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

Write your examination number here.

AN ROINN OIDEACHAIS AGUS EOLAÍOCHTA

LEAVING CERTIFICATE EXAMINATION, 2001

PHYSICS — HIGHER LEVEL

MONDAY, 18 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.

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.

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.

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

Answer ☐ (6)

(ii) When a central heating radiator heats a room, the heat reaches other parts of the room mainly by

A. conduction
B. convection
C. radiation
D. conduction and radiation
E. conduction and convection.

Answer ☐ (6)

(iii) The sound intensity in a room increases from 10^{-8} W m^{-2} to 10^{-6} W m^{-2} when a vacuum cleaner is turned on. The relative increase in sound intensity is

A. 10^{-2} dB
B. 0.2 dB
C. 2 dB
D. 20 dB
E. 100 dB.

Answer ☐ (6)

(iv) Which one of the following plays a significant role in the operation of a Van de Graaff generator?

A. Magnetic induction.
B. Mutual induction.
C. Internal resistance.
D. Point discharge.
E. Polarisation.

Answer ☐ (6)

(v) A galvanometer can be converted to an ohmmeter by connecting it

A. in series with a fixed resistor
B. in series with a rheostat
C. in series with a battery and a rheostat
D. in parallel with a fixed resistor
E. in parallel with a battery and a rheostat.

Answer ☐ (6)

(vi) Which one of the following statements is *not* correct?

A. When there is a change in the magnetic flux threading any closed loop, an e.m.f. is induced in the loop.
B. An electrical generator is a device that converts mechanical energy to electrical energy.
C. A transformer converts a low a.c. voltage to a high a.c. voltage and vice versa.
D. If an electric motor is prevented from rotating freely, the coil will become hot and may "burn out".
E. In a circuit using an a.c. power source, a lamp glows more brightly when an iron core is inserted in a solenoid that is in series with the lamp.

Answer ☐ (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 (82 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 verify the principle of conservation of momentum, two bodies A and B were held in close contact with a compressed spring between them. When the spring was released, the two bodies moved in opposite directions. The masses of A and B were increased and the experiment was repeated a number of times. Each time it was found that body A travelled a distance of 25 cm in a time t_1 and that body B travelled a distance of 20 cm in a time t_2. The recorded data are given in the following table.

Mass of A/g	Mass of B/g	t_1/ms	t_2/ms
50	75	126	148
100	125	181	179
150	200	223	232

Use the above data to show how the experiment verified the principle of conservation of momentum. (18)

Draw a labelled diagram of the apparatus that might have been used in the experiment. (9)

Explain how the times t_1 and t_2 were measured. (9)

How was the effect of friction minimised in the experiment? (5)

6. The following is part of a student's account of an experiment to measure the specific latent heat of vaporisation of water.

"Steam was passed into cold water in a copper calorimeter until a suitable rise in temperature was obtained. Precautions were taken to ensure that the steam did not condense before it entered the calorimeter."

Draw a labelled diagram of the apparatus that might have been used in the experiment. (9)

Give the equation used to calculate the specific latent heat of vaporisation of water. (9)

Describe how the mass of steam passed into the water was determined. (6)

State why it was necessary to ensure that the steam did not condense before it entered the calorimeter and explain how this was achieved. (12)

What was the advantage of having cold water in the calorimeter initially? (5)

7. In an experiment to verify Joule's law, an electric current I was passed through a heating coil and the power P generated in the coil was measured. The coil was allowed to cool down and the procedure was then repeated for different values of the current. The recorded data are given in the following table.

I/A	0.5	1.0	1.5	2.0	3.0	4.0	5.0
P/W	2.0	7.9	19	34	70	125	205

Draw a suitable graph on graph paper and explain how this verifies Joule's law. (18)

From the graph, determine the resistance of the heating coil. (9)

Describe, with the aid of a labelled diagram, how the power generated in the heating coil could have been determined. (9)

Explain why it was necessary to allow the heating coil to cool down each time. (5)

SECTION C (198 marks)

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

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8. (*a*) Define (i) work, (ii) energy. (6)

Show that the loss in potential energy of a freely falling body is equal to the gain in its kinetic energy. (12)

A girl swings back and forth on the end of a rope 8 m long that is attached to the ceiling of a gymnasium. If, at the highest point of each swing, she is 3 m from the ceiling, what is her maximum speed? (12)

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

(*b*) Give an expression for Newton's Universal Law of Gravitation. (6)

A satellite is in a circular orbit of radius R around the earth, which has a mass M. Show that the period T of the satellite is given by $T^2 = \dfrac{4\pi^2 R^3}{GM}$, where G is the universal constant of gravitation. (15)

The first artificial satellite to orbit the earth, Sputnik, had a period of 96 minutes. What was its height above the surface of the earth, assuming that its orbit was circular? (15)

($G = 6.67 \times 10^{-11}$ N m^2 kg^{-2} ; $M = 5.98 \times 10^{24}$ kg ; radius of the earth $= 6.38 \times 10^6$ m.)

