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, 1993

08687

PHYSICS — HIGHER LEVEL

THURSDAY, 17 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)

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 pressure, the pascal, is equivalent to

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

Answer [ ] (6)

(ii) When a force of 20 N moves a body a distance of 40 m in 5 s the average power developed is

A. 32 W
B. 160 W
C. 640 W
D. 1280 W
E. 4000 W.

Answer [B] (6)

(iii) When white light is passed through a piece of red glass the spectrum of the transmitted light may be described as

A. a band emission spectrum
B. a continuous emission spectrum
C. a line absorption spectrum
D. a continuous absorption spectrum
E. a band absorption spectrum.

Answer [ ] (6)

(iv) Which of the following would cause the capacitance of a parallel plate capacitor to be doubled, assuming that the dielectric was the same in each case?

A. Doubling the distance between the plates while keeping the common area of the plates constant.
B. Doubling the common area of the plates and doubling the distance between the plates.
C. Keeping the common area of the plates constant while reducing the distance between the plates by a factor of four.
D. Increasing the common area of the plates by a factor of four while keeping the distance between the plates constant.
E. Keeping the common area of the plates constant while halving the distance between the plates.

Answer ☐ (6)

(v) Fig. 1 shows the variation of current with potential difference for

A. a thermistor
B. an electrolyte
C. a metal
D. a diode
E. a gas.

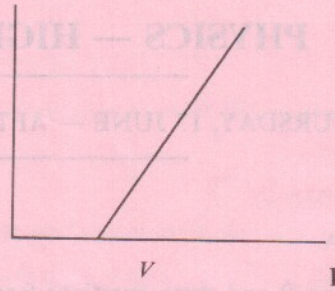

Fig. 1

Answer E (6)

(vi) In the process of decay a radioactive nucleus emits a total of 2 α-particles and 3 β-particles. As a result

A. the atomic number of the nucleus decreases by one and the mass number decreases by eight
B. the atomic number of the nucleus increases by one and the mass number decreases by four
C. the atomic number of the nucleus increases by one and the mass number decreases by one
D. the atomic number of the nucleus decreases by five and the mass number decreases by four
E. the atomic number of the nucleus decreases by four and the mass number decreases by five.

Answer A (6)

2. Answer *five* of the following.

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

(ii) What is meant by the term limiting friction? The maximum friction which holding something in place - if the force is increased it will excede the friction. (6)

(iii) If the intensity level of a sound increases by 20 dB the sound intensity increases by a factor of x100 (6)

(iv) The American physicist M. Millikan is remembered for his experiments with falling oil drops which showed that charge comes in lots of a basic unit, (6)

(v) When a current of 2 A is flowing in a wire the charge which passes a particular point in 10 minutes is 2A x 60 x 10s = 2 x 600 C = 1200 C (6)

(vi) What is meant by nuclear fusion? The joining of two atomic nuclei to form a new nucleus of approximately the mass + atomic number = sum of parents. This process is usually used to liberate energy (6)

3. Answer *five* of the following.

(i) Explain the term thermometric property. A property which is variant with temperature & may be represented by a number (6)

(ii) What is meant by the ideal gas? An ideal gas is one which perfectly obeys $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ (the combined gas law). (6)

(iii) On the Kelvin scale the value of 273.16 K is assigned to the Tripple point of water (where water can be solid, liquid & gas simultaneously) (6)

(iv) The thermometric property on which a thermocouple thermometer is based is P.d generated by a join between two metals, at a given Temp. (6)

(v) When a current flows through a resistor the rise in temperature of the resistor in a given time is proportional to $= \frac{I^2t}{RC}$, assuming that the change in resistance of the resistor is negligible. (6)

R = Resistance of Resistor I^2 = current thro' resistor t = time of resistance

(vi) When the temperature of a pure semiconductor increases its Resistance decreases. (6)

4. Answer *five* of the following.

(i) X-rays are produced when High Energy (Accelerated) electrons strike a metal target. (6)

(ii) X-rays were discovered by ? towards the end of the century. (6)

(iii) Give two uses of X-rays. Medical imaging (e.g. broken bones) (6)

(iv) What is the photoelectric effect? (6)

(v) Give an expression for the energy of a photon in terms of the wavelength of the light (6)

(vi) What is the work function of a metal for which the threshold frequency is 5.0×10^{14} Hz? (Planck's constant, $h = 6.6 \times 10^{-34}$ J s.) (6)

$V = IR$

$P = VI$ $\quad \frac{V}{R} = I$

$W = \frac{VIt}{C}$

$\frac{I^2t}{RC}$

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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 verify Newton's second law a force was applied to a body. The acceleration, a, of the body was determined for a series of values of the force, F. The total mass of the body was kept constant. The following results were obtained.

F/N	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55
a/m s^{-2}	0.60	0.70	0.80	1.0	1.1	1.2	1.4	1.5

Draw a suitable graph on graph paper and hence explain how these results verify Newton's second law. (21)

Use the graph to find the total mass of the body. (12)

Describe how the force might have been applied to the body in this experiment. (6)

6. A spectrometer may be used, with a diffraction grating, in an experiment to measure the wavelength of monochromatic light.

