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, 1999

PHYSICS — HIGHER LEVEL

MONDAY, 21 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.

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 energy, the joule, is equivalent to

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

Answer ☐ (6)

(ii) When a body is thrown vertically upwards and reaches its greatest height

A. its velocity is zero and its acceleration is zero
B. its velocity is downwards and its acceleration is zero
C. its velocity is zero and its acceleration is downwards
D. its velocity is downwards and its acceleration is downwards
E. its velocity is zero and its acceleration is upwards.

Answer ☐ (6)

(iii) According to the kinetic theory of gases the temperature of a gas on the Kelvin scale is proportional to

A. the mean speed of the molecules
B. the root-mean-square speed of the molecules
C. the square root of the mean speed of the molecules
D. the square root of the mean kinetic energy of the molecules
E. the mean kinetic energy of the molecules.

Answer ☐ (6)

(iv) When the source of a note, e.g. an ambulance siren, is moving away from an observer

A. the frequency decreases and the pitch decreases
B. the frequency decreases and the pitch increases
C. the frequency increases and the wavelength decreases
D. the wavelength decreases and the pitch decreases
E. the wavelength increases and the pitch increases.

Answer ☐ (6)

(v) What is the effective resistance of the arrangement of resistors shown in Fig. 1?

A. 1 Ω
B. 2 Ω
C. 3⅓ Ω
D. 4½ Ω
E. 9 Ω

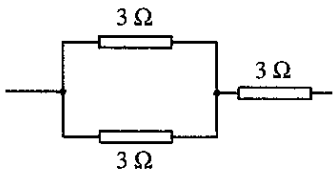

Fig. 1

Answer ☐ (6)

(vi) In a uni-polar (field effect) transistor, in normal use,

A. the gate is negative with respect to the source and the drain
B. the gate is negative with respect to the source and positive with respect to the drain
C. the gate is positive with respect to the source and negative with respect to the drain
D. the drain is negative with respect to the source and positive with respect to the gate
E. the drain is positive with respect to the source and negative with respect to the gate.

Answer ☐ (6)

2. Answer *five* of the following.

(i) What is meant by a vector quantity?.....

..... (6)

(ii) In defining the Kelvin scale of temperature the number .....is assigned to the

.....of water. (6)

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

..... (6)

(iv) A certain type of glass has a refractive index of 1.6. Calculate the critical angle for this glass.

..... (6)

(v) Give one advantage of using a potentiometer, rather than a voltmeter, to measure the electromotive force (e.m.f.) of a cell. .....

..... (6)

(vi) Why does a charged particle, moving at constant speed at right angles to a uniform magnetic field, follow a circular path? .....

..... (6)

3. Answer *five* of the following.

(i) A body starts from rest with uniform acceleration a. Give an expression for the time t taken to undergo a displacement s. ..... (6)

(ii) The amount of work done in unit time is called the..... (6)

(iii) What is meant by the period of a simple harmonic motion? .....

.....

..... (6)

(iv) What is meant by the frequency of a wave ..... (6)

(v) The unit of charge, the ....., is defined as the charge carried by a current of .....flowing for one second. (6)

(vi) Sketch a diagram to show how the magnitude of an a.c. voltage varies with time. (6)

4. Answer *five* of the following.

(i) In 1921 Albert Einstein won the Nobel Prize in Physics for his work on the photoelectric effect. What is the photoelectric effect?.....

..... (6)

(ii) Give the equation used by Einstein to explain the photoelectric effect.....

..... (6)

(iii) What is meant by the work function of a metal? .....

..... (6)

(iv) Calculate the energy of a photon of frequency 1.6×10^{15} Hz. (The Planck constant, $h = 6.6 \times 10^{-34}$ J s.)

..... (6)

(v) When light shines on a photodiode, pairs of .....and.....are created. (6)

(vi) The current in a photodiode is proportional to the ..... of the incident light. (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.

