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

Write Your Examination Number here

AN ROINN OIDEACHAIS 14458

LEAVING CERTIFICATE EXAMINATION, 1996

PHYSICS — HIGHER LEVEL

THURSDAY, 13 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 force, the newton, is equivalent to

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

Answer ☐ (6)

(ii) A rectangular tank contains 3.0 kg of water. If the area of the base of the tank is 0.15 m^2 the pressure at the base due to the water is (g = 9.8 m s^{-2})

A. 196 Pa
B. 133 Pa
C. 20 Pa
D. 4.4 Pa
E. 2.0 Pa.

Answer ☐ (6)

(iii) Which of the following statements concerning a constant volume gas thermometer is *not* correct?

A. It can be used as a standard thermometer.
B. It is based on the ideal gas.
C. It has a very wide range.
D. The thermometric property on which it is based is the volume of a fixed mass of gas.
E. The temperature depends on the pressure of the gas in the bulb.

Answer ☐ (6)

(iv) The image formed by a diverging lens is

A. always virtual, erect and magnified
B. virtual, erect and magnified if the object is inside the focus
C. virtual, inverted and diminished if the object is outside the focus
D. always virtual, inverted and diminished
E. always virtual, erect and diminished.

Answer ☐ (6)

(v) The electric field intensity at a distance r from a positive point charge Q is

A. proportional to r and its direction is towards Q
B. inversely proportional to r and its direction is away from Q
C. proportional to r^2 and its direction is away from Q
D. inversely proportional to r^2 and its direction is towards Q
E. inversely proportional to r^2 and its direction is away from Q.

Answer ☐ (6)

(vi) Fig. 1 shows a small resistance connected to a moving-coil galvanometer. Such an arrangement can be used as

A. a rectifier
B. a d.c. voltmeter
C. an a.c. voltmeter
D. a d.c. ammeter
E. an ohmmeter.

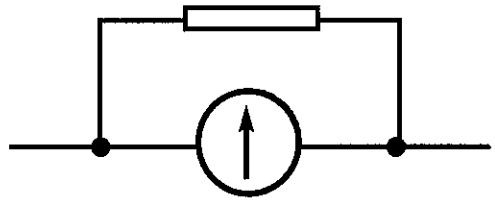

Fig. 1

Answer ☐ (6)

2. Answer *five* of the following.

(i) What is meant by centripetal force? .....

..... (6)

(ii) According to the kinetic theory of gases the .....of the molecules of a gas is inversely proportional to the density of the gas at constant ..... (6)

(iii) The threshold of hearing is defined as .....

..... (6)

(iv) The wave nature of light was demonstrated by.....at the beginning of the ..... century. (6)

(v) The grid in a cathode ray tube controls the ..... of electrons reaching the screen and hence the ..... of the trace on the screen. (6)

(vi) In the unipolar (field effect) transistor the .....

is controlled by the ..... (6)

3. Answer *five* of the following.

(i) Define refractive index.....

..... (6)

(ii) Light travels through optical fibres as a result of..... (6)

(iii) When an astronomical telescope is in normal adjustment the ratio of the focal length of the objective lens to the focal length of the eyepiece lens is equal to the .....of the telescope and the sum of the focal lengths is equal to the ..... (6)

(iv) White light may be dispersed using a ..... or a ..... (6)

(v) What is the relationship between the energy of a photon of light and the wavelength of the light? .....

..... (6)

(vi) When a light-emitting diode (LED) is emitting light, it must be .....biased and, in normal use, it should have a ..... connected in .....with it. (6)

4. Answer *five* of the following.

(i) The relationship $P \propto I^2$ is an expression for the ..... in a resistor. It is generally known as .....law. (6)

(ii) The current flowing in the filament of a light bulb when it is first switched on is greater than it is a short time later. Explain.....

..... (6)

(iii) When transmitting electrical energy through metal cables, why is it more economical to use high voltages?

..... (6)

(iv) What causes heating in the core of a transformer?.....

..... (6)

(v) Calculate the current flowing in the element of a 1.5 kW toaster connected to the 220 V mains.....

..... (6)

(vi) Give one way in which heating is reduced in the cables used in domestic circuits.....

..... (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.

