A/Q I

OXFORD LOCAL EXAMINATIONS

GENERAL CERTIFICATE OF EDUCATION

Summer Examination, 1951

Advanced and Scholarship Level

PHYSICS, PAPER I

WEDNESDAY, JUNE 20. TIME ALLOWED—3 HOURS

[Write the number of the paper, Q I, on the left at the head of each sheet of your answers in the space provided.

Answer SIX questions only, including at least ONE question from each of the four sections of the paper.

Mathematical tables are provided.]

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

SECTION A

1. Give the theory of a simple beam balance, and specify the conditions that must be fulfilled for it to be (*a*) accurate, (*b*) sensitive.

The arms of a balance are each 15·0 cm. long, the mass of the beam is 200 gm., the centre of gravity of the beam is 1 mm. below the central knife edge, and the three knife edges are coplanar. A closed vessel of volume 300 c.c. is counterpoised when the atmospheric pressure is 76·5 cm. of mercury. Estimate the deflexion of the beam that is observed if the barometer falls to 75·0 cm., the temperature being unchanged.

(Take the density of air as 0·00125 gm. per c.c. under the initial conditions; the effect of air buoyancy on the counterpoising metal weights is negligible.)

2. Define the moment of inertia of a body about a given axis, and obtain from first principles an expression for the kinetic energy of a rigid body rotating about a fixed axis with a given angular velocity.

A small flywheel has an axle of diameter 1 cm.; the mass of the whole body is 2,000 gm., and its moment of inertia about an axis passing through the centre of the axle is 24,000 gm. cm.^{2} The flywheel is placed with its axle on two parallel rails, which form a slope inclined to the horizontal, and it travels a distance of 400 cm. down this slope in 14 sec., starting from rest. Find the inclination of the rails to the horizontal, and also the kinetic energy of the flywheel at the end of this time.

3. Define the terms *stress*, *strain*, *modulus of elasticity*, and describe how you would measure Young's modulus for a material in the form of a wire.

The breaking stress for steel is $1{\cdot}5 \times 10^{10}$ dyne cm.$^{-2}$, and Young's modulus is 2×10^{12} dyne cm.$^{-2}$ Assuming that there is no change in volume, that the wire thins uniformly throughout its length, and that Hooke's law holds for the whole of the extension, calculate the percentage change in diameter of a steel wire which is stretched until it breaks.

Section B

4. Describe an experiment to measure the real coefficient of expansion of a liquid directly, and give the theory of the method.

A barometer with a steel scale which is correct at 15° C. is read at 25° C., when the observed height is 75·33 cm. What is the height corrected to 0° C. in the usual way? What is the reason for making this correction?

(Take the real coefficient of expansion of mercury as 0·00018 per °C., and the coefficient of linear expansion of steel as 0·000012 per °C.)

5. Explain why the value of the specific heat of a gas depends on the conditions under which the determination is made.

Describe an experiment to determine the specific heat of a gas at constant volume.

The specific heats of nitrogen at constant pressure and constant volume are 0·245 and 0·175 respectively. The density of nitrogen at S.T.P. is 1·25 gm. per litre, and standard pressure is $1{\cdot}016 \times 10^6$ dyne per sq. cm. Calculate a value for the mechanical equivalent of heat from these figures.

Section C

6. Define the terms *luminous flux*, *luminous intensity*, *lumen*.

Obtain from first principles a formula for the illumination of a small surface due to a small source of light in terms of the candlepower of the source, the distance between source and surface, and the angle of incidence on the surface.

On one side of a photometer screen is placed a 60 c.p. lamp at a distance of 3 ft.; on the other side is a 100 c.p. lamp placed 2 ft. away. How many sheets of glass, each transmitting 85 per cent. of the light it receives, should be inserted between the latter lamp and the screen in order to give as good a match as possible?

7. Give an account of the chief defects of the eye as an optical instrument, and indicate how they are corrected by the use of suitable spectacles.

An astronomical telescope has an objective of focal length 100 cm., and an eyepiece of focal length 10 cm. It is used to look at an object 6 metres from the objective, the final image being formed at the man's near point, which is 15 cm. from the eyepiece. Calculate the separation of the lenses, and the angular magnification.

Section D

8. Define the *absolute electromagnetic unit of current*, and obtain from first principles an expression for the magnetic field at distance R cm. from a long straight wire carrying a current i e.m.u.

Describe how you would attempt to verify experimentally that the intensity of the magnetic field for a given value of i is proportional to $1/R$.

9. Describe the construction of the quadrant electrometer, and explain how it may be used to compare the capacities of two condensers.

Two condensers of capacities 3 and 5 microfarads respectively are connected in series across a 200-volt dry battery. The condensers are separately taken out of the circuit without discharging them, and are then joined to one another in parallel. Calculate the potential difference between the plates, and the final total energy of the system.

10. Describe a simple form of cathode-ray oscilloscope tube, and explain the general principles on which it works.

A beam of electrons while traversing a uniform magnetic field of 5 oersted at right angles to its path is caused to describe an arc of a circle of radius 10 cm. Calculate the velocity of the electrons, and the accelerating voltage required to impart this velocity.

(The ratio e/m of the charge on an electron to its mass is $1{\cdot}76 \times 10^7$ e.m.u. per gram; one volt is 10^8 absolute e.m.u of potential difference.)