5. The relationship between the acceleration of a body and its mass was investigated by applying a constant force to a body of mass 150 g and then measuring the acceleration. The mass of the body was increased by placing additional masses on top of the body and the acceleration was found in each case. The values obtained for the additional masses, m, and the corresponding accelerations, a, are shown in the following table.

m /g	0	50	100	150	200	250	300	350
a /cm s^{-2}	125	90	74	61	50	47	40	35

Explain how the constant force in this experiment might have been applied. (6)

Draw a suitable graph to show the relationship between the acceleration of the body and its mass. (18)

From the graph calculate the value of the constant force which was applied to the body. (11)

Explain how the effect of friction might have been taken into account in this experiment and give one other precaution which might have been taken to ensure a more accurate result. (6)

6. An experiment was performed to compare the specific heat capacities of aluminium and paraffin oil. Hot aluminium was added to paraffin oil in an aluminium calorimeter. The following results were obtained.

Mass of calorimeter	=	40.8 g
Mass of calorimeter + oil	=	67.1 g
Initial temperature of calorimeter + oil	=	16 °C
Mass of aluminium	=	10.7 g
Temperature of hot aluminium	=	100 °C
Final temperature of calorimeter + oil + aluminium	=	24 °C

Use the data above to calculate the ratio of the specific heat capacity of aluminium to that of paraffin oil. (21)

Explain how the temperature of the hot aluminium might have been measured. (8)

In this experiment the accuracy of the final result may be improved by cooling the oil before placing it in the calorimeter. Explain. (6)

Give two other ways in which the accuracy of the final result might be improved. (6)

7. The following is part of a student's account of an experiment to plot the characteristic curve of a diode.

"In the experiment the diode was forward biased and a resistor was connected in series with it. The measurements were taken and plotted on a graph. The diode was then reverse biased and the measurements repeated. These measurements were also plotted on the graph."

Explain what is meant by forward biasing the diode and state how the student would have known which way to connect the diode so that it would be forward biased. (8)

Draw a circuit diagram for this experiment with the diode in forward bias. (12)

State the measurements to be taken in this experiment and sketch the graph which could have been obtained. (12)

Explain why the resistor was connected in series with the diode and give one other precaution which the student might have taken when carrying out this experiment. (9)

SECTION C (198 marks)

Answer **three** questions from this section.

Each question carries the same number of marks.

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

Describe a laboratory experiment to determine the value of g, the acceleration due to gravity. State two precautions which you would take to ensure the accuracy of your result. (24)

Prove that the sum of the potential and kinetic energies of a freely falling body is constant. (15)

A sphere A of mass m rolls along a frictionless plane with a speed of 0.4 m s^{-1} as shown in Fig. 2. It collides with a sphere B of mass $2m$ which is at rest. After the collision spheres A and B move on in the same direction as shown in Fig. 2. The initial speed of sphere A after the collision is 0.1 m s^{-1}.

Calculate the initial speed of sphere B after the collision. (9)

Show that the total kinetic energy of the two spheres following the collision is less than their kinetic energy before the collision and explain why this should be the case. (12)

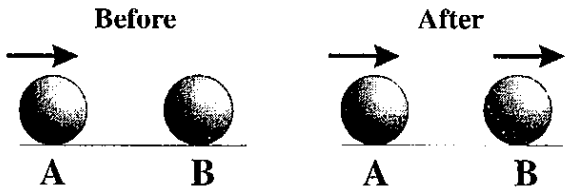

Fig. 2

9. Explain the term resonance. Give an example of resonance. (9)

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

Explain, with the aid of a diagram, why a sound wave may change direction when it enters a medium of different density. Give an example. (12)

State the factors on which the natural frequency of a stretched string depends. Give the units in which these factors are measured. (18)

State the relationship between the natural frequency of the stretched string and any two of the factors which you have given. (6)

Explain how one of these factors could be changed, while keeping the others constant, so as to double the frequency of vibration of the string. (6)

10. Define (i) capacitance, (ii) resistance. (12)

State the factors on which the capacitance of a parallel-plate capacitor depends. (9)

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

Explain the principles involved in each of the following.

