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

Write Your Examination Number here

AN ROINN OIDEACHAIS

12741

LEAVING CERTIFICATE EXAMINATION, 1997

PHYSICS — HIGHER LEVEL

THURSDAY, 19 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. J s^{-2}
B. J s^{-1}
C. J s
D. N m^{-1} s^{-1}
E. N m^{-1} s^{-2}.

Answer ☐ (6)

(ii) When light from a certain light source S is passed through a diffraction grating and onto a screen, Fig. 1, pairs of red and green lines, X and Y, are seen on the screen. Which of the following statements is correct?

A. X is red because the wavelength of red light is less than the wavelength of green light.
B. X is green because the wavelength of green light is less than the wavelength of red light.
C. Y is green because the wavelength of green light is less than the wavelength of red light.
D. Y is red because the frequency of red light is less than the frequency of green light.
E. X is green because the frequency of green light is less than the frequency of red light.

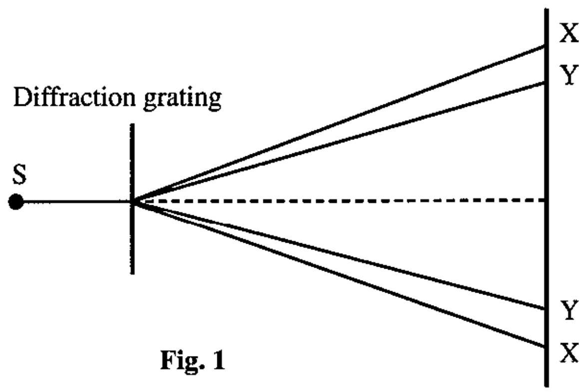

Fig. 1

Answer ☐ (6)

(iii) The temperature of a beaker of water is to be measured using a resistance thermometer consisting of a length of platinum wire. The resistance of the wire in melting ice, in the water in the beaker and in steam above boiling water is found to be 12 Ω, 27 Ω and 62 Ω, respectively. The temperature of the water in the beaker is

A. 70 °C
B. 33 °C
C. 30 °C
D. 15 °C
E. 7.5 °C.

Answer ☐ (6)

(iv) The energy stored in a parallel plate capacitor is

A. proportional to the capacitance and proportional to the charge on the plates
B. inversely proportional to the capacitance and proportional to the square of the charge on the plates
C. proportional to the capacitance and proportional to the square of the charge on the plates
D. inversely proportional to the capacitance and inversely proportional to the charge on the plates
E. proportional to the capacitance and inversely proportional to the square of the charge on the plates.

Answer ☐ (6)

(v) A constant current of 4.0 A flows through a 5 Ω resistor for 1.5 minutes. The heat produced in the resistor is

A. 30 J
B. 120 J
C. 150 J
D. 1800 J
E. 7200 J.

Answer ☐ (6)

(vi) Millikan's oil-drop experiment was designed to measure

A. the speed of an electron
B. the mass of an electron
C. the charge on an electron
D. the charge to mass ratio for an electron
E. the force on an electron.

Answer ☐ (6)

2. Answer *five* of the following.

(i) Define simple harmonic motion. ....

.... (6)

(ii) The coefficient of dynamic friction between two surfaces is ....

.... (6)

(iii) What is meant by the solar constant? ....

.... (6)

(iv) Give the principle on which the definition of the ampere is based...

.... (6)

(v) In a voltage amplifier, using a bipolar (npn) transistor, the resistor connected between the positive terminal of the battery and the .... of the transistor is called a ....resistor. (6)

(vi) How are artificial radioactive isotopes produced?...

.... (6)

3. Answer *five* of the following.

(i) The .... of a body is equal to the product of its mass and its velocity. (6)

(ii) The .... between two .... is proportional to the product of the masses and inversely proportional to .... (6)

(iii) The .... of an element is equal to the mass of the element deposited by .... (6)

(iv) One mole of electrons has a mass of 5.48×10^{-7} kg. What is the mass of an electron? (Avogadro's number, $N_A = 6.02 \times 10^{23}$ mol^{-1}.) .... (6)

(v) Two moving bodies have the same kinetic energies. If the speed of the first is 4 times the speed of the second what is the ratio of the mass of the first to the mass of the second?..

