LEAVING CERTIFICATE EXAMINATION, 1972

PHYSICS—HIGHER LEVEL

FRIDAY, 16th JUNE—MORNING, 9.30 to 12

Any **six** questions to be answered

1. Answer *eleven* of the following sixteen items (*a*), (*b*), (*c*), . . ., etc. Each item carries six marks. *Keep your answers short.*

(*a*) Which has the greater momentum: a body of mass 2 kg moving with a velocity of 5 metres per second or a body of mass 3 kg moving with a velocity of 4 metres per second?

(*b*) A rocket of mass 20,000 kg is at rest on the ground. What force is required to make the rocket move off with a vertical acceleration equal to $\frac{1}{2}$ g?
(Take $g = 9{\cdot}8$ m s^{-2} = 980 cm s^{-2}).

(*c*) Write down an expression for Newton's law of gravitation.

(*d*) In a constant volume gas thermometer the pressure of the gas is 74 units at 0°C and 102 units at 100°C. What would the thermometer read in °C when the pressure of the gas is 81 units?

(*e*) The critical angle for water is 48° 36′. Find its refractive index.
(Take sin 48° 36′ = 0·75).

(*f*) Chromatic aberration is due to the dispersion of white light by a lens. What is meant by the underlined term?

(*g*) Write down an expression for the energy of a charged capacitor in terms of capacitance C and potential V.

(*h*) Define (i) magnetic dip, (ii) magnetic declination.

(*i*) In Fig. I the potential difference across the 6 ohm resistor is 9 volts and the internal resistance of E is 1 ohm. Find the e.m.f. of E.

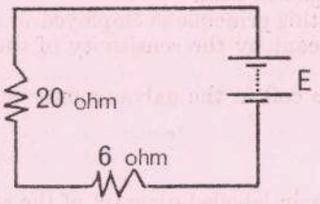

Fig. I

(*j*) Fig. II shows a lamp L which is lighting, an a.c. source and a solenoid C. What may be observed when a bar of soft iron is placed inside C, and why?

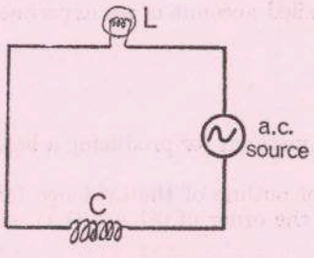

Fig. II

(*k*) How would you confirm which is the positive pole of a d.c. supply?

(*l*) Taking the faraday to be 96,500 coulombs and Avogadro's number to be 6×10^{23}, find the charge on the electron.

(*m*) In the photoelectric effect how is the energy of the emitted electrons related to the wavelength of the incident light?

(*n*) How is the anode (plate) current of a triode affected as the grid voltage becomes more negative with respect to the cathode?

(*o*) Complete the nuclear reaction

$$_{13}Al^{27} + {}_{2}He^{4} \rightarrow {}_{15}P^{30} +$$

(*p*) Why do the leaves of a charged electroscope collapse when a radioactive substance is brought close to the electroscope?

(66 marks)

2. A particle is travelling with uniform angular velocity ω in a circle of radius r and centre O. The particle moves from point P to point Q in time t (see Fig. III). Show that the change in velocity in the direction PO is $r\omega \sin\omega t$. Hence or otherwise prove that the acceleration of the particle at P in the direction PO is $r\omega^2$.

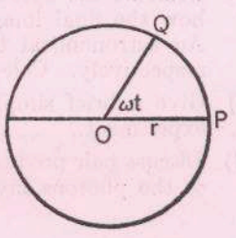

Fig. III

Show that the period of a satellite in circular orbit close to the earth's surface (neglecting air resistance) is equal, approximately, to the period which a simple pendulum would have if its length were equal to the earth's radius.

Find the velocity necessary in order to keep the satellite in this orbit.

(Take $g = 9{\cdot}8$ m s^{-2} = 980 cm s^{-2}; radius of earth = 6,400 km = $6{,}400 \times 10^5$ cm).

(66 marks)

[P.T.O.

3. (*a*) Derive the expression

$$p = \frac{1}{3}\frac{nm\bar{c}^2}{v}$$

and show how it is related to one of the gas laws.

(*b*) Describe how you would measure temperature using a platinum resistance thermometer.

What is a thermistor? In what respect has the thermistor an advantage over the platinum resistance thermometer?

(66 marks)

4. Explain the origin of emission spectra in terms of atomic structure. Indicate the sources which give rise to line spectra, to band spectra, to continuous spectra.

In what way do absorption spectra differ from emission spectra? Outline the experimental procedure to produce an absorption spectrum of sodium.

How did the study of line spectra influence the ideas regarding the energy of electrons in atoms?

(66 marks)

5. Give three ways in which one musical note may differ from another and relate these differences to wave characteristics.

Compare sound with light under the following headings: wave nature, reflection, refraction, polarisation, giving experimental evidence in support of your answer.

(66 marks)

6. Derive an expression for the couple on a rectangular coil of n turns and carrying a current i, when it is placed in a radial magnetic field.

Show how this principle is employed in a moving-coil galvanometer to measure current.

What is meant by the sensitivity of the galvanometer? Indicate the factors on which the sensitivity depends.

Why is the coil in the galvanometer usually wound on a metal former?

(66 marks)

7. (*a*) Draw a clearly labelled diagram of the circuit you would use to measure the internal resistance of a cell. Describe how you would carry out the experiment and give the theory associated with it.

(*b*) Give a detailed account of an experiment to check the accuracy of an ammeter without using another ammeter.

(67 marks)

8. Summarise two methods for producing a beam of electrons. How may a beam of electrons be used to produce *X*-rays?

Give a brief outline of the evidence for believing that (i) *X*-rays are electromagnetic waves and have wavelengths of the order of 0·1 nm (1Å), and (ii) electrons have a wave nature.

(67 marks)

9. (*a*) Write a note on mass-energy conservation in nuclear reactions.

The mass of a hydrogen atom is 1·0078 a.m.u. (atomic mass units) and the mass of a neutron is 1·0087 a.m.u. If the mass of the helium atom is 4·0026 a.m.u. calculate the energy involved in the formation of the helium nucleus.

(Take 1 a.m.u. $= 1{\cdot}66 \times 10^{-27}$ kg $= 1{\cdot}66 \times 10^{-24}$ g; $\quad c = 3 \times 10^8$ m s^{-1} $= 3 \times 10^{10}$ cm s^{-1})

(*b*) What is meant by the half-life of a radioactive substance? Measurements on a sample of a radioactive substance at a certain time showed that 40% of the original nuclei had disintegrated, and measurements on it 10 days later showed that 85% of the original nuclei had disintegrated. Find the half-life of the radioactive sample.

(67 marks)

10. Answer any *two* of the following.

(*a*) Outline how an a.c. generator operates. Comment briefly on the passage of a.c. through capacitors.

(*b*) Describe the optical arrangement in a compound microscope and show, by means of a ray diagram, how the final image is formed.

An astronomical telescope consists of two convex lenses of focal lengths 1 metre and 0·16 metre, respectively. Calculate the magnifying power of the telescope in normal (infinite) adjustment.

(*c*) Give a brief simple account of the measurement of the electronic charge, e, by Millikan's oil-drop experiment.

(*d*) Discuss pair production and annihilation. Explain why there is a lower limit in each case to the energy of the photons involved.

(67 marks)