WARNING: You must return this section with your answer book otherwise marks will be lost.

Write your Examination Number here

AN ROINN OIDEACHAIS

LEAVING CERTIFICATE EXAMINATION, 1994

PHYSICS — HIGHER LEVEL

THURSDAY, 16 JUNE — AFTERNOON, 2.00 to 5.00

Answer **all** questions in Section A.

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

SECTION A (120 marks)

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 power, the watt, is equivalent to

A. kg m s^{-1}
B. kg m s^{-2}
C. kg m^2 s^{-1}
D. kg m^2 s^{-2}
E. kg m^2 s^{-3}.

Answer ☐ (6)

(ii) The acceleration due to gravity, g, on the surface of a planet of mass m and radius r is

A. proportional to m and inversely proportional to r
B. proportional to m and inversely proportional to r^2
C. proportional to r and inversely proportional to m
D. proportional to r^2 and inversely proportional to m
E. proportional to r^2 and inversely proportional to m^2.

Answer ☐ (6)

(iii) The threshold of hearing is

A. the lowest frequency to which the human ear can respond when the intensity level is 1 B
B. the lowest intensity to which the human ear can respond when the frequency is 1 kHz
C. the lowest pitch to which the human ear can respond when the intensity level is 1 B
D. the lowest intensity to which the human ear can respond when the intensity level is 1 B
E. the lowest intensity level to which the human ear can respond when the intensity is 1 W m^{-2}.

Answer ☐ (6)

3. Answer *five* of the following.

(i) Define centripetal force. ....

.... (6)

(ii) When a tennis ball is struck by a racquet its momentum changes by 1.6 kg m s^{-1} in a particular direction. If the ball is in contact with the racquet for 0.1 s what is the average force exerted by the racquet on the ball?

.... (6)

(iii) According to Archimedes' principle when a body is immersed in a fluid the ....

.... is equal to the .... (6)

(iv) When a body is sliding along a surface the frictional force is proportional to the.................................

.... and the constant of proportionality is called the

.... (6)

(v) The ....at a point is defined as the force per unit positive charge at that point. (6)

(vi) The force required to deflect a beam of electrons in a cathode ray tube may be produced by ....

.... (6)

4. Fig. 1 shows a simple diagram of a spectrometer. Answer *five* of the following.

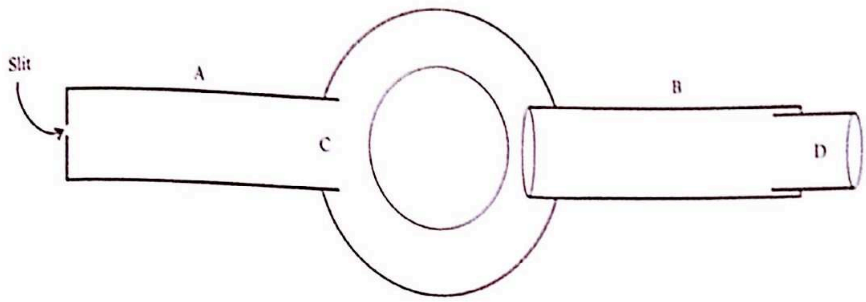

Fig. 1

(i) Name the parts labelled A and B.

A. .... B. .... (6)

(ii) What is the function of part A? ....

.... (6)

(iii) What part of the spectrometer is represented by the letter D?.. (6)

(iv) Part A contains a lens C. What type of lens is it? .... (6)

(v) When the spectrometer has been properly adjusted the distance from the slit to the lens C should be equal to .... (6)

(vi) When a diffraction grating is placed on the spectrometer table a series of images may be observed. What adjustment should be made to the spectrometer if the images are found to be too faint? ....

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

5. In an experiment to measure the specific heat capacity of a liquid a quantity of the liquid was heated in a copper calorimeter. The following measurements were obtained.

Mass of calorimeter .... = 26.5 g
Mass of calorimeter + liquid .... = 71.3 g
Initial temperature of calorimeter + liquid .... = 16 °C
Final temperature of calorimeter + liquid .... = 21 °C
Energy supplied .... = 584 J

Using these measurements calculate a value for the specific heat capacity of the liquid given that the specific heat capacity of copper is 390 J kg^{-1} K^{-1}. (15)

Describe the apparatus which might have been used in this experiment in addition to the calorimeter. (9)

Give two ways in which heat losses from the calorimeter might have been reduced in this experiment. (6)

Explain why using a larger mass of the liquid while supplying the same amount of energy might have produced a less accurate result. (9)

