AN ROINN OIDEACHAIS

LEAVING CERTIFICATE EXAMINATION, 1980 009518

PHYSICS—HIGHER LEVEL

WEDNESDAY, 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) Define the unit of work i.e. the joule.

(b) A force of 5 N is applied at right angles to one end of a bar of length 2 m. What is the moment of this force about the centre of the bar?

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

(d) Define temperature on the Celsius scale for a thermocouple.

(e) Derive an expression for the distance between nodes on a standing (stationary) wave, in terms of the velocity and the frequency of the wave.

(f) What is the magnifying power of a simple telescope in normal (infinite) adjustment, if the objective has a focal length of 0·5 m and the eyepiece has a focal length of 0·1 m?

(g) With regard to a diffraction pattern produced by waves incident on a narrow aperture, what is the effect of (i) reducing the width of the aperture, (ii) increasing the wave frequency?

(h) Two thin lenses, each of focal length 0·2 m are placed in contact. Calculate the focal length of the combination.

(i) A magnetic field (B) is applied at right angles to a rectangular block of conducting material through which a current (I) flows parallel to its longest side and perpendicular to B. (See Fig. 1)

A centre-zero galvanometer (G) is connected to the centres of the top and bottom faces of the block. Why does the galvanometer register a small current?

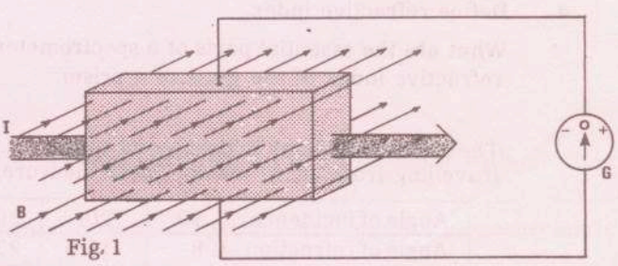

Fig. 1

(j) If the current through the block in Fig. 1 was due to positive charge carriers rather than electrons, what would be the effect (if any) on the galvanometer?

(k) Why are curved pole pieces used in moving-coil meters?

(l) What is meant by spherical aberration?

(m) In Fig. 2, $\vec{B}$ is the magnetic flux density of the earth and $\vec{B}_H$ its horizontal component. What is the angle θ usually called?

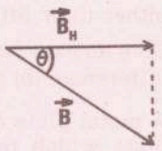

Fig. 2

(n) Insert the standard notation for a proton in the following nuclear reaction and then complete the reaction.

$$^{7}_{3}\text{Li} + \text{proton} \longrightarrow {}^{4}_{2}\text{He} +$$

(o) What words are omitted from the following statement?
"In the Compton effect, where X- rays are scattered by electrons, the incident beam of X- rays has a greater ..... while the scattered beam has a greater ....."

(p) What is meant by nuclear fusion?

[P.T.O.

2. Explain the terms: kinetic energy, potential energy, centripetal force.

A 0·5 kg mass is attached by means of a string of length 2 m to a fixed point, so forming a simple pendulum. The mass is released when the string makes an angle of 6° with the vertical (See Fig. 3).

Calculate:

(i) the vertical height, h, through which the mass moves, when the string becomes vertical i.e. at P,

(ii) the average vertical speed of the mass while the pendulum is moving to position P,

(iii) the actual speed of the mass at P,

(iv) the tension in the string at P.

(Take $g = 10$ m s^{-2})

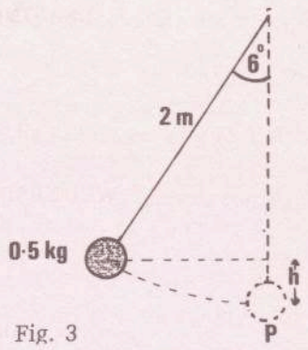

Fig. 3

3. The behaviour of an ideal monatomic gas is governed by the equation $\frac{PV}{T} = C$, where C is a constant and where P, V and T have their usual meanings. On the basis of the kinetic theory, however, another equation may be derived for the pressure of a gas by considering the motion of individual molecules of a gas.

(i) Explain the underlined term. How is the constant C usually expressed?

(ii) Outline an experiment to demonstrate that the molecules of a gas are in motion.

(iii) State four of the basic assumptions of the kinetic theory of gases.

(iv) Write down the kinetic theory equation for the pressure of a gas and hence show that the total kinetic energy of the molecules of the gas is 3/2 CT.

(v) State Avogadro's law. How may the law be interpreted on the basis of the kinetic theory?

4. Define refractive index.

What are the essential parts of a spectrometer? Describe how it may be used in the measurement of the refractive index of the glass of a prism.

The scientist Ptolemy in the second century A.D. measured the angles of incidence and refraction for light travelling from air to water. These measurements (in degrees) are given in the following table.