Give two adjustments which should be made to a spectrometer before it is used. (6)

What is the reading indicated by the spectrometer scales shown in Fig. 2(a) and enlarged in Fig. 2(b)? (9)

In an experiment one of the first order images was found at the position shown in the diagram and the other was found at a reading of 68° 50′. Given that the diffraction grating had 600 lines per mm calculate the wavelength of the light used. (18)

Why should the positions of the second and third order images also be obtained? (6)

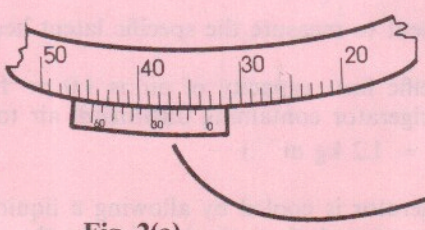

Fig. 2(a)

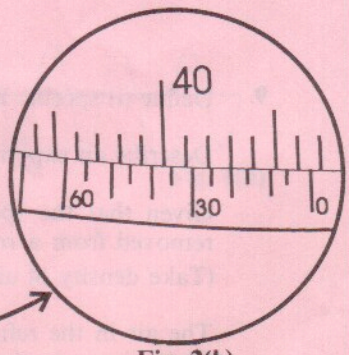

Fig. 2(b)

7. In an experiment to determine the electrochemical equivalent of copper a current, I, was passed through a copper voltameter for a time, t, and the mass, m, of copper liberated from the solution was determined. This was done for three different values of I and the following results were obtained.

I/A	0.40	0.80	1.2
m/g	0.12	0.25	0.30

Given that the value of t in each case was 15 minutes calculate a value for the electrochemical equivalent of copper. (15)

Draw a circuit diagram for this experiment, labelling the anode and the cathode. (6)

Explain why it was necessary to have a rheostat in the circuit. (6)

Why should the cathode be cleaned before placing it in the voltameter? (3)

Explain how the accuracy of the final result might have been affected by using larger currents. (9)

SECTION C (200 marks)

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

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8. State Newton's Universal Law of Gravitation. (6)

Explain what is meant by (i) centripetal force, (ii) potential energy. (9)

Describe a laboratory experiment to determine the value of g, the acceleration due to gravity. (15)

Derive an expression for (i) the speed, (ii) the periodic time, of a satellite in a circular orbit around the earth in terms of its height above the earth and the radius and mass of the earth. (18)

A spacecraft of total mass 8.0×10^4 kg is in a circular orbit 200 km above the surface of the earth.
Calculate:

(i) the speed of the spacecraft; (6)

(ii) the energy required to launch the spacecraft into this orbit. (Neglect the effect of the change in the value of g with height.) (12)
($G = 6.7 \times 10^{-11}$ N m^2 kg^{-2}; $g = 9.8$ m s^{-2}; mass of earth $= 6.0 \times 10^{24}$ kg; radius of earth $= 6.4 \times 10^6$ m.)

9. Define (i) specific heat capacity, (ii) specific latent heat. (12)

Describe an experiment to measure the specific latent heat of vaporisation of water. (18)

Given that the specific heat capacity of air is 1.0×10^3 J kg^{-1} K^{-1} calculate how much energy must be removed from a refrigerator containing 0.15 m^3 of air to lower the temperature of the air from 20 °C to 4 °C. (Take density of air $= 1.2$ kg m^{-3}.) (15)

The air in the refrigerator is cooled by allowing a liquid to evaporate in a closed pipe inside the refrigerator. The vapour is then pumped through the pipe to the outside of the refrigerator, where it condenses again. Explain how this process cools the air in the refrigerator. (9)

Given that 2.3 g of the liquid evaporate per minute how long will it take to cool the air in the refrigerator from 20 °C to 4 °C if the specific latent heat of vaporisation of the liquid is 2.5×10^5 J kg^{-1}? (12)
(Assume that the heat lost by the refrigerator itself is negligible.)

10. Explain the terms (i) natural frequency, (ii) resonance. (12)

Describe a laboratory experiment to measure the speed of sound in air. (15)

Explain the physical principles underlying each of the following.

(i) A tuning fork placed on a sonometer may cause the sonometer wire to vibrate. (9)

(ii) The pitch of the note from a train's whistle is higher to a person standing near the track when the train is approaching than when it is going away. (12)

(iii) A note of a particular frequency played on a piano sounds different from a note of the same frequency played on a guitar. (6)

Fig. 3 shows two loudspeakers, both of which are connected to the same source, e.g. a signal generator. State what a person walking slowly from A to B would hear and explain how this phenomenon occurs. (12)