(i) A resistor connected to a galvanometer as shown in Fig. 3 may allow the galvanometer to be used to measure large currents. (9)

(ii) A capacitor connected in series in a circuit conducts a.c but not d.c. (9)

(iii) When the plates of a charged capacitor are joined together a spark may be seen. (9)

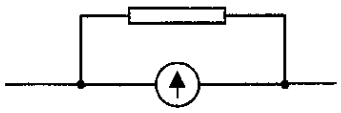

Fig. 3

11. State Lenz's law of electromagnetic induction and describe an experiment to illustrate the law. (18)

Draw a labelled diagram of an induction coil and explain how it works. Give an example of the use of an induction coil. (21)

Fig. 4 shows a coil connected in series with a lamp L and a 12 V a.c. power supply. The lamp lights when the power supply is switched on. Explain why the brightness of the lamp will decrease if an iron core is placed in the coil. (15)

The resistance of the lamp in the circuit in Fig. 4 is 60 Ω. If the resistance of the rest of the circuit is negligible calculate the electromotive force (e.m.f.) induced in the coil when the current flowing through the lamp is 80 mA. (12)

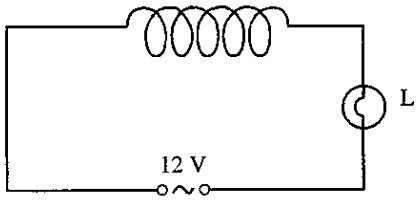

Fig. 4

12. A uranium ore was discovered by Marie and Pierre Curie early this century to contain the two radioactive isotopes, radium and polonium.

Explain the underlined words. (12)

Radium-226 decays to polonium-218 in two stages, with the same particle emitted in each stage. Name this particle and give an equation for the process. (12)

Outline an experiment to demonstrate the ionising effect of the particles emitted. (12)

Given that the half-life of radium-226 is very much greater than the half-life of polonium-218 explain why you would expect to find much more radium-226 than polonium-218 in a sample of the uranium ore. (9)

If a sample of radium contains 2.6×10^{21} radium-226 nuclei and is emitting 3.5×10^{10} particles per second calculate (i) the decay constant, (ii) the half-life, of radium-226. (21)

13. Answer any *two* of the following.

(*a*) State the principle of moments. (6)

Fig. 5 shows a uniform beam supported at its centre. Two bodies A and B, each of weight 2.0 N, are suspended from the beam so that body B rests on the bottom of a beaker as shown in the diagram. The two bodies are suspended at distances of 40 cm and x, respectively, from the centre of the beam. When water is poured into the beaker the beam gradually turns towards the horizontal.

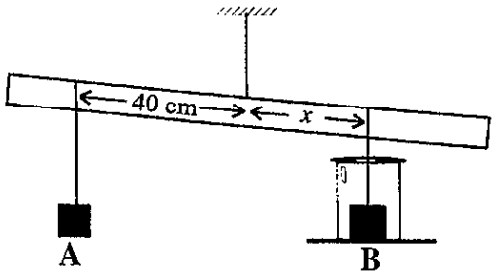

Fig. 5

Explain why the beam turns towards the horizontal as water is poured into the beaker. (9)

When body B is covered in water the beam is horizontal and in equilibrium. Given that the volume of B is 2.4×10^{-5} m^3 calculate the distance x.

(Density of water = 1.0×10^3 kg m^{-3}; acceleration due to gravity, $g = 9.8$ m s^{-2}.) (18)

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

Use a ray diagram to show how the final image is formed in an astronomical telescope in normal adjustment and describe the image formed in such a telescope. (15)

In an astronomical telescope in normal adjustment the distance between the lenses is 84 cm and the magnifying power of the telescope is 20. Calculate the focal lengths of the lenses. (12)

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

Fig. 6 shows a solid conductor which carries a positive charge. Copy the diagram and indicate how the charge is distributed over the surface of the conductor. (6)

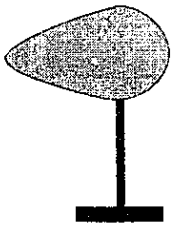

Fig. 6

Outline an experiment to verify how the charge is distributed over the surface of the conductor. (12)

Using the conservation of total electric flux, or otherwise, show that the total charge on the body in Fig. 6 resides on its surface. (9)

(*d*) State Faraday's first law of electrolysis. (6)

Describe an experiment to measure the electrochemical equivalent of a metal, e.g. copper. (18)

Explain, in terms of ions, why the mass of an element liberated during electrolysis depends on the current flowing through the voltameter. (9)