....(6)

(vi) The energy released in a certain nuclear reaction was 2.5×10^{-12} J. Given that the speed of light in a vacuum, $c = 3.0 \times 10^{8}$ m s^{-1}, what was the change in mass? ....

.... (6)

4. Answer *five* of the following.

(i) That fact that sound shows .... and ....effects indicates that it is a wave motion. (6)

(ii) The loudness of a sound depends mainly on the .... of the wave but it also decreases at higher .... (6)

(iii) Define sound intensity. ....

....(6)

(iv) What is meant by the threshold of hearing? ....

....(6)

(v) If the intensity of a sound increases by a factor of 2 what is the increase in intensity level? ....

.... (6)

(vi) The natural frequency of a string of fixed length is proportional to ....

and inversely proportional to .... (6)

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LEAVING CERTIFICATE EXAMINATION, 1997

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. The following is part of a student's account of an experiment to measure the value of g, the acceleration due to gravity, using a simple pendulum. "The pendulum was attached to the retort stand in such a way that it could swing freely about a fixed point. The length of the pendulum was measured. It was set swinging through a small angle and the time for 30 oscillations, t, was found. This procedure was repeated for a series of values of the length, l. The following results were obtained."

l/m	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
t/s	32.9	37.3	41.4	46.5	51.1	53.2	57.3	59.6

Draw a suitable graph on graph paper and from the graph determine a value for the acceleration due to gravity, g. (21)

How might the student have ensured that the point about which the pendulum was swinging remained fixed? (6)

Explain how the number of oscillations affects the accuracy of this experiment. (6)

While counting the number of oscillations for each value of the length the student noticed that the amplitude decreased slightly. Did this affect the accuracy of the final result? Explain. (6)

6. The following measurements were obtained in an experiment to determine the specific latent heat of fusion of ice.

Mass of calorimeter .... = 46.8 g
Mass of calorimeter + warm water .... = 99.2 g
Temperature of calorimeter + warm water .... = 26 °C
Temperature of ice .... = 0 °C
Mass of ice .... = 8.6 g
Final temperature of calorimeter + water + ice .... = 12 °C

Given that the calorimeter was made of copper of specific heat capacity 390 J kg^{-1} K^{-1} and that the specific heat capacity of water is 4180 J kg^{-1} K^{-1} calculate a value for the specific latent heat of fusion of ice. (21)

Describe how the mass of the ice might have been determined. (6)

Explain why warm water was used in the calorimeter and why the ice should have been dried before being added to the water in the calorimeter. (12)

7. A certain logic gate has two inputs, A and B, and one output. Part of the truth table for the gate is shown in Fig. 2.

State the name of this gate and give its symbol. (6)

Copy Fig. 2 and complete the last two lines of the truth table. (6)

Draw a diagram of a circuit which might have been used in an experiment to verify the truth table. Label the input and output terminals and give the steps involved in carrying out the experiment. (21)

Explain how the output of the gate might have been detected. (6)

A	B	Output
1	1	1
1	0	1

Fig. 2

SECTION C (200 marks)

Answer **three** questions from this section.

Each question carries the same number of marks.

