LEAVING CERTIFICATE EXAMINATION, 1987

PHYSICS—HIGHER LEVEL

Answer **all** questions in Section A.

Answer **two** questions from Section B and **three** questions from Section C.

SECTION A (120 marks)

Answer each question in this section.
Each question carries the same number of marks.
Write your answers in the spaces provided.
Write your examination number at the top.
Be sure to return this section of the examination paper, enclosing it in the answer book you use in answering Sections B and C.

1. Answer *five* of the following items, (i), (ii), (iii), etc. In the case of each item write the letter corresponding to the correct answer in the box provided.

(i) When a body is thrown vertically upwards and reaches its greatest height

A. its velocity is zero and its acceleration is zero
B. its velocity is zero and its acceleration is not zero
C. its velocity is not zero and its acceleration is downwards
D. its velocity is not zero and its acceleration is upwards
E. its velocity is zero and its acceleration is upwards.

Answer [B] (6)

(ii) The weight of a body is W at a point on the earth's surface where the radius of the earth is r. At which of the following heights above the surface of the earth will the weight of the body be $W/4$?

A. $r/2$
B. r
C. $2r$
D. $3r$
E. $4r$.

Answer [C] (6)

(iii) The unit of power, the watt, may be written as $J s^{-1}$ $N m s^{-1}$

A. $N s^{-1}$
B. $N s$
C. $N m s$
D. $N m s^{-1}$
E. $N m s^{-2}$.

Answer [D] (6)

(iv) The fundamental frequency of a uniform stretched string of fixed length is 200 Hz. If the tension of the string is increased by a factor of 4 its new fundamental frequency is

A. 50 Hz
B. 100 Hz
C. 400 Hz
D. 800 Hz
E. 3,200 Hz.

Answer [C] (6)

$$f = \frac{n}{2l}\sqrt{\frac{T}{\mu}}$$

(v) The resistance of a piece of uniform copper wire is $R = \rho \frac{L}{A}$ ρ

A. proportional to its length and to its diameter
B. proportional to its length and to its diameter squared
C. proportional to its length and inversely proportional to its diameter squared
D. proportional to its length and inversely proportional to its diameter
E. proportional to its length and inversely proportional to the square root of its diameter.

Answer [C] (6)

(vi) Which of the following is the order of magnitude of the radius of the nucleus?

A. 10^{-10} m
B. 10^{-15} m
C. 10^{-19} m
D. 10^{-27} m
E. 10^{-31} m.

Answer [B] (6)

2. Answer *five* of the following.

(i) Give an equation which defines simple harmonic motion .... $s \propto -\omega^2 a$ .... (6)

(ii) What is the relationship between force and momentum? .... The rate of change of momentum is equil + in the same direction as the force applied .... (6)

(iii) Avogadro's constant is defined as the number of particles in .... 1 mole .... and is equal to the number of atoms in 12 g of .... Carbon - 12 .... (6)

(iv) What is the Doppler effect? .... The apparent change in frequency due to the motion of the source .... (6)

(v) Name the scientist who established the relationship between the mass of an element liberated in a voltameter and the charge which passed through the voltameter .... Faraday .... (6)

(vi) In a field effect transistor (FET) the .... ~~Emitter~~ Drain .... current is controlled by the .... ~~Base~~ Gate .... voltage. (6)

3. Answer *five* of the following.

(i) When two bodies become charged by contact with each other, one loses .... electrons .... and becomes .... positively .... charged while the other gains .... electrons .... and becomes .... negatively .... charged. (6)

(ii) Fig. 1 shows a positively charged conductor. Indicate on the diagram how the charge would be distributed over the surface of the conductor.

