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, 2000

PHYSICS — HIGHER LEVEL

MONDAY, 19 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 pressure, the pascal, is equivalent to

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

Answer ☐ (6)

(ii) The period of a simple pendulum is 2 s. If the length of the pendulum is doubled, the period is

A. 4 s
B. 2 s
C. $2\sqrt{2}$ s
D. $2\pi\sqrt{2}$ s
E. $\sqrt{2}$ s.

Answer ☐ (6)

(iii) The threshold of hearing is

A. the lowest intensity to which the human ear can respond when the intensity level is 1 B
B. the lowest frequency to which the human ear can respond when the intensity level is 1 B
C. the lowest intensity to which the human ear can respond when the frequency is 1 Hz
D. the lowest frequency to which the human ear can respond when the intensity is 1 W m^{-2}
E. the lowest intensity to which the human ear can respond when the frequency is 1 kHz.

Answer ☐ (6)

(iv) An alternating voltage has a peak value of 75 V. The r.m.s. value is

A. $\sqrt{75}$ V
B. $\sqrt{(75)^2}$ V
C. $75\sqrt{2}$ V
D. $\dfrac{75}{\sqrt{2}}$ V
E. $\dfrac{75}{2\sqrt{2}}$ V.

Answer ☐ (6)

(v) In an X-ray tube, which one of the following is used to produce X-rays?

A. Alpha particles
B. Cathode rays
C. Gamma rays
D. Infrared rays
E. Microwaves

Answer ☐ (6)

(vi) The function of the control rods in a nuclear fission reactor is to control

A. the energy released per fission
B. the leakage of radiation
C. the kinetic energy of the neutrons
D. the rate at which energy is produced
E. the speed of the neutrons.

Answer ☐ (6)

2. Answer *five* of the following.

(i) An object immersed in a fluid appears to weigh .... than it does in air because of the .... acting on it. (6)

(ii) The U-value of a structure is decreased by adding .... to it. (6)

(iii) The fact that light can be polarised shows that it is a .... (6)

(iv) When a tungsten filament lamp is switched on the .... of the filament increases and so the current flowing through it .... (6)

(v) Forces between electric charges at rest are called .... forces. When charges are moving there are additional forces between them called .... forces. (6)

(vi) In a cathode ray tube electrons are emitted from the cathode by ....emission. The number of electrons reaching the screen is controlled by the voltage on the... (6)

3. Answer *five* of the following.

(i) When does a body travelling at a constant speed have an acceleration?.. .... (6)

(ii) The relationship between the linear velocity v and the angular velocity ω of a body moving in a circle of radius r is... (6)

(iii) When a body is undergoing simple harmonic motion the velocity is .... when the .... is a maximum. (6)

(iv) The speed of light in air is 3.0×10^8 m s^{-1}. The speed of light in glass is 2.0×10^8 m s^{-1}. What is the refractive index of the glass? .... (6)

(v) An electron is accelerated through a potential difference V. Give an equation which relates the velocity of the electron to V. .... (6)

(vi) In photoelectric emission the velocity of the emitted electrons depends on the .... and on the .... (6)

4. Answer *five* of the following.

(i) The charge on an electron was determined at the beginning of the 20th century in the famous oil drop experiment. Name the American physicist who devised this experiment. .... (6)

(ii) How are the oil drops charged in the oil drop experiment? ....

.... (6)

(iii) Name a force, other than weight, which acts on an oil drop during the oil drop experiment. ....

....(6)

(iv) Which one of the following values is *not* possible when the charge on an oil drop is measured accurately: 6.4×10^{-19} C; 8.0×10^{-19} C; 2.4×10^{-19} C; 3.2×10^{-19} C? (Charge on electron = 1.6×10^{-19} C.)