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8. State (i) Newton's second law of motion, (ii) Archimedes' principle. (12)

Describe an experiment to verify Newton's second law. (18)

When a small body is released in a liquid it initially accelerates and then reaches a constant speed. Explain, with the aid of a diagram, why the body reaches a constant speed. (12)

A sphere of radius r and density ρ_s is released from rest in a tall graduated cylinder which is filled with a liquid of density ρ_l. Show that the upthrust (buoyancy force), B, acting on the sphere is given by $B = \frac{4}{3}\pi r^3 \rho_l g$, where g is the acceleration due to gravity. Hence show that the initial acceleration of the sphere is given by $a = g(\rho_s - \rho_l)/\rho_s$. (24)

9. State the laws of refraction of light. (9)

Describe an experiment to measure the refractive index of a liquid *or* a solid. (18)

Draw a labelled diagram to show how the final image is formed in an astronomical telescope in normal adjustment and state the factors which determine the magnifying power of such a telescope. (15)

Fig. 3 shows a lamp box L placed at a fixed distance from a screen S. A converging lens is placed between L and S. Explain why there will, in general, be two positions of the lens for which a sharp image of the opening in the lamp box will be formed on the screen. One of these positions is shown in Fig. 3. Using the values given on the diagram find:

(i) the distance between the two positions of the lens for which a sharp image is formed on the screen;

(ii) the focal length of the lens. (15)

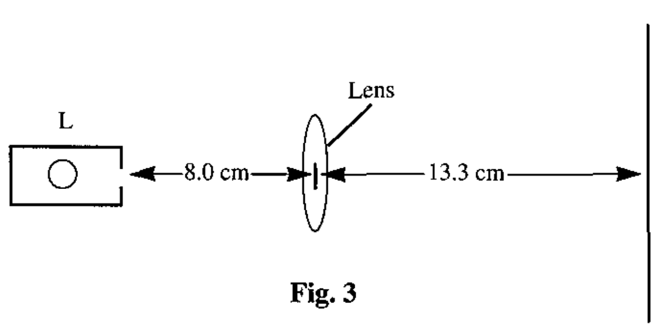

Fig. 3

Show that the minimum distance between the lamp box and the screen for which a sharp image of the opening in the lamp box will be formed on the screen is equal to four times the focal length of the lens. (9)

10. Define (i) electric field intensity, (ii) electric flux. (12)

Describe an experiment to demonstrate an electric field pattern. (12)

What is meant by conservation of total electric flux? (6)

Explain how conservation of total electric flux may be used to show that (*a*) the charge on a conductor resides on its surface, (*b*) there can be no electric field inside an empty hollow conductor. (21)

Two point charges are situated at A and B, a distance of 35 cm apart in a vacuum, Fig. 4. The charge at A is a positive charge of 16 μC and the field intensity at X, a distance of 12 cm from A, is zero. Calculate:

(i) the field intensity at X due to the charge at A;

(ii) the charge at B.

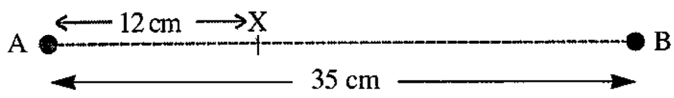

Fig. 4

(Permittivity of free space, $\varepsilon_0 = 8.9 \times 10^{-12}$ F m^{-1}.) (15)

11. Define resistivity. (6)

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

State the principle on which the moving-coil galvanometer is based and name one other device which is based on the same principle. (9)

Use a circuit diagram to show how a resistor may be used to convert a galvanometer to (*a*) an ammeter, (*b*) a voltmeter. Comment on the size of the resistance of the resistor in each case. (9)

A galvanometer coil consists of 18 m of copper wire. The wire is of uniform circular cross-section and has a diameter of 0.085 mm. The resistivity of copper is 1.7×10^{-8} Ω m. Calculate the resistance of the coil. (9)

Given that the full scale deflection of the galvanometer is 2 mA calculate:

(i) the maximum voltage which should be applied between its terminals;

(ii) the resistance of the resistor required to convert the galvanometer to a voltmeter of full scale deflection 10 V. (15)

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

The photoelectric effect was explained by Albert Einstein in a paper published in 1905. Describe fully Einstein's explanation of the photoelectric effect. Mention a German physicist whose work contributed to this explanation and give the equation which is now known as Einstein's photoelectric law. (27)

(*b*) Explain the term radioactivity. (6)

Describe an experiment to measure the half-life of a short-lived radioactive isotope. (18)

