudness of the note emitted by a tuning fork is 10 decibels.

(*b*) The loudness of the noise in a railway carriage is 80 phons.

(*c*) Some loudspeakers do not give faithful reproduction.

(*d*) Speaking in some public halls is like speaking out-of-doors; such halls, also, are not suitable for concerts.

9. The object glass of a telescope is a simple converging lens of power 0·5 dioptres, made of glass of dispersive power 0·0175, and the eye lens is an achromatic combination of focal length 5 cm. If the telescope is focused so that the blue image of a white star is formed at infinity, what is the position of the red image ? Determine the focal lengths of the components of an achromatized objective of the same power if another glass of dispersive power 0·0200 is also available.

Describe a reflecting telescope. What is gained by using large telescopes and why are such telescopes usually of the reflecting type in spite of the possibility of achromatization ?

10. What is meant by the polarization of light ? How is polarization explained on the hypothesis that light has wave properties ?

Describe how polarization can be produced and detected by reflexion. Mention another way of obtaining polarized light and describe how you would determine which of the two methods is the more effective.

Describe briefly **two** uses of polarized light.

11. Describe the procedure necessary to measure the magnetic field, of the order of 1,000 oersteds, between the poles of an electromagnet, using a search coil and a ballistic galvanometer whose sensitivity in scale divisions per microcoulomb is known. Show how the field strength may be calculated from the readings obtained.

Explain the modifications that would have to be made in the dimensions of the coil and in the procedure to permit a determination of the horizontal component of the earth's magnetic field.

12. Describe experiments (one in each instance) with a discharge tube containing air at low pressure to determine (*a*) the ratio of the charge to the mass of an electron, (*b*) the ratio of the mass of a nitrogen atom to the mass of an oxygen atom.

State, in each case, the quantities that have to be measured to enable the ratios to be calculated. The calculations themselves are *not* required.