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5. In an experiment to determine the coefficient of dynamic friction between two surfaces a body of mass 200 g was placed on a horizontal surface and a force F was applied to it so that it moved with a constant speed. A series of masses, m, were then placed on the body and the value of F required to produce a constant speed in each case was determined. The values of m and the corresponding values of F are shown in the table.

m/g	0	100	200	300	400	500	600
F/N	0.50	0.72	1.02	1.23	1.54	1.84	2.02

Draw a suitable graph on graph paper and hence determine the coefficient of dynamic friction. (18)

Describe, with the aid of a diagram, how the value of F might have been determined in this experiment. (9)

Why is the experiment arranged so that the body (i) moves on a horizontal surface, (ii) moves with a constant speed? (Acceleration due to gravity, $g = 9.8$ m s^{-2}.) (12)

6. The following is part of a student's account of an experiment to measure the wavelength of monochromatic light.

"The apparatus was arranged so that a number of bright images could be observed. The angular positions, θ, of five of these images were determined. The results obtained are shown in the table. The diffraction grating had 400 lines per mm."

n	2	1	0	1	2
θ/degree	28.5	14.0	0.0	14.4	28.8

Describe the apparatus which might have been used in this experiment. Explain how the apparatus would have been arranged and how the angular positions of the images would have been determined. (15)

Use all the data given in the table to calculate a value for the wavelength of the light. (12)

The values for the angular positions of the images on the right of the central image are larger than the corresponding ones on the left. Suggest a possible reason for this and give two other factors which might have affected the accuracy of the experiment. (12)

7. Draw a circuit diagram for an experiment to plot the characteristic curve of a diode. Indicate how the circuit would be modified to obtain the reverse bias characteristic. (12)

Give the measurements which would be taken in this experiment. Using clearly labelled axes sketch the graph which would be obtained. (12)

What general conclusion concerning the resistance of the diode can be arrived at from the graph? (6)

Give one precaution which should be taken in this experiment and explain why the precaution should be taken. (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 (i) the principle of conservation of momentum, (ii) Newton's second law of motion. (12)

Describe an experiment to verify the principle of conservation of momentum. (21)

Explain how the principle of conservation of momentum and Newton's third law of motion apply to the acceleration of a spacecraft. (18)

Two bodies, A and B, have masses m_1 and m_2 and are moving along the line OX, Fig. 2, with velocities u_1 and u_2. The velocity of A is greater than the velocity of B and at a certain instant A collides with B. The bodies are in contact for a time t. After the collision A is at rest and B is moving along OX with a velocity v.

Assuming that no external forces act on the bodies along the line OX deduce an expression for:

(i) v in terms of u_1, u_2, m_1 and m_2;

(ii) the force exerted by A on B in terms of m_1, u_1 and t. (15)

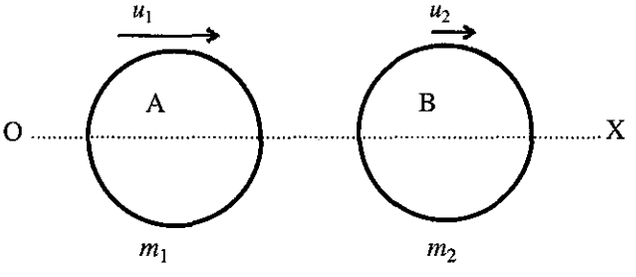

Fig. 2

9. Define specific latent heat. (6)

Describe an experiment to measure the specific latent heat of fusion of ice. (18)

Conduction, convection and radiation are three methods of transferring heat. Give a brief explanation of each. (9)

Explain the principles involved in each of the following.

(i) The U-value of a structure is reduced by adding insulation to it. (6)

(ii) On a hot day the sea is usually colder than the land. (9)

(iii) The human body is cooled by perspiring. (9)

(iv) On a hot day the water at the surface of a still lake or pond is usually warmer than the water some distance below the surface. (9)

10. Define the unit of current, i.e. the ampere. (9)

Describe an experiment to illustrate the principle on which the definition of the ampere is based. (12)

Fig. 3 shows three resistors, of resistance R_1, R_2 and R_3, respectively, connected to a cell of e.m.f. (electromotive force) 1.5 V. The potential difference between A and B was measured using a potentiometer and found to be 1.2 V.