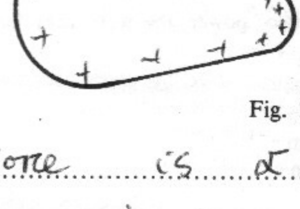

Fig. 1 (6)

(iii) State Coulomb's law of force between electric charges .... Force is $\propto$ to the product of the charges and inversley $\propto$ to the square of the Distance. .... (6)

(iv) Define the unit of charge, i.e. the coulomb .... The coulomb is the charge transfered when a current of 1 A flows for 1 s. .... (6)

(v) Give an expression for the force on a charge q travelling at a speed v in a uniform magnetic field of flux density B .... F = BQV .... (6)

(vi) What charge is required to liberate 0·66 g of copper? (Electrochemical equivalent of copper = $3{\cdot}3 \times 10^{-7}$ kg C^{-1}.) .... m = zIt .... m = zQ

Q = m/z = 1.66 × 10⁻³ / 3.3 × 10⁻⁷ .... (6)

4. Answer *five* of the following.

(i) What is meant by electromagnetic induction? .... The induction of an Emf in a closed loop of conductor when the magnetic field around it changes. (6)

(ii) State Lenz's law of electromagnetic induction .... The emf induced serves to oppose the change of the ... causing it. (6)

(iii) Name the principal parts of an a.c. generator .... Coil, Brushes, slip-rings fixed magnets .... (6)

(iv) What causes eddy currents in the core of a transformer? .... changing magnetic field near a conductor ....

How is the effect of these currents reduced? .... lamination of the core. .... (6)

(v) An induction coil was invented by .... callan ...., working at Maynooth College in the .... 19 .... century. (6)

(vi) A transformer coil is designed to be used on a 220 V a.c. supply. What is likely to happen if the transformer is accidentally connected to a 220 V d.c. supply? .... Nothing ....

Explain .... As there is no alternating current there is no changing magnetic field => there is no induced current or EMF. (6)

LEAVING CERTIFICATE EXAMINATION, 1987

PHYSICS—HIGHER LEVEL

SECTION B (80 marks)

Answer **two** of the questions from this section.
Each question carries the same number of marks.

5. In an experiment to measure acceleration a constant force was applied to a body so that it moved over a sheet of paper, marked with vertical lines 1 mm apart. As the body moved it left marks on the paper at intervals of 1/50 s as shown in Fig. 2. Calculate the average velocity of the body between A and B. Hence, or otherwise, determine a value for the acceleration of the body. (24)

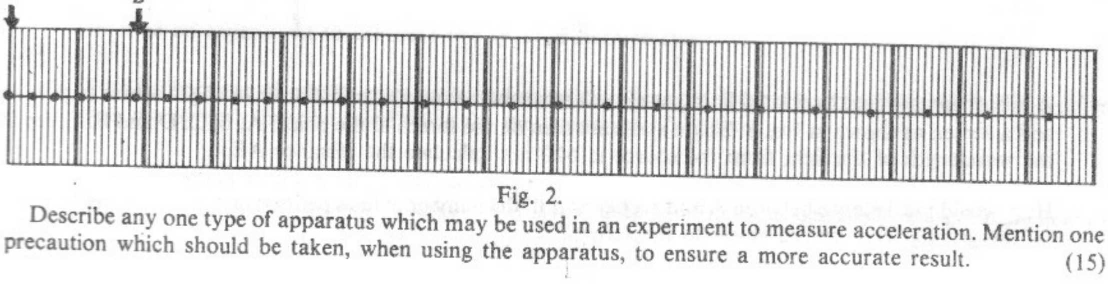

Fig. 2.

Describe any one type of apparatus which may be used in an experiment to measure acceleration. Mention one precaution which should be taken, when using the apparatus, to ensure a more accurate result. (15)

6. The speed of sound in air may be measured in a laboratory experiment by setting up stationary waves. Explain how stationary sound waves may be produced and give a method for the detection of the nodes (or antinodes). Hence, show how the speed of sound in air is measured. (18)

If the frequency of the waves is increased how is the distance between the nodes (or antinodes) changed? Explain how this change may affect the accuracy of the experiment. (12)

Given that the speed of sound in air is 340 m s^{-1} and that the distance between successive nodes (or antinodes) is 33 cm calculate the frequency of the waves. (9)

7. Joule's law was verified experimentally by passing a current through a heating coil in a calorimeter containing water and determining the rise in temperature, θ, for a series of values of the current, I. The time for which the current flowed in each case was 3 minutes. The results obtained are shown in the following table.