9. (*a*) Use diagrams to show how rays of light parallel to the principal axis are reflected by (i) a concave mirror, (ii) a convex mirror. (12)

Describe a laboratory experiment to measure the focal length of a concave mirror. (12)

A convex mirror produces an image that is one quarter the size of an object placed 24 cm from the mirror. What is the focal length of the mirror? (12)

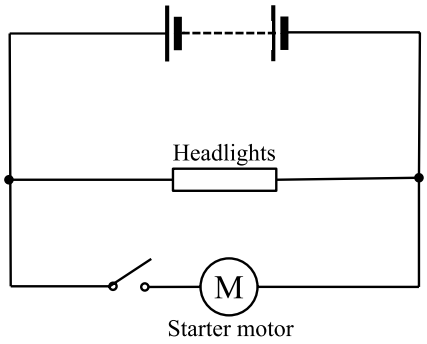
(*b*) Draw a labelled diagram showing the principal parts of a spectrometer. (9)

A spectrometer is to be used in an experiment to measure the wavelength of monochromatic light. Give three adjustments that should be made to the spectrometer. (9)

A prism or a diffraction grating may be used with a spectrometer to view the spectrum of white light. Give two differences between what is observed with the prism and what is observed with the grating. (12)

10. Define (i) potential difference, (ii) e.m.f. (electromotive force). (12)

Describe an experiment to measure the internal resistance of a cell. (24)



In the diagram, a car battery has an e.m.f. of 13.75 V and an internal resistance of 0.08 Ω. The effective resistance of the car headlights is 1.50 Ω and the effective resistance of the starter motor is 0.20 Ω. Calculate:

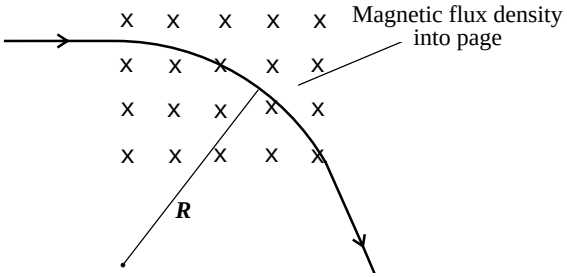
(i) the potential difference across the headlights when they are the only load on the battery; (9)

(ii) the total current flowing in the circuit while the starter motor is switched on; (12)

(iii) the potential difference across the headlights while the starter motor is switched on. (9)

11. Describe an experiment to demonstrate that a current-carrying conductor in a magnetic field experiences a force. Name two devices based on the principle illustrated by this experiment. (21)

Give an expression for the force on a particle of charge q moving with a velocity v at right angles to a magnetic field of flux density B. Explain why the particle moves in a circular path while in the magnetic field, as shown in the diagram. (12)



If the radius of the circular path in the magnetic field is R, prove that the momentum p of the charged particle is given by $p = BqR$. (12)

What path would the charged particle follow if its velocity were parallel to the magnetic flux density? (6)

An electromagnetic relay is a magnetic switch in which a small current can be used to switch on a large current. Draw a labelled diagram of an electromagnetic relay and explain how it works. (15)

12. (*a*) What is meant by the half-life of a radioactive substance? (6)

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

A detector records 1200 counts per minute when the activity of a radioactive sample is first measured. Six minutes later the activity has fallen to 150 counts per minute. Calculate the half-life of the sample. (9)

(*b*) What is meant by nuclear fission? (6)

Draw a labelled diagram to show the structure of a nuclear fission reactor. (9)

In a nuclear fission reactor, a chain reaction is allowed to proceed at a steady controlled rate. Explain how the rate of the chain reaction is controlled. (9)

The power generated in a nuclear reactor is 150 MW. Calculate the number of fissions occurring per second in the reactor, given that 180 MeV of energy is released per fission. (9)

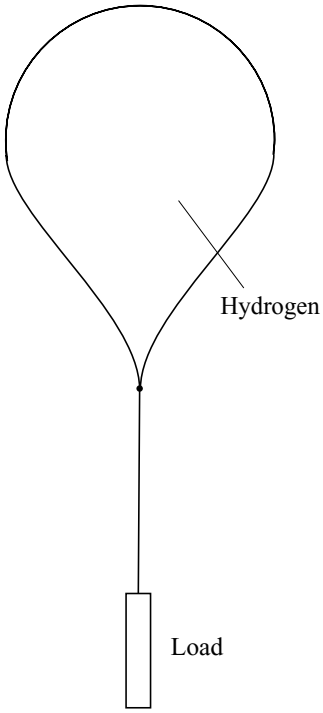
(1 eV = 1.60×10^{-19} J.)