Complete the following nuclear reaction and comment on its historical significance.

$${}^{14}_{7}N + {}^{4}_{2}He \longrightarrow {}^{17}_{8}O \;+$$ (9)

13. Answer any *two* of the following.

(*a*) Define the term centripetal acceleration. (6)

State the principle of conservation of energy as it applies to a freely falling body. (6)

Fig. 5 shows a body of mass 0.24 kg attached to a fixed point P by a light string of length 0.80 m. When the body is at A, vertically below P, it is given an initial horizontal velocity of 5.0 m s^{-1} as shown in the diagram. It then follows a circular path to position B. When the body is at B calculate:

(i) the velocity of the body;

(ii) the centripetal acceleration of the body;

(iii) the force exerted by the string on the body.

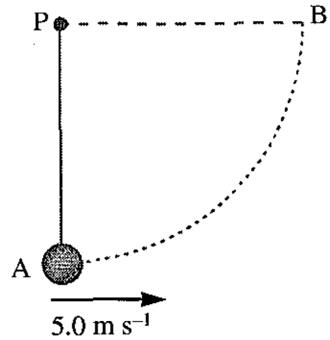

Fig. 5

(Take the acceleration due to gravity, $g = 9.8$ m s^{-2}.) (21)

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

Describe how Brownian movement may be demonstrated in the laboratory. What conclusion may be drawn from this experiment? (12)

State Avogadro's law and show how it may be proved from the kinetic theory equation $pV = \frac{1}{3} Nm\overline{c^2}$. (15)

(*c*) State Faraday's law of electromagnetic induction and describe an experiment to illustrate this law. (15)

A coil consists of 200 turns of wire of total resistance 400 Ω and is connected to an a.c. supply. Over a certain time period of 1 ms (1×10^{-3} s) the flux threading each turn of the coil increases by 4.0×10^{-4} Wb. Calculate:

(i) the average induced e.m.f. over the 1 ms period;

(ii) the average current in the coil if the average applied voltage over the 1 ms period is 100 V. (18)

(*d*) What are cathode rays? (6)

State briefly how it may be shown experimentally that cathode rays are charged and indicate how the sign of the charge may be identified. (9)

Fig. 6 shows a diagram of a cathode ray tube. State how cathode rays are produced in the tube and explain what happens when they strike the screen. Identify the parts of the tube labelled X and Y and give their functions. (18)

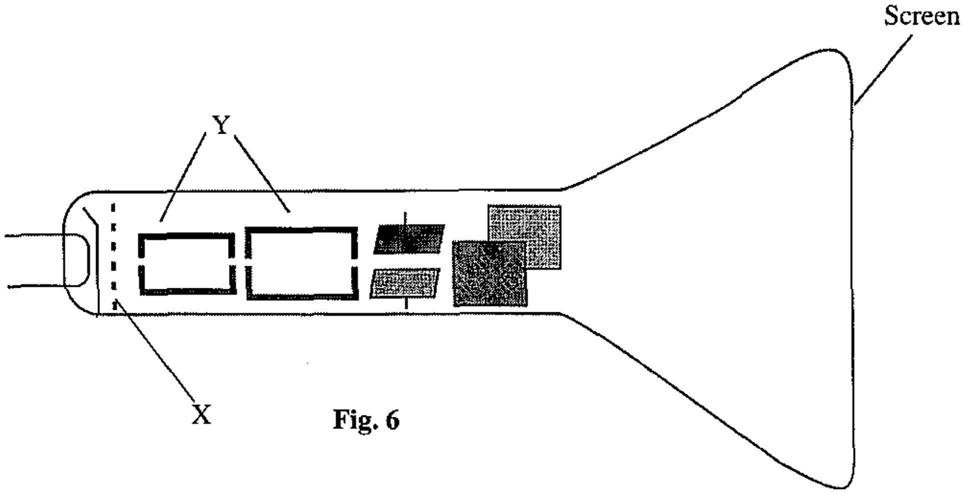

Fig. 6