Angle of incidence	10	20	30	40	50	60	70	80
Angle of refraction	8	15·5	22·5	29	35	40·5	45·5	50

From the given data and using a suitably constructed graph, calculate the refractive index of water.

5. Define: capacitance, electric field intensity (strength).

Two factors on which the capacitance of a parallel plate air capacitor depends are (i) the area of the plates, (ii) the separation between the plates. Outline an experiment to show how the capacitance depends on either (i) *or* (ii).

Give an expression for the energy of a charged capacitor in terms of (a) the capacitance and the potential difference, (b) the capacitance and the charge.

A metal plate of area A is suspended directly above an identical plate which rests on a table, thus forming a parallel plate air capacitor. (See Fig. 4). A charge Q is given to the capacitor. Show that the energy per unit volume in the capacitor is $\frac{1}{2}\varepsilon_0 E^2$, where E is the electric field intensity and where the permittivity of air is taken to be ε_0. Show also that the force of electrical attraction between the plates is $\frac{Q^2}{2\varepsilon_0 A}$.

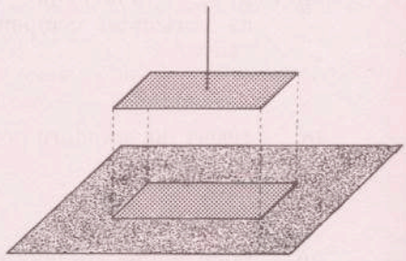
Fig. 4

6. State the laws of electromagnetic induction.
Describe simple experiments (one in each case) to demonstrate these laws.

Fig. 5 illustrates a coil (C) with a large number of turns and a soft iron core, connected to a 12 V battery. Across the switch (S) a gas-filled (e.g. neon) bulb (L) is connected. Explain why the bulb flashes briefly when the switch is opened, after having being closed for a while. Indicate another possible way in which the bulb might be connected in the circuit so as to produce the same effect.

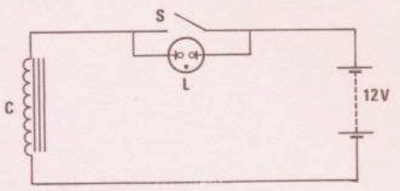

Fig. 5

7. *(a)* Describe an experiment to compare the electromotive force of two cells and give the theory associated with the experiment.

(b) Describe an experiment to show (i) how the resistance of a thermistor varies with temperature *or* (ii) how the grid voltage controls the anode current in a triode. Sketch the form of graph you would expect to obtain in the experiment you describe.

8. Give a brief account of the experimental evidence in support of the wave nature of X-rays.
Summarise the properties of X-rays. In what respect does the origin of X-rays differ from that of optical spectra?
An X-ray tube with a copper anode is operated at 40 kV and with a beam current of 10 mA. X-rays of wavelength 0·15 nm, called the K_α line, are emitted along with X-rays of other wavelengths. The intensity of the K_α line is half the intensity of all the X-rays emitted. The cooling water supplied to the anode of the tube removes 398 J of heat per second. Calculate the number of K_α photons emitted per second. (Planck's constant $= 6{\cdot}6 \times 10^{-34}$ J s, velocity of light $= 3{\cdot}0 \times 10^{8}$ m s^{-1}.)

9. Describe, with the aid of a diagram, the structure of a Geiger-Muller (GM) tube. Explain how the tube is used to detect the radiations emitted from radioactive nuclei. Comment on the relative effectiveness of the GM tube in detecting α, β and γ rays.
Outline another method of detecting radioactivity and indicate the principle involved.
The isotope $^{90}_{38}Sr$ decays by β emission and has a decay constant of $8 \times 10^{-10}\ s^{-1}$. Calculate the mass of this isotope present in a source which emits $2{\cdot}4 \times 10^{4}$ β particles per second. (Take Avogadro's constant(number) $= 6{\cdot}0 \times 10^{23}\ mol^{-1}$.)

10. Answer any *two* of the following.

(a) Define the ampere. Describe an experiment to check the accuracy of an ammeter without using another ammeter.

(b) Describe a method, giving the relevant theory, of measuring the wavelength of monochromatic light using Young's slits *or* a diffraction grating.

(c) Explain the terms, amplitude, frequency, fundamental, harmonic, in relation to wave motion. With regard to sound, describe how each of the above may be demonstrated experimentally.

(d) Describe the structure of a photoelectric cell. Explain how the effect of varying the intensity *or* the wavelength of the light incident on a photoelectric cell may be investigated in the laboratory.

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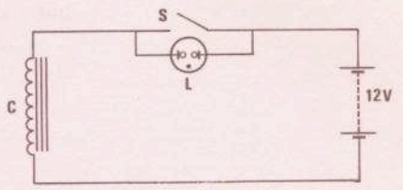

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