I/A	0·5	1·0	1·5	2·0	2·5	3·0	3·5
θ/°C	1·0	4·0	6·4	14·0	21·6	29·4	40·0

Draw a suitable graph and explain how this verifies Joule's law. (18)

How would the accuracy of the experiment have been affected if the current had flowed for a shorter time in each case? (6)

Given that the mass of water in the calorimeter was 80 g in each case and assuming that all of the electrical energy supplied was absorbed by the water use the graph to determine the resistance of the heating coil. (Specific heat capacity of water = $4 \cdot 18 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$.) (15)

SECTION C (200 marks)

Answer **three** questions from this section.
Each question carries the same number of marks.

8. Define (i) energy, (ii) specific latent heat. (12)

Describe a laboratory experiment to measure the specific latent heat of fusion of ice. (21)

A hailstone falls from rest and reaches a constant speed at a height of 2·0 km above the ground. Use a diagram to show the forces acting on the hailstone and explain why it reaches a constant speed. (12)

When the hailstone is at a height of 2·0 km its mass is 2·50 g. What is its potential energy? Assuming that all of this potential energy is converted to latent heat during the fall, calculate the mass of the hailstone on reaching the ground. (Specific latent heat of fusion of ice = $3 \cdot 3 \times 10^5 \text{ J kg}^{-1}$; acceleration due to gravity, $g = 9 \cdot 8 \text{ m s}^{-2}$.) (21)

9. (*a*) State the laws of refraction of light. (6)

Describe an experiment to measure the focal length of a converging lens. (15)

Use a ray diagram to show how the final image is formed in a compound microscope. (9)

(*b*) Diffraction and interference both occur when light passes through a diffraction grating. Explain. (9)

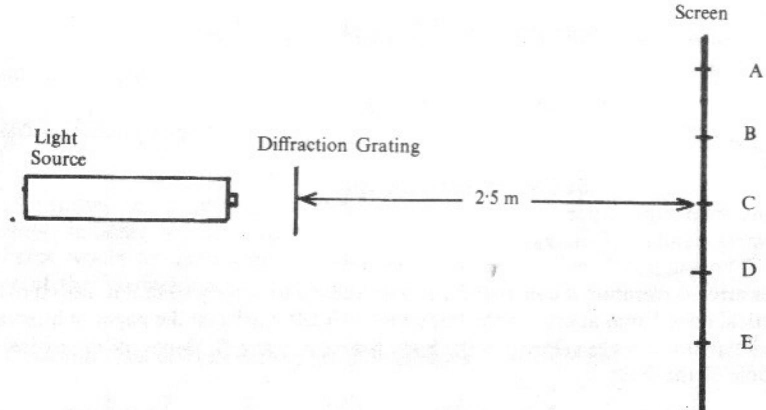

Fig. 3

A diffraction grating, having 80 lines per mm, is arranged between a monochromatic light source (e.g. a laser) and a screen as shown in Fig. 3. Bright spots are seen on the screen at the points A, B, C, D and E. Given that the wavelength of the light from the source is 620 nm calculate the distance AE. (15)

How would the distance between A and E change if (i) the number of lines per mm on the grating were reduced, (ii) the grating were moved closer to the screen? (12)

10. State Ohm's law. (6)

Describe an experiment to show how the resistance of a wire varies with its temperature. (18)

