UNIVERSITIES OF MANCHESTER LIVERPOOL
LEEDS SHEFFIELD AND BIRMINGHAM

**JOINT MATRICULATION BOARD**

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GENERAL CERTIFICATE OF EDUCATION

**PHYSICS—Paper II**

ADVANCED

Tuesday 1 June 1965 9.30 - 12.30

**Careless and untidy work will be penalized**.

*Answer* **nine** *questions including:*
(a) **six** *questions from* SECTION (1):
(*b*) **three** *questions from* SECTION (2).

*Candidates are advised to spend about* 15 *minutes on each* SECTION (1) *answer and about 30 minutes on each* SECTION (2) *answer.*

**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.sec.*$^2$ *and that one calorie is equivalent to 4.2 joules.*

*Mathematical tables are supplied.*

## SECTION (1)

*Answer* **six** *questions from this section.*

**1.** Derive an expression for the time period of vertical oscillations of small amplitude of a mass suspended from the free end of a light helical spring.

What deformation of the wire of the spring occurs when the mass moves?

**2**. Explain in terms of molecular forces why some liquids spread over a solid surface whilst others do not.

A glass capillary tube of uniform bore of diameter 0.050 cm. is held vertically with its lower end in water. Calculate the capillary rise. Describe and explain what happens if the tube is lowered so that 4.0 cm. protrudes above the water surface. Assume that the surface tension of water is 70 dyne cm.$^{-1}$

**3.** **A** brass wire of diameter 1.0 mm. and density 8.5 gm.cm.$^{3}$ is stretched under a tension of 2.0 kgm.wt. between bridges 50 cm. apart. Calculate its fundamental frequency when vibrating transversely.

A horse-shoe magnet is placed so that the wire, at its centre, passes between the poles and a current is passed along the wire. Draw a diagram to illustrate the directions of the magnetic field, the current and the force on the wire. Describe what is observed if an alternating current of constant amplitude is used and the frequency of the current is slowly increased from 20 c.p.s. to 100 c.p.s.

**4.** Describe the processes which lead to the formation of numerous dark lines (Fraunhofer lines) in the solar spectrum. Explain why the positions of these lines in the spectrum differ very slightly when the light is received from opposite ends of an equatorial diameter of the sun.

**5.** When light is incident in a metal plate electrons are emitted only when the frequency of the light exceeds a certain value: How has this been explained?

The maximum kinetic energy of the electrons emitted from a metallic surface is $1.6 \times 10^{-12}$ erg when the frequency of the incident radiation is $7.5 \times 10^{14}$ c.p.s. Calculate the minimum frequency of radiation for which electrons will be emitted. Assume that Planck's constant = $6.6 \times 10^{-27}$ erg sec.

**6.** An isolated conducting spherical shell of radius10 cm., in vacuo, carries a positive charge of $1.0 \times 10^{-7}$ coulomb. Calculate (*a*) the electric field intensity, (*b*) the potential, at a point on the surface of the conductor. Sketch a graph to show how one of these quantities varies with distance along a radius from the centre to a point well outside the spherical shell. Point out the main features of the graph.

(Candidates using the c.g.s. system of units may assume that 1 coulomb = $3.0 \times 10^{9}$ e.s.u. of charge; those using the rationalized M.K.S. system, that the electric space constant = $8.85 \times 10^{-12}$ farad m.$^{-1}$.)

**7.** Describe in detail how. using a Wheatstone bridge arrangement, you would measure the mean temperature coefficient of resistance between 0° C . and 100° C. for iron wire.

**8.** What is an *electron-volt* ? Assuming that the charge on an electron is $1.60 \times 10^{-19}$ coulomb express one electron-volt in terms of another unit

Calculate the kinetic energy and velocity of protons after being accelerated from rest through a potential difference of $2.00 \times 10^{5}$ volt.

(Assume that the mass of a proton = $1.67 \times 10^{-24}$ gm.)

SECTION (2)

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

*Answer* **three** *questions from this section.*

**9.** State Newton's second law of motion.

Show that a force must act on a particle moving in a circle with constant speed, and derive an expression for this force.

What is the nature of the force maintaining the motion of (*a)* an artificial satellite, (*b*) an electron in a hydrogen atom?

Observations are made of the period of revolution and height of an artificial satellite revolving about the earth in a circular orbit. Show how an estimate of the mass of the earth may be made by using the observations and other necessary data.

**10.** Describe, with the aid of a labelled diagram. how you would find the specific heat of a liquid by the method of continuous flow.

Discuss the advantages and disadvantages of the method compared with the method of mixtures.

The temperature of 50 gm. of a liquid contained in a calorimeter is raised from 15.0° C. (room temperature) to 45.0° C. in 530 sec. by an electric heater dissipating 10.0 watts. When 100 gm. of liquid is used and the same change in temperature occurs in the same time, the power of the heater is 16.1 watts. Calculate the specific heat of the liquid.

**11.** Explain in detail how, with the aid of a pin and a plane mirror, you would determine the focal length of a thin bi-convex lens.

Having found the focal length of this lens, explain how you would find the radius of curvature of one of its faces by Boys' method. Discuss whether or not this method can be used to find the radii of curvature of the faces of a thin converging meniscus lens.

The radii of curvature of the faces of a thin converging meniscus lens of material of refractive index 3/2 are

10 cm. and 20 cm. What is the focal length of the lens (a) in air, (*b*) when completely immersed in water of refractive index 4/3?

**12.** In an experiment using a spectrometer in normal adjustment fitted with a plane transmission grating and using monochromatic light of wavelength $5.89 \times 10^{-5}$ cm., diffraction maxima are obtained with telescope settings of 153° 44', 124° 5', 76° 55' and 47° 16', the central maximum being at 100° 30'. Show that these observations are consistent with normal incidence and calculate the number of rulings per cm. of the grating.

If this grating is replaced by an opaque plate having a single vertical slit $2.00 \times 10^{-2}$ cm. wide, describe and explain the diffraction pattern which may now be observed. Contrast the appearance of this pattern with that produced by the grating.

**13.** Define *intensity of magneti:ation I* and *magnetic susceptibility k,* and with the aid of a diagram explain what is meant by *hysteresis.*

Sketch a graph showing how *I* varies with the applied magnetizing field as the field applied to a specimen of soft iron, initially unmagnetized, is slowly increased from zero. On the same diagram sketch the corresponding graph for steel.

By reference to your earlier account state, with reasons, desirable magnetic properties of materials to be used as (a) the core of an electromagnet, (*b*) the core of a transformer, (*c*) a permanent magnet.

**14.** A given material is described as being *radioactive* with a *half-value period (half-life)* of 2 days. Explain the terms printed in italics.

Describe and explain experiments that could be performed to identify the types of radiation which radioactive substances can emit.