LEAVING CERTIFICATE EXAMINATION, 1989

PHYSICS — HIGHER LEVEL

THURSDAY 15 JUNE — MORNING 9.30 to 12.30

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) The unit of momentum may be written as

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

Answer ☐ (6)

(ii) When a satellite is travelling in a circular orbit of radius r, its period, T, is proportional to

A. r^3
B. r^2
C. $1/r^2$
D. $r^{2/3}$
E. $r^{3/2}$.

Answer ☐ (6)

(iii) The critical angle for a certain substance is 25°. The refractive index of the substance is

A. 0·04
B. 0·42
C. 1·3
D. 1·5
E. 2·4.

Answer ☐ (6)

(iv) An electric motor is connected to a battery and used to turn a wheel. If a brake is applied to the wheel so that the speed of the motor is reduced the current flowing through the motor

A. decreases because the induced e.m.f. decreases
B. remains the same because the induced e.m.f. does not change
C. increases because the induced e.m.f. decreases
D. increases because the induced e.m.f. increases
E. decreases because the induced e.m.f. increases.

Answer ☐ (6)

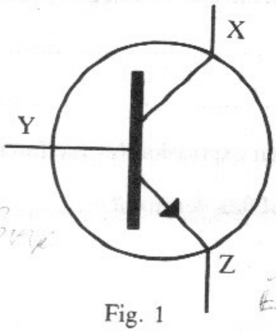
(v) Which of the following has *no* effect on the maximum kinetic energy of the electrons emitted from a metal by photoelectric emission?

A. The nature of the metal.
B. The work function of the metal.
C. The frequency of the light.
D. The brightness of the light.
E. The wavelength of the light.

Answer ☐ (6)

(vi) Fig. 1 shows a diagram of a transistor which is to be used in an amplifier circuit. Which of the following statements is correct?

A. Y is the base and should be positive with respect to Z.
B. Z is the emitter and should be positive with respect to X.
C. Y is the collector and should be positive with respect to X.
D. Z is the base and should be negative with respect to X.
E. X is the emitter and should be negative with respect to Y.



Collector

Base

Emit

Fig. 1

Answer ☐ (6) A

2. Answer *five* of the following.

(i) State the principle of conservation of energy. .... (6)

(ii) What is meant by the solar constant? Amount of Energy normally falling on 1 m² of the Earths Atmosphere per second when the Earth (6) at its mean distance from the sun.

(iii) What is meant by electric flux? ....
$\Psi = EA$ A: Area E: Electric field str. Ψ = flux (6)

(iv) State Faraday's law of electromagnetic induction .... (6)

(v) X-rays are produced when fast electrons hit metal .... (6)

(vi) Name the Irish physicist who was awarded a Nobel prize in 1951. ETS Walton

Give one development in physics with which he was associated. Mass energy Equation, First time accelerator used to produce (6) a Nuclear reaction

3. Answer *five* of the following.

(i) State Newton's first law of motion. .... (6)

(ii) The moment of a force is equal to Product of Force and ⊥ distance from Axis

Its unit is Nm (6)

(iii) A person of mass 60 kg is standing in a lift which is moving with an acceleration of 0·5 m s^{-2} upwards.

What is the resultant force acting on the person? 30 N $F = (ma) = (60)(.5)$ (6)

(iv) A tank of oil, in the form of a cube of side 1·5 m, sits on a horizontal surface. The pressure at the bottom of the tank due to the oil is 800 Pa. Calculate the weight of the oil. .... (6)

(v) Define the unit of current, i.e. the ampere ....

....

....(6)

(vi) Give an expression for the force on a charge q moving with a velocity v at right angles to a magnetic field of flux density B. ....(6)

4. Fig. 2 shows an arrangement used by a student to determine the electrochemical equivalent of copper. Answer *five* of the following.

(i) Label the anode and cathode on the diagram (Fig. 2). (6)

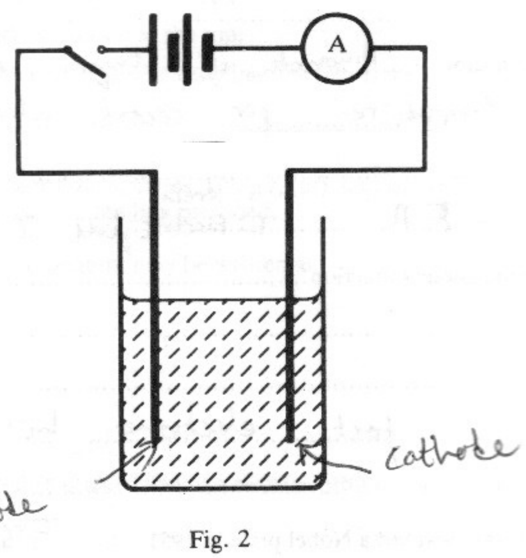


Fig. 2

(ii) Name the device which is missing from the circuit. .... Rheostat ....(6)

(iii) Give two measurements which must be made in this experiment. .... time

.... current ....(6)

(iv) State Faraday's first law of electrolysis. .... $m = ZIt$

.... m = mass of transfered .... I : current flowing

.... z = e.c.e of material .... t : time current flows for ....(6)

(v) Given that the mass of copper deposited by a charge of 500 C was 0·16 g calculate a value for the electrochemical equivalent of copper. .... 3.2×10^{-7} kg C^{-1}

....(6)

(vi) Give two practical applications of electrolysis. .... Electroplating, Ore seperation

....(6)

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PHYSICS — HIGHER LEVEL

Section A is on a separate sheet which provides spaces for your answers. The completed sheet should be enclosed in your answer book.
Write your answers to Sections B and C in your answer book.