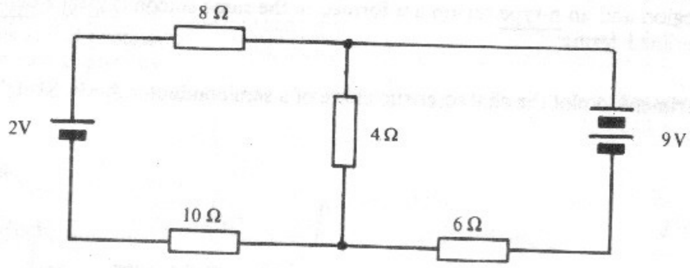

Fig. 4

Use Kirchhoff's laws to calculate the current flowing through the 4 Ω resistor in the circuit shown in Fig. 4. (24)

Draw a simple circuit diagram for an ohmmeter and explain how it works. (18)

11. Give *two* properties of the electron. (6)

A photoelectric cell and a photodiode are two devices which are sensitive to light. Describe the structure of each and, in each case, explain what happens when light falls on the device. (24)

Describe an experiment to show how the current in a photoelectric cell *or* a photodiode depends on the intensity of the light falling on it. (15)

When light of frequency $4{\cdot}6 \times 10^{16}$ Hz falls on a certain photoelectric cell the photocurrent is found to be 0·12 mA. Assuming that each of the incident photons causes an electron to be emitted and that all of the emitted electrons cross the cell, calculate

(i) the number of photons striking the cathode per second, (12)

(ii) the light energy falling on the cathode per second. (9)

(Charge on electron, $e = 1{\cdot}6 \times 10^{-19}$ C; Planck's constant, $h = 6{\cdot}6 \times 10^{-34}$ J s.)

12. Name the three main types of nuclear radiation and give *two* properties of each. (18)

Name *one* type of detector used to detect nuclear radiation and explain how it works. (15)

When cobalt-59 is irradiated with neutrons a radioactive isotope of cobalt is formed and a gamma ray photon is emitted. Write an equation to represent this reaction and give *one* use of the isotope formed. (Refer to the Periodic Table of the elements in the Mathematics Tables, p. 44.) (15)

The mass of the cobalt-59 nucleus is $9{\cdot}7859 \times 10^{-26}$ kg and the mass of the nucleus produced in the above reaction is $9{\cdot}9520 \times 10^{-26}$ kg. Given that the mass of a neutron is $1{\cdot}6749 \times 10^{-27}$ kg calculate the energy of the photon produced in the reaction. (Neglect the kinetic energies of the particles involved. Take the speed of light in vacuum, $c = 3{\cdot}0 \times 10^8$ m s^{-1}.) (18)

13. Answer any *two* of the following.

(*a*) Fig. 5 shows a particle travelling on a circular path of radius r with a constant angular speed, ω. In a time t the particle moves from the point P to the point Q shown in the diagram. Derive expressions, in terms of r, ω and t, for the components of the displacement of the particle from O parallel to the X and Y axes. (12)

Hence, or otherwise, derive an expression for (i) the tangential velocity, (ii) the centripetal acceleration, of the particle. (21)

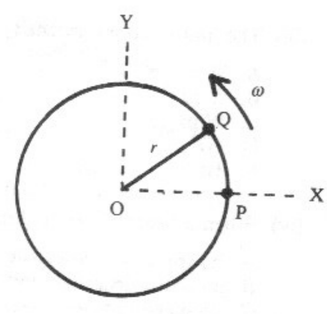

Fig. 5

(*b*) State the principles underlying the establishment of a scale of temperature. (9)

Describe an experiment to calibrate *one* type of thermometer. (15)

If the temperature of a body were measured using this thermometer and another thermometer of a different type, would both give the same value for the temperature? Explain. (9)

(*c*) Define (i) potential difference, (ii) capacitance. (12)

Explain how the capacitance of a charged body is increased by bringing an oppositely charged body near to it. (9)

Describe an experiment to show how the capacitance of a pair of parallel plates varies with their common area. (12)

(*d*) When a p-type region and an n-type region are formed in the same silicon crystal a depletion layer is formed. Explain the underlined terms. (12)

Describe an experiment to plot the characteristic curve of a semiconductor diode. Sketch the graph you would expect to obtain. (21)