13. Answer any *two* of the following parts (*a*), (*b*), (*c*), (*d*).

(*a*) Define (i) density, (ii) pressure. (6)

State Archimedes' principle. (6)

Weather balloons are released regularly into the atmosphere and carry equipment to monitor atmospheric conditions. A weather balloon made from a material of mass 6 kg is inflated by filling it with hydrogen gas. The total volume of the inflated balloon is 15 m^3.



(i) Calculate the upthrust on the inflated balloon. (6)

(ii) Calculate the total weight of the inflated balloon. (Assume that the volume of the gas is the same as the volume of the balloon.) (9)

(iii) What is the maximum load that the balloon can carry? (6)

(Density of air = 1.25 kg m^{-3}; density of hydrogen = 0.12 kg m^{-3}; acceleration due to gravity = 9.80 m s^{-2}.)

(*b*) Describe an experiment to demonstrate Brownian movement. (9)

What conclusion can be drawn from this experiment about the nature of gases? (6)

Use the kinetic theory equation $pV = \frac{1}{3} Nm\overline{c^2}$ to obtain an expression for the pressure of a gas in terms of its density ρ and the mean square speed of its molecules. (9)

The root-mean-square speed of the molecules of a gas is 390 m s^{-1} when its pressure is 1.00×10^5 Pa. Calculate the density of the gas. (9)

(*c*) Distinguish between longitudinal and transverse waves. (6)

Describe how you would determine whether light is a transverse or longitudinal wave motion. (12)

The accurate measurement of the speed of light was a significant development in physics. Outline a terrestrial method that was used to measure the speed of light. (15)

(*d*) What is a semiconductor diode? (6)

Draw a diagram of a circuit that could be used to show the operation of a photodiode. (9)

An alternating current of very low frequency (e.g. 1 Hz) is supplied to a light-emitting diode.

Draw a suitable circuit diagram for this arrangement. (6)

What is observed while the current is switched on? Explain your answer. (12)

2. Answer *five* of the following.

(i) Give an equation that defines simple harmonic motion. .....(6)

(ii) A heat pump is a device used to transfer energy from .....

to .....(6)

(iii) What is the thermometric property on which the thermocouple is based?.....

.....(6)

(iv) The loudness of a musical note depends on the ..... of the wave and its quality

depends on .....(6)

(v) State two factors which affect the efficiency of a transformer. .....

.....(6)

(vi) How much charge is required to plate a necklace with 5 mg of gold? The electrochemical equivalent of

gold is 6.8×10^{-7} kg C^{-1}. .....(6)

3. Answer *five* of the following.

(i) Give two differences between X-rays and cathode rays. .....

.....(6)

(ii) Name the scientist who discovered X-rays. .....(6)

(iii) How might cathode rays be detected? .....(6)

(iv) What is thermionic emission? .....

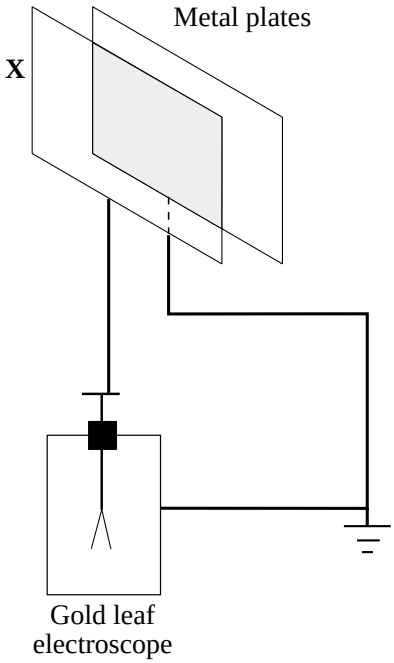
.....(6)

(v) Give two ways by which a beam of electrons may be deflected. .....

.....(6)

(vi) The work function of zinc is 6.9×10^{-19} J. What is the minimum frequency of ultraviolet radiation that will cause the photoelectric effect to occur in zinc? (Planck constant, $h = 6.6 \times 10^{-34}$ J s.) .....(6)

4. The diagram shows the apparatus used to investigate the capacitance of a pair of parallel metal plates. Answer *five* of the following.



(i) What is observed when a fixed charge *Q* is placed on plate X? .....

.....(6)

(ii) What is observed when the distance between the plates is decreased while the plate X is charged?

.....(6)

(iii) Give an expression for the capacitance of a pair of parallel metal plates. .....(6)

(iv) What is the effect on the capacitance when a sheet of plastic is placed between the plates?.....

.....(6)

(v) How much energy is stored in a 2200 μF capacitor when it is charged to a potential difference of 9 V?

.....(6)

(vi) Give two uses for a capacitor. .....

.....(6)

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