SECTION B (80 marks)

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

5. In an experiment using a simple pendulum to determine the value of g, the acceleration due to gravity, the following results were obtained for the length of the pendulum, l, and the time for 40 oscillations, t.

l/m	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9
t/s	34·6	42·9	51·4	56·6	62·6	65·7	70·4	75·9

Draw a suitable graph on graph paper and hence determine the value of g. (24)

Between which points is the length of the pendulum measured? (6)

State why it is important that the pendulum be allowed to swing through only a small angle and give one other precaution which should be taken when carrying out this experiment to ensure an accurate result. (9)

6. The following is part of a student's description of an experiment to measure the specific latent heat of fusion of ice.

"Some warm water was poured into a copper calorimeter. Crushed, dried ice was added to the water. The temperature of the ice was assumed to be 0 °C."

Explain (i) why warm water was used, (ii) why the ice was crushed and dried. (12)

How would the mass of the ice have been determined? (6)

Give the other measurements which would have been taken. (6)

Give the equation which would have been used in the calculation of the specific latent heat of fusion of the ice and mention one precaution, other than those already given, which would improve the accuracy of the result. (9)

Explain how the value obtained for the specific latent heat of fusion would have been affected if the temperature of the ice had not been 0 °C when it was added to the water. (6)

7. The internal resistance of a cell was measured by connecting a number of resistors of known resistance, in turn, across the terminals of the cell and measuring the potential difference across the resistor in each case. The following results were obtained.

R/Ω	2·0	5·0	10·0
V/V	1·0	1·3	1·4

Given that the e.m.f. (electromotive force) of the cell was measured and found to be 1·5 V, use the values given to calculate the internal resistance of the cell. (15)

Draw a circuit diagram for this experiment. (6)

Name an instrument which might have been used to measure the e.m.f. of the cell and the potential difference across the resistor. (6)

What problems would arise if resistors of (*a*) much smaller resistance, (*b*) much larger resistance, were used? (12)

SECTION C (200 marks)

Answer **three** questions from this section.

Each question carries the same number of marks.

8. Define (i) velocity, (ii) angular velocity. (6)

Explain what is meant by centripetal force. (6)

Describe an experiment to measure the coefficient of dynamic friction. (18)

A particle moves on a horizontal circular path of radius r with a constant angular velocity ω. Derive an expression for the linear velocity of the particle in terms of r and ω. (9)

A racing track is in the form of a circle of radius 20 m. A motorcyclist, travelling around the track with a constant angular velocity of 0·50 rad s^{-1}, passes a particular point P moving due North, Fig. 3. When passing the point Q the motorcyclist is moving due South. Calculate the magnitude and direction of

(i) the displacement of Q from P, (6)

(ii) the velocity of the motorcyclist at Q. (9)

Given that the coefficient of friction between the tyres and the track is 0·6 calculate the maximum angular velocity with which the motorcyclist can travel without slipping.

(Take the acceleration due to gravity, $g = 9{\cdot}8$ m s^{-2}.) (12)

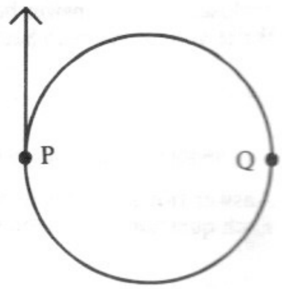

Fig. 3

9. Give *four* assumptions of the kinetic theory of gases. (6)

Use the kinetic theory equation, $pV = \frac{1}{3}Nm\overline{c^2}$, to prove Avogadro's law. (12)

State Boyle's law and describe an experiment to verify it. (15)

Explain how Boyle's law is used in the definition of the Kelvin temperature scale. (9)

State what is meant by the triple point of water and explain why the number 273·16 is assigned to it. (9)

The product of the pressure and volume (pV) of a fixed mass of gas is 16·0 Pa m^3 at the triple point of water. Assuming ideal gas behaviour, what is the value of pV for the gas at 300 K? Given that the mass of the gas is 0·24 g calculate the root-mean-square speed of its molecules at this temperature. (15)

10. State the laws of refraction of light. (6)

Explain the difference between a real image and a virtual image. (6)

Use a ray diagram to show how (i) a real image, (ii) a virtual image, is formed by a converging lens. (12)

Name the principal parts of a spectrometer and give two adjustments which must be made to this instrument before it is used. (12)

Describe an experiment, using a spectrometer or otherwise, to find the wavelength of monochromatic light. (18)

Fig. 4 shows a ray of light travelling from glass to air. Explain, in terms of waves, why the light changes direction as it goes from glass into air as shown in the diagram. (12)

