A 54—I

OXFORD LOCAL EXAMINATIONS

General Certificate of Education

Summer Examination, 1964

Advanced Level

PHYSICS, PAPER I

Monday, 15 June. Time allowed: 3 hours

Write the number of the paper, **A 54/I,** *on the left at the head of each sheet of your answers in the space provided.*

Answer **one** *question from* **each** *of the five sections A, B, C, D and E (i.e.* **five** *questions in all).*

Mathematical tables and graph paper are provided.

[Take g to be 981 cm./sec.^{2}.]

SECTION A.

1. Define *moment of a force, moment of a couple.*

Discuss the application of the principle of moments to the solution of equilibrium problems in statics, and show how it may be applied to find an expression for the sensitivity of a beam balance.

A simple beam balance with the three knife-edges coplanar has arms which are each 15 cm. long. The mass of the beam is 200 gm. and its centre of gravity is 2 mm. below the central knife-edge. If its pointer is 16 cm. long, find the distance through which the tip of the pointer is displaced when the masses in the pans differ by 10^{-2} gm.

2. Explain what is meant by (*a*) elasticity, (*b*) a modulus of elasticity. Define *Young's modulus*, and describe carefully how you would determine its value for the material of a long wire.

When observations were taken with a certain wire, the extension was found to be proportional to the load up to 10 kg. wt., when it was 3·50 mm. The next kilogram added caused a further 1 mm. extension, and the next a further 1·5 mm. When the load was removed, the wire had a permanent extension of 2·5 mm. Estimate (*a*) the work done in extending the wire 6 mm., and (*b*) the potential energy then stored in the extended wire.

Section B.

3. What do you understand by the term *ideal gas*? Discuss the experimental evidence that leads to the ideal gas equation $pV = RT$.

The bulb of a simple constant-volume air thermometer has a volume of 120 cc., and it is connected to the manometer by tubing of volume 10 cc., which remains at room temperature (15° C.) throughout an experiment. When the bulb is immersed in an ice/water mixture at 0° C., the gas in the bulb is at a pressure of 880 mm. of mercury. To what pressure will it be subjected when the bulb is immersed in steam at 100° C.?

4. Define *coefficient of thermal conductivity*, and describe how you would determine the conductivity of a bad conductor, such as cork.

A thin-walled metal hot-water tank, of effective surface area 6 square metres, is covered with a layer of insulation 3 cm. thick. The coefficient of thermal conductivity of the insulating material is 10^{-3} watt cm.$^{-1}$ (C. deg.)$^{-1}$. Find the power which must be supplied by an electric immersion heater to maintain the water at 60° C. when the outer face of the insulation is at 30° C.

Taking the air temperature to be constant at 15° C., and assuming that the temperature difference between the outer face of the lagging and the air is proportional to the power supplied, find the temperature of the water in the tank when the power supply is raised to 867 watts.

Section C.

5. Draw a diagram showing the passage of a parallel beam of monochromatic light through a glass prism without internal reflection. Explain carefully (*a*) how the inclination of the wave-fronts to the surface alters at each face, and (*b*) how the wavelength in glass is related to the wavelength in air.

Describe how you would use a spectrometer to determine the angle of minimum deviation for monochromatic light passing through such a prism.

When the spectrometer telescope is adjusted to be directly in line with the collimator, the scale reading is 115·0°. What will the scale readings be for the minimum deviation settings if the angle of the prism is 60° and the refractive index 1·65?

6. Obtain from first principles a formula relating the radius of curvature of a spherical mirror with the distances, measured from the pole of the mirror, to a small object situated on its axis, and its image.

Describe how you would determine the radius of curvature of a convex mirror by an optical method.

A wire framework in the shape of a cube of side 2 cm. is placed with its centre on the axis of a convex mirror having a radius of curvature of 20 cm. The cube is oriented so that four of its edges are parallel to the axis, and the nearer face of the cube is 10 cm. from the pole of the mirror. Calculate the length, in the direction of the axis, of the image formed, and also the areas of the two faces of the image that are at right angles to the axis.

Section D

7. Discuss, in terms of simple ionic theory, the electrolysis of a dilute aqueous solution of sulphuric acid using platinum electrodes.

Describe how you would determine the electrochemical equivalent of silver.

Explain how the value of the electronic charge can be estimated from a knowledge of the electrochemical equivalent of silver and of the Avogadro number N. What assumptions are involved in your argument?

8. Describe a simple experiment which demonstrates that a force is experienced by a current-carrying conductor in a magnetic field. State the factors that determine (*a*) the magnitude, (*b*) the direction, of the force.

A rectangular coil of wire carrying a steady current is pivoted on an axis which is at right angles to a radial magnetic field. Obtain an expression for the torque experienced by the coil, and explain the relevance of this result to the design of moving coil galvanometers.

A moving coil galvanometer has a resistance of 25 ohms, and gives a full-scale deflection when carrying a current of $4{\cdot}4 \times 10^{-6}$ amp. What current will give a full-scale deflection when the galvanometer is shunted by a 0·1 ohm resistance?

SECTION E.

9. How would you demonstrate, for a thermionic diode, that (*a*) the current passing between the electrodes is a consequence of the emission of negative charge by the cathode, (*b*) the cathode emission increases as its temperature increases? Draw a graph showing, for a constant cathode temperature, how the current between the electrodes depends on the potential difference between them. Explain, as far as you can, the form of the graph.

Explain briefly how the rectifying action of the diode is employed both in power units and in radio receivers. Draw a labelled diagram of **either** a rectifier unit working from 50-cycle 230-volt mains and giving a nearly steady direct-voltage output **or** a simple radio receiving circuit which incorporates a diode.

10. Describe a modern form of X-ray tube, and explain its action.

Outline the evidence for believing (*a*) that X-rays are an electromagnetic radiation, (*b*) that wavelengths in the X-ray region are of the order of 10^{-3} times those of visible light.