6. The relationship between the natural frequency of a stretched string and its tension was investigated by applying a force to the end of a wire of fixed length, l. The applied force was varied and the resulting values of the natural frequency f, and the tension T, of the wire were determined. The following results were obtained.

f/Hz	256	288	320	341	384	427	480	512
T/N	5.0	6.0	9.0	10.0	12.0	14.0	18.0	22.0

Draw a suitable graph on graph paper to illustrate the relationship between the natural frequency of the wire and its tension. State the relationship and explain how the graph verifies it. (18)

Given that the length l of the wire was 64 cm use the graph to calculate a value for the mass per unit length of the wire. (Assume that the wire was vibrating at its lowest natural frequency, i.e. its fundamental frequency.) (12)

Explain how the natural frequency of the wire might have been determined in this experiment. (9)

7. The following is part of a student's account of an experiment to determine the internal resistance of a cell.

"The e.m.f. of the cell was measured using a potentiometer and found to be 1.5 V. When a resistor, of resistance 2.0 Ω, was connected to the cell the potential difference between its terminals was found to be 1.1 V."

Draw a circuit diagram for this experiment. (9)

Explain how the e.m.f. of the cell would have been measured. (12)

What is the advantage of using a potentiometer rather than a voltmeter to measure the e.m.f. of the cell? (6)

Using the values given in the student's account calculate a value for the internal resistance of the cell. (12)

SECTION C (200 marks)

Answer **three** questions from this section.

Each question carries the same number of marks.

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

Give an equation which defines simple harmonic motion. (6)

Describe a laboratory experiment to determine the value of g, the acceleration due to gravity. (18)

A particle is undergoing simple harmonic motion in a straight line. When it is 5.4 cm from its equilibrium position the magnitude of its acceleration is 2.8 cm s^{-2}. What is the period of the motion? (12)

Fig. 2 shows a simple pendulum which has a length of 85 cm. The maximum angular displacement of the pendulum is 35°. Use the principle of conservation of energy to calculate the maximum speed of the pendulum bob.

Explain why the motion of this pendulum should not be considered to be simple harmonic motion.

(Acceleration due to gravity, $g = 9.8 \text{ m s}^{-2}$.)

(24)

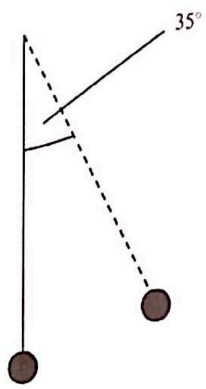

Fig. 2

9. Explain the terms (i) thermometric property, (ii) ideal gas. (12)

State Boyle's law and describe an experiment to verify it. (21)

Explain how Boyle's law may be used in the definition of the Kelvin scale of temperature. (15)

The following is part of a student's account of an experiment to calibrate and use a mercury thermometer and a thermocouple thermometer.

"When the thermometers had been calibrated both were placed in a beaker of warm water. The mercury thermometer gave a value of 51 °C while the thermocouple thermometer gave a value of 52.5 °C. I concluded that the true value for the temperature of the water was 51 °C rather than 52.5 °C."

Why did the two thermometers give different values for the temperature of the water in the beaker? (9)

Explain why the student was not entitled to conclude that 51 °C was the "true value" for the temperature of the water. (9)

10. State Ohm's law. (6)

Describe an experiment to measure the resistivity of the material of a wire. (18)

Give an expression for the effective resistance of two resistors connected in parallel with each other. (3)

In the circuit shown in Fig. 3, R is a variable resistor which has a maximum resistance of 600 Ω. When R is set at its maximum value calculate:

(i) the effective resistance of the circuit (assume that the internal resistance of the battery is negligible);

(ii) the current flowing in the 1 kΩ resistor. (21)

If the resistance of R is reduced explain the effect this would have on (i) the current flowing in the 800 Ω resistor, (ii) the potential at A, (iii) the current flowing in the 1 kΩ resistor. (18)

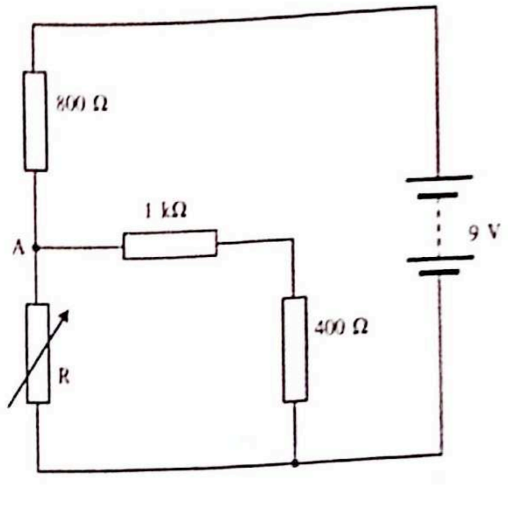

Fig. 3

11. State the laws of electromagnetic induction. (12)

Describe an experiment to illustrate *one* of these laws. (12)

Draw a labelled diagram of an a.c. generator. (12)

Fig. 4 shows a power supply P, which can supply either a.c. or d.c. at a set voltage, connected to an unknown component X, and an ammeter which can be set to measure either a.c. or d.c. as required. In each of the following cases state what X is and give the reason for your answer.

