LEAVING CERTIFICATE EXAMINATION, 1981

PHYSICS—HIGHER LEVEL

THURSDAY, 25 JUNE—MORNING, 9.30 to 12.30

Any **six** questions to be answered.

All questions carry the same marks.

1. Answer *eleven* of the following items *(a), (b), (c),* etc. All the items carry the same marks. *Keep your answers short.*

(a) How much power is supplied when a force of 5 N moves a body a distance of 6 m in a time of 3 seconds?

(b) Complete the statement: For a body falling freely under gravity the loss in . . . . . is equal to the gain in . . . . . .

(c) Define simple harmonic motion.

(d) Give an example of a body having zero velocity but not zero acceleration.

(e) What is meant by chromatic aberration?

(f) In Fig. 1 a ray of light enters a semi-circular slab of glass at A and leaves it at B. What condition must be fulfilled for the light to follow the path shown?

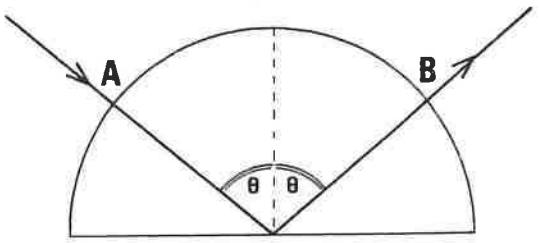

Fig.1

(g) The refractive indices of glass and water are 5/3 and 4/3 respectively. Find the relationship between the speed of light in the two media.

(h) Write the following in order of *increasing* frequency:- blue light; X-rays; radio waves; yellow light.

(i) Calculate the wavelength of the sound emitted by a pipe of length 0·3 m, when closed at one end and resonating at its fundamental frequency. (Assume end correction to be negligible).

(j) Sketch a graph showing how the resistance of a copper wire varies with its temperature between 0°C and 100°C.

(k) What is meant by polarisation of a simple cell?

(l) The graph in Fig. 2 shows the variation of current (I) with potential difference (V) for a thermionic diode. Why does the current essentially become independent of the potential difference at the point marked B and beyond as shown?

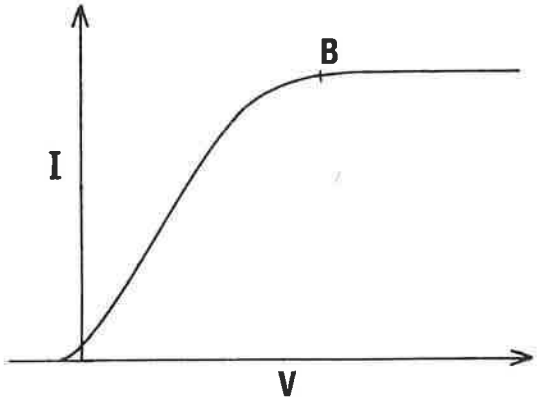

Fig.2

(m) In the formula $B = \mu_0 NI$ for the magnetic flux density along the axis of a long solenoid what do the symbols μ_0 and N represent?

(n) What is the basic principle on which a transformer or an induction coil operates?

(o) In De Broglie's equation $p = h/\lambda$, what do p and λ represent?

(p) Complete the following nuclear reaction:-

$$^{239}_{94}\text{Pu} + ^{1}_{0}\text{n} \longrightarrow ^{142}_{56}\text{Ba} + ^{95}_{38}\text{Sr} +$$

What name is given to this type of nuclear reaction?

2. State Newton's law of gravitation.
Assuming that the periodic time, T, of a simple pendulum of length, l, is given by

$$T = 2\pi\sqrt{\frac{l}{g}}$$

show that

$$T^2 = \frac{3\pi l}{G\rho r}$$

where r is the radius of the earth (assumed spherical), ρ is the mean density of the earth, and G is the gravitational constant.

In an experiment to determine the density of the earth the periodic time, T, of a simple pendulum was measured for different lengths, l, in the range 0·10 m to 1·0 m.

The table of results given below shows the values of l and the corresponding values of T^2 calculated from the measured values of the periodic time.

l (m)	0·10	0·20	0·30	0·40	0·50	0·60	0·70	0·80	0·90	1·00
T^2 (s^2)	0·37	0·76	1·40	1·70	2·00	2·60	2·90	3·20	3·60	4·40

Plot a graph of T^2 against l and hence calculate ρ. (Assume that $G = 6{\cdot}7 \times 10^{-11}$ N m^2 kg^{-2}; $r = 6{\cdot}4 \times 10^6$ m; $\pi = 22/7$).

3. *(a)* Describe how the specific heat capacity of a metal may be measured experimentally.
The temperature of 100 g of water was raised from 20°C to 40°C in 10 minutes by a heating coil of resistance 5 Ω and carrying a current of 2 A. Given that the specific heat capacity of water is $4{\cdot}2 \times 10^3$ J kg^{-1} K^{-1} calculate the amount of energy lost to the surroundings. If you were carrying out this experiment in the laboratory what steps would you take to reduce this energy loss?

(b) Draw a labelled diagram of a constant volume gas thermometer and describe how it may be used to measure the temperature of a liquid.

4. Answer *(a)* and *(b)* and either *(c)* or *(d)*.

(a) Describe an experiment to measure the refractive index of water.