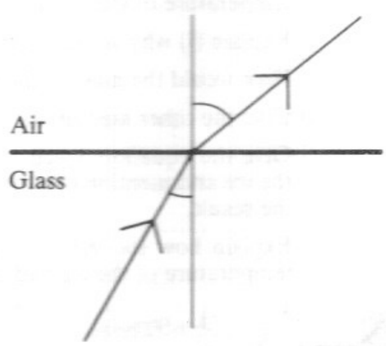

Fig. 4

11. State Joule's law. (6)

Explain why it is more economical to transmit electrical energy at high voltages and give one advantage of using a.c. rather than d.c. for this purpose. (12)

Draw a diagram of a domestic circuit containing two lamps, each controlled by a separate switch. (12)

Calculate the current normally flowing through a 100 W bulb connected to the 220 V mains supply. State why the initial current through the bulb when it is switched on is greater than the normal current. (15)

An electric cable consists of a single strand of insulated copper wire. The wire is of uniform circular cross-section and is designed to carry a current of 5 A. The maximum rate at which heat may be produced in the wire without causing a significant increase in temperature is 0·1 W per metre length of the cable. Calculate

(i) the maximum resistance per unit length of the wire,

(ii) the minimum diameter of the wire given that the resistivity of copper, assumed constant, is $1{\cdot}7 \times 10^{-8}\ \Omega$ m. (21)

12. Explain the terms (i) doping, (ii) depletion layer. (12)

Describe an experiment to plot the characteristic curve of a semiconductor diode. (18)

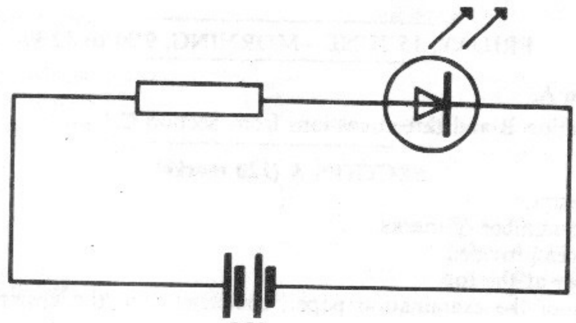

Fig. 5

(i) Fig. 5 shows a light-emitting diode (LED) connected in series with a resistor and a 6 V battery. Calculate the minimum resistance of the resistor given that the maximum current which should be allowed to flow through the diode is 10 mA. Assume that the potential difference across the diode is 1·7 V when the current is 10 mA. (12)

(ii) If the battery in Fig. 5 were to be replaced with a source of a.c. current, e.g. a signal generator, which was producing an alternating current of very low frequency (e.g. 1 Hz) what would be the effect on the diode? Explain how this effect comes about. (12)

(iii) Sketch a graph to show how the potential difference across the resistor varies with time when the source of a.c. current is in the circuit. (6)

(iv) Give two practical applications of light-emitting diodes. (6)

13. Answer any *two* of the following.

(*a*) Define the term sound intensity and give its unit. (9)

What are the wave properties on which (i) the loudness, (ii) the pitch, of a musical note depends? (6)

When the source of a musical note is moving, a person standing nearby may notice a change in the note. State what the change is and give the name of this effect. (6)

Explain briefly, with the aid of a suitable diagram, how this effect occurs. (12)

(*b*) Define potential difference. (6)

How may it be shown experimentally that a capacitor stores energy? (9)

Derive an expression for the energy stored in a capacitor in terms of its capacitance and the potential difference between its plates. (9)

Fig. 6 shows a capacitor connected in series to a power supply, P, and a lamp, L. Explain why the lamp lights if P is an a.c. power supply but not if it is a d.c. power supply. (9)

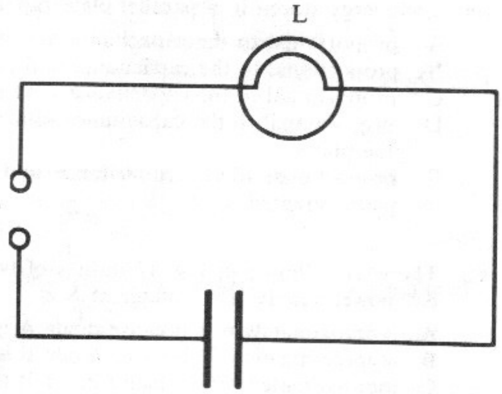

Fig. 6

(*c*) Describe an experiment to plot the magnetic field due to a current in a solenoid. (9)

Name the principal parts of an electromagnetic relay and explain how it works. (18)

Give one application of the electromagnetic relay. (6)

(*d*) Explain what is meant by nuclear fission. (6)

What is the function of (i) the moderator, (ii) the control rods, in a nuclear reactor? (12)

The fission of one uranium-235 nucleus releases 200 MeV of energy. Calculate the amount of energy, in joules, released by the fission of 1 kg of uranium-235.

(Mass of 1 mol of U-235 = 235 g; Avogadro's number, $N_A = 6{\cdot}0 \times 10^{23}$ mol^{-1};
1 eV = $1{\cdot}6 \times 10^{-19}$ J.) (15)