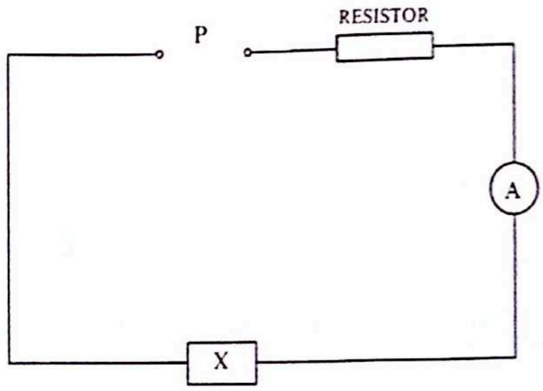

Fig. 4

(i) When the power supply is switched to a.c. a current flows. When the supply is switched to d.c. a larger current flows. Reversing the terminals of X has no effect on the current. (12)

(ii) When the power supply is switched to a.c. a current flows. Reversing the terminals of X has no effect on the current. When the supply is switched to d.c. no current flows. (9)

(iii) When the power supply is switched to a.c. a current flows. When the supply is switched to d.c. no current flows. When the terminals of X are reversed, with the power supply still switched to d.c., a current flows. (9)

12. (*a*) What is the photoelectric effect? (6)

Give an expression for Einstein's photoelectric law. (9)

Light of wavelength 4.6×10^{-7} m falls on a metal which has a work function of 2.3 eV. Calculate the maximum kinetic energy of the emitted electrons.

(Speed of light in vacuum, $c = 3.0 \times 10^{8}$ m s^{-1}; charge on electron, $e = 1.6 \times 10^{-19}$ C; Planck's constant, $h = 6.6 \times 10^{-34}$ J s.) (15)

(*b*) Distinguish between nuclear fission and nuclear fusion. (12)

Complete the following nuclear reaction by replacing X with the appropriate symbol. (Refer to the Periodic Table of the elements in the Mathematics Tables, p. 44.) (9)

$$^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{141}_{55}\text{Cs} + \text{X} + 2\,{}^{1}_{0}\text{n} + 181 \text{ MeV}$$

Given that the masses of the uranium and caesium nuclei are 235.0439 u and 140.9196 u, respectively, and the mass of a neutron is 1.0087 u calculate the mass, in kg, of nucleus X.

(Charge on electron, $e = 1.60 \times 10^{-19}$ C; speed of light in vacuum, $c = 3.00 \times 10^{8}$ m s^{-1}; 1 u $= 1.66 \times 10^{-27}$ kg.) (15)

13. Answer any *two* of the following.

(*a*) State the difference between vector quantities and scalar quantities and give one example of each. (6)

Describe an experiment to verify the parallelogram law. (18)

A particle travels from A to B along the arc of a circle of radius 60 cm and centre O, as shown in Fig. 5. Calculate (i) the distance travelled, (ii) the displacement undergone, by the particle. (9)

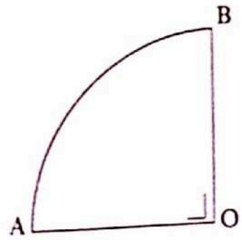

Fig. 5

(*b*) What is meant by refraction of light? (6)

Explain, in terms of waves, how refraction occurs. (12)

Outline briefly a terrestrial method for measuring the speed of light. (15)

(*c*) Define capacitance. (6)

How might it be demonstrated experimentally that a charged capacitor stores energy? Derive an expression for the energy stored in a charged capacitor. (18)

A capacitor has a capacitance of 4.7 μF. What is the charge on the plates when the energy stored is 0.52 mJ? (9)

(*d*) What is meant by the term doping in relation to semiconductors? (6)

Explain briefly the basic principles of (i) a bipolar transistor, (ii) a unipolar (field effect) transistor. (12)

Draw a circuit diagram for a NOT gate, clearly labelling the input and output terminals. Give the truth table for this type of gate. (15)