(b) Explain the terms: diffraction; interference. Give one condition which must be satisfied if interference of light waves is to be observed.

(c) In an experiment to measure the wavelength of light emitted by a sodium lamp, a spectrometer is used in conjunction with a diffraction grating which has 5×10^5 lines per metre. With the telescope in the straight through position the zero order image is observed at the 200° mark on the spectrometer scale. The first order images are then observed at 182° 50′ and 217° 10′. Calculate the wavelength of sodium light. State what other measurement might be made to improve the accuracy of the result.

(d) In an experiment to measure the wavelength of sodium light a sodium lamp was placed at the centre of a metre scale. A diffraction grating having 6×10^4 lines per metre was placed at a distance of 1·5 m from the scale. The first order image was seen at the 44·9 cm mark and at the 55·4 cm mark on the scale. Calculate the wavelength of the sodium light. State what other measurement might have been taken to improve the accuracy of the result.

5. Define: potential; field intensity; capacitance.
Derive the relationship between the potential on the surface of a charged spherical conductor and the field intensity at the surface.

Fig. 3 shows a charged conductor on an insulating stand.
Describe experiments, one in each case, to show that
(i) the charge density on the surface of the conductor is greater at the narrow end,
(ii) the potential is the same at all points on the surface.

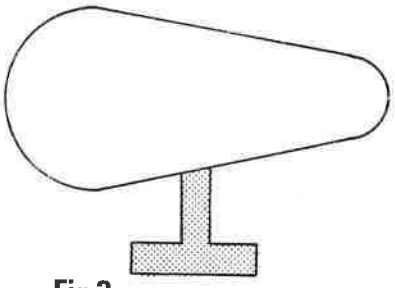

Fig.3

Explain why the capacitance of a charged conductor is increased by bringing an earthed conductor near to it.

6. State the laws of electromagnetic induction.
Draw a labelled diagram of a dynamo. How is the dynamo related to the d.c. motor?
A simple d.c. motor has an internal resistance r. When connected across a potential difference the current which flows is I. If the potential difference is V show that the back e.m.f. (E) is given by the expression

$$E = V - Ir.$$

Outline an experiment by which this back e.m.f. could be measured for a given motor.

Fig. 4 shows a small filament bulb connected in series with a power supply S of fixed voltage and a coil C with a large number of turns and an iron core. Explain why the bulb lights when the switch is closed if the supply is d.c. but not if it is a.c.

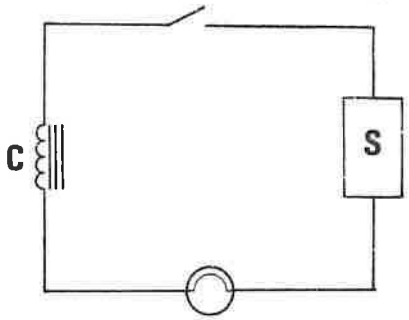

Fig.4

7. *(a)* Describe a laboratory method of measuring the speed of sound in a gas other than air.

(b) Describe an experiment to measure the internal resistance of a cell and give the theory associated with the experiment.

8. *(a)* Describe, with the aid of a suitable diagram, how X-rays are produced in an X-ray tube.
Calculate the minimum wavelength of X-rays produced in an X-ray tube operating at 100 kV. (Assume $c = 3{\cdot}0 \times 10^8$ m s^{-1}; $h = 6{\cdot}6 \times 10^{-34}$ J s; $e = 1{\cdot}6 \times 10^{-19}$ C).

(b) When a freshly cleaned piece of zinc is placed on the cap of a negatively charged electroscope and illuminated with ultraviolet radiation the leaves of the electroscope collapse.

(i) Why do the leaves collapse?

(ii) Why do the leaves not collapse if the zinc is illuminated with infra red radiation?

(iii) Why should the zinc be freshly cleaned?

(iv) What determines the rate at which the leaves collapse?

(v) Why do the leaves not collapse if the zinc is covered with a piece of ordinary glass?

Explain why the leaves do not collapse if the electroscope is charged positively rather than negatively.

9. Summarise the properties of α -particles, β -particles and γ-rays.
What is meant by (i) radioactive isotope; (ii) half-life?
Describe an experiment to measure the half-life of a radioactive isotope of relatively short half-life.
The mass of a certain sample of a radioactive isotope is found to decrease by 60% in 10 days. Calculate the half-life of the isotope.

10. Answer any *two* of the following.

(a) State the principle of conservation of momentum and show how it may be derived from Newton's second and third laws of motion.

(b) Show how the kinetic theory equation $p = \frac{1}{3}\frac{nm\overline{c^2}}{V}$ is consistent with any *one* of the gas laws.

Calculate the root-mean-square speed of the molecules in a sample of a certain gas at S.T.P., given that the density of the gas at S.T.P. is 0·10 kg m^{-3} and the density of mercury is $1{\cdot}36 \times 10^4$ kg m^{-3}. (Take $g = 10$ m s^{-2}).

(c) Describe an experiment to measure the specific charge (e/m) of the hydrogen ion, H^+.

(d) Given the equation, $F = BIl \sin \theta$ for the force on a current-carrying conductor in a magnetic field show that the deflection of a moving coil galvanometer is proportional to the current passing through it. What are the factors which determine the sensitivity of this type of instrument?