.... (6)

(v) The charge to mass ratio for the electron can be determined by passing a beam of electrons through

.... and ....fields. (6)

(vi) The charge to mass ratio for the electron is 1.76×10^{11} C kg^{-1}. What is the mass of the electron? (Charge on electron = 1.6×10^{-19} C.) .... (6)

AN ROINN OIDEACHAIS AGUS EOLAÍOCHTA

LEAVING CERTIFICATE EXAMINATION, 2000

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. In an experiment to measure the coefficient of dynamic friction between two surfaces, a force was applied to a block of mass 150 g resting on a horizontal surface. The applied force was increased until the block moved at a constant speed when given a gentle push. A mass *m* was then placed on top of the block and the applied force was again increased until the block moved at a constant speed when given a gentle push. This procedure was repeated for a series of values of *m*. The values of *m* and the corresponding values of the applied force, *F*, are given in the following table.

m /g	0	100	200	300	400	500	600
F/N	0.40	0.62	0.95	1.03	1.24	1.38	1.64

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

Draw a labelled diagram to show how the apparatus might have been arranged in this experiment. (9)

Why was the experiment arranged so that the block moved with constant speed? (9)

Explain how the value of the applied force might have been increased each time. (5)

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

6. The following is part of a student's account of an experiment to measure the speed of sound in air in the laboratory.

"The apparatus was adjusted until a stationary wave was obtained. The frequency was recorded. The distance was measured and from this the wavelength was calculated."

Explain, with the aid of a labelled diagram, how the apparatus might have been arranged in this experiment. (9)

Give the steps involved in setting up a stationary wave in this experiment. (12)

State what distance the student measured and explain how this measurement was used to find the wavelength. (9)

How might the frequency have been obtained in this experiment? (3)

Write down the equation used to calculate the speed of sound in air and give two precautions which should be taken to obtain an accurate value for the speed. (8)

7. In an experiment to measure the resistivity of nichrome the following readings were obtained for a length of nichrome wire.

Resistance of wire/Ω	8				
Length of wire/cm	60.4				
Micrometer reading/mm	0.34	0.32	0.35	0.36	0.32

Explain why several values for the micrometer reading were taken. (9)

The reading on the micrometer when it was fully closed was 0.02 mm. Taking this into account, calculate the diameter of the wire. Hence calculate a value for the resistivity of nichrome. (23)

The three quantities measured in this experiment are resistance, length and diameter. Which of these three quantities is measured the least accurately? Explain your answer and give one way in which the accuracy of this quantity could be improved. (9)

SECTION C (198 marks)

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

8. (*a*) Define (i) displacement, (ii) acceleration. (6)

A body is travelling with a velocity u in a certain direction. It then accelerates uniformly in the same direction for a time t. Show that $s = ut + \frac{1}{2}at^2$ where s is the displacement of the body and a is the acceleration. (9)

A car accelerates uniformly from rest to a speed of 15 m s^{-1} in a time of 4 s. It then moves at a constant speed for the next 6 s. Calculate

(i) the total distance travelled by the car,

(ii) the average speed of the car over the whole journey. (15)

(*b*) Describe an experiment to verify the parallelogram law. (18)

A parachutist is falling with a vertical velocity of 15 m s^{-1} when he is blown by the wind which has a horizontal velocity of 8 m s^{-1}. Calculate the resultant velocity of the parachutist. (12)

At a certain instant during the descent the parachutist is directly over a point X on the ground (Fig. 1). The parachutist lands 10 s later at the point Y. What is the distance XY? (6)

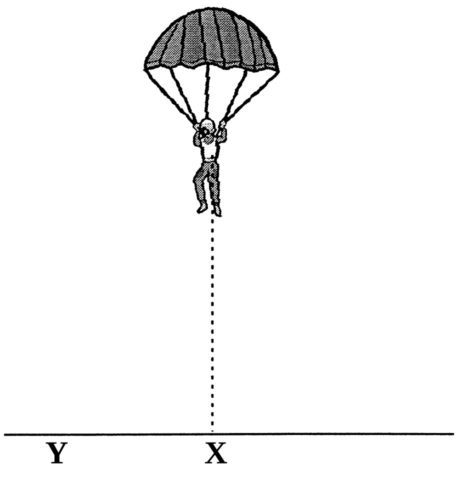

Fig. 1

9. Explain the terms (i) ideal gas, (ii) triple point of water. (12)

State Boyle's law and describe an experiment to verify it. (18)