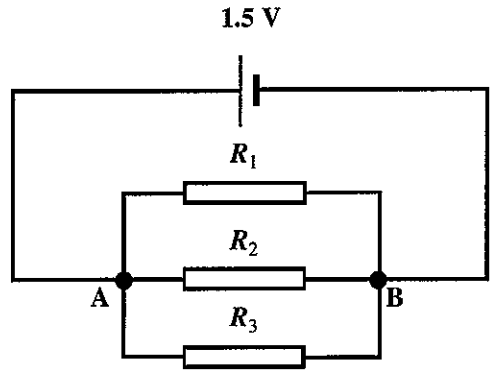

Fig. 3

Derive an expression for the effective resistance of the three resistors in terms of R_1, R_2 and R_3. (15)

Explain why the potential difference between A and B is less than 1.5 V. (9)

Given that the effective resistance of the three resistors is 2.0 Ω calculate a value for the internal resistance of the cell. (12)

Explain the advantage of using a potentiometer rather than a voltmeter to measure the potential difference between A and B. (9)

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

Outline an experiment to illustrate one of these laws. (9)

Draw a labelled diagram of an a.c. generator and explain how it works. (18)

At a particular point on the earth's surface the magnetic flux density of the earth's magnetic field is 2.3×10^{-5} T and the angle of dip is 70°. Calculate the horizontal component, B_H, of the earth's magnetic field at this point. (6)

A rectangular coil of wire, Fig. 4, is suspended with its plane perpendicular to B_H. The area of the coil is 0.25 m^2 and it consists of 100 turns of wire. The coil is rotated through 90° in 0.20 s.

Sketch a graph to show how the induced e.m.f. (electromotive force) varies during this time. (6)

Calculate the average e.m.f. induced in the coil while it is being rotated. (15)

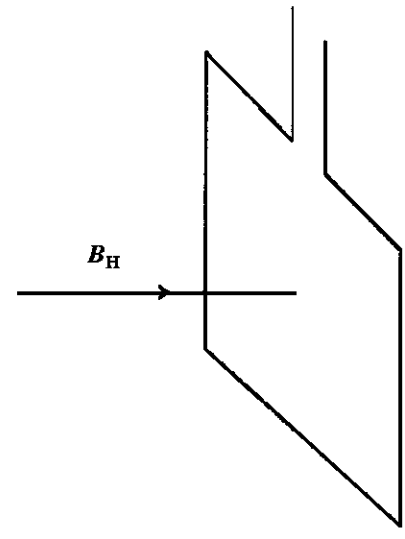

Fig. 4

12. What is meant by the term radioactivity? (6)

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

Polonium-218 is radioactive with a half-life of 3.1 minutes and emits α-particles. Give an equation to represent the decay of Po-218 and name the element produced in the reaction. (Refer to the Periodic Table of the elements in the Mathematics Tables, p. 44.) (15)

Calculate the decay constant for Po-218. (9)

A sample of Po-218 has a mass of 3.5 μg. Calculate the number of α-particles emitted per second from the sample. (1 mol of Po-218 = 218 g; Avogadro's constant, $N_A = 6.0 \times 10^{23}$ mol^{-1}.) (18)

13. Answer any *two* of the following.

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

Describe an experiment to measure the acceleration due to gravity, g, using a simple pendulum. (18)

Given that the value of g on the surface of the earth is 9.8 m s^{-2} calculate a value for g at a height above the earth equal to twice the radius of the earth. (Assume that the earth is spherical.) (9)

(b) How may it be shown experimentally that sound is a wave motion? (9)

State the three characteristics of a musical note and give a wave property on which each depends. (9)

State what is meant by the Doppler effect and explain, with the aid of a diagram, how this effect occurs. (15)

(c) Define capacitance. (6)

Derive an expression for the energy stored in a parallel plate capacitor. (12)

A capacitor of capacitance 0.47 μF carries a charge of 2.0 μC. Calculate (i) the potential difference between the plates, (ii) the energy stored. (15)

(d) State Faraday's first law of electrolysis and explain what is meant by the electrochemical equivalent of an element. (12)

Draw a circuit diagram of an arrangement which could be used to electroplate an object with copper. (12)

If the mass of copper required to electroplate the object is 15 g and the current flowing is 10 A, calculate the time for which the current must flow.
(Electrochemical equivalent of copper = 3.3×10^{-7} kg C^{-1}.) (9)