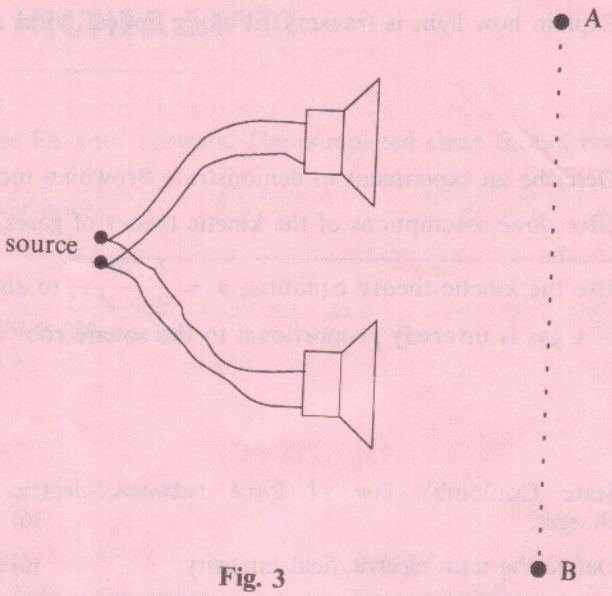

Fig. 3

11. (*a*) Define resistivity. (6)

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

A 10 Ω resistor consists of a piece of wire of uniform cross-sectional area and of length 65 cm. If the resistivity of the material of the wire is 1.3×10^{-6} Ω m what is the diameter of the wire? (6)

(*b*) State the principle on which a moving-coil galvanometer works and draw a labelled diagram of such a galvanometer. (18)

A galvanometer has an internal resistance of 50 Ω and a full scale deflection of 2 mA. Calculate the resistance of the resistor required to convert the galvanometer to (i) an ammeter of full scale deflection 5 A, (ii) a voltmeter of full scale deflection 10 V. (18)

12. (*a*) Describe, with the aid of a labelled diagram, the basic structure of a bi-polar transistor. (9)

Fig. 4(a) shows a simple voltage amplifier circuit. Explain why a small change in the potential difference between A and B causes a large change in the potential difference between X and Y. (15)

A small alternating (a.c.) voltage as illustrated in Fig. 4(b) is applied between A and B. Copy Fig. 4(b) and, using the same axes, show the alternating voltage between X and Y. (9)

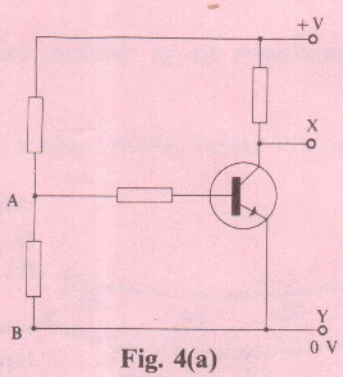

Fig. 4(a)

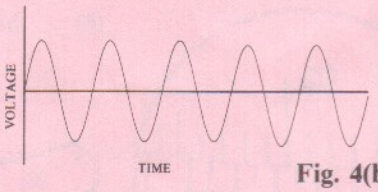

Fig. 4(b)

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

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

Explain how stable elements may be made radioactive and give one use of such artificial radioactive isotopes. (9)

13. Answer any *two* of the following.

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

Describe an experiment to measure the refractive index of a liquid *or* a solid. (15)

Explain how light is transmitted along optical fibres and give one use of such fibres. (12)

(*b*) Describe an experiment to demonstrate Brownian movement. (12)

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

Use the kinetic theory equation, $p = \frac{1}{3}\frac{Nmc^2}{V}$, to show that the root-mean-square speed of the molecules of a gas is inversely proportional to the square root of the density of the gas at constant pressure. (12)

(*c*) State Coulomb's law of force between electric charges. (6)

Define the term electric field intensity. (6)

Two positive point charges, each of 1.2 μC, are situated at the vertices A and C of a right-angled isosceles triangle as shown in Fig. 5. Calculate the total electric field intensity at B given that |AB| = |BC| = 40 cm. (21)

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

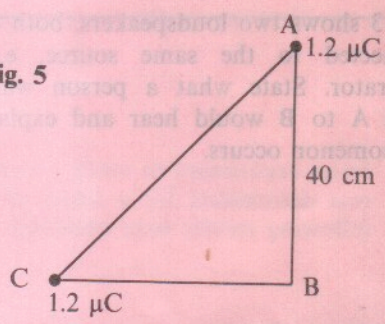

Fig. 5

(*d*) State *one* law of electromagnetic induction. (6)

Explain the principles underlying the operation of an induction motor. (15)

Fig. 6 shows a coil with an iron core connected to a lamp and an a.c. power supply. Explain why the lamp would light more brightly if the a.c. supply were replaced with a d.c. supply. (12)

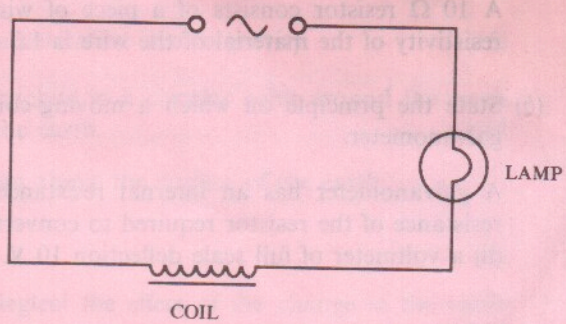

Fig. 6