Explain how Boyle's law may be used in the definition of the Kelvin scale of temperature. (12)

Draw a labelled diagram of a constant volume gas thermometer and explain how the volume of the gas is kept constant when the thermometer is being used. (12)

Explain why it is necessary to have a standard thermometer and give one reason why the constant volume gas thermometer is used as the standard thermometer. (12)

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

Draw a ray diagram showing the formation of a real image by a converging lens. (6)

An erect image, three times the size of the object, is formed when an object is placed 10 cm from a converging lens. Find the position of the image and the focal length of the lens. (12)

Use a ray diagram to show how the final image is formed by an astronomical telescope in normal adjustment. (9)

(*b*) What is a diffraction grating? (6)

Derive the diffraction grating formula $n\lambda = d \sin\theta$, where d is the distance between the centres of two adjacent lines on the grating. (12)

Describe an experiment to determine the wavelength of monochromatic light. (15)

11. State one law of electromagnetic induction. (6)

Draw a labelled diagram of an induction coil and explain how it works. (18)

Define magnetic flux, ϕ. (6)

A flat circular coil of radius 1.6 cm and consisting of 80 turns of wire lies in a plane which is perpendicular to a magnetic field of magnetic flux density 0.20 T. Calculate the magnitude of the induced e.m.f. when the flux density is steadily reduced to zero in 0.50 s. (12)

Explain the principles involved in each of the following.

(i) When a small metal cylinder is dropped through one end of the copper tube shown in Fig. 2, it falls freely under gravity. If the small cylinder is first magnetised, it then takes much longer to fall through the tube. (12)

(ii) If a transformer had a solid iron core the core would get hot when the transformer was in use. (12)

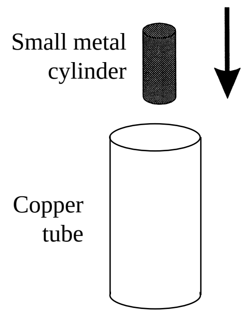

Fig. 2

12. What is an alpha particle? What is the change in (i) the atomic number, (ii) the mass number, of a nucleus when an alpha particle is emitted? (12)

Outline an experiment to investigate the range of alpha particles in air. (12)

In 1911 Ernest Rutherford proposed a new model for the structure of the atom. Describe Rutherford's model of the atom and outline the principle of the experiment that led to this model. (18)

Complete the following nuclear reaction and state its historical significance. (9)

$$^{14}_{7}N + \quad \rightarrow \ ^{17}_{8}O + ^{1}_{1}H$$

The radioactive isotope radium-226 undergoes alpha decay and has a decay constant of 1.35×10^{-11} s^{-1}. Calculate the number of alpha particles emitted per second by a 2 μg sample of this isotope. (15)
(1 mol of radium-226 = 226 g; the Avogadro constant, $N_A = 6.02 \times 10^{23}$ mol^{-1}.)

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. (18)

If the value of the acceleration due to gravity, g, on the surface of the earth is 9.8 m s^{-2} calculate a value for g at a height above the surface of the earth equal to the diameter of the earth. (Assume the earth is spherical.) (9)

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

What is meant by saying that Coulomb's law is an example of the inverse square law? (6)

Define the term electric field intensity, E, and give its unit. (9)

Fig. 3 shows a negatively charged metal sphere in a vacuum. The magnitude of the charge is 4.0×10^{-6} C. The point P is 50 cm from the centre of the sphere. Calculate the electric field intensity, in magnitude and direction, at the point P. (12)

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

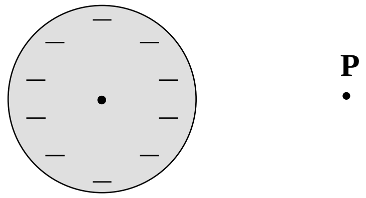

Fig. 3

(*c*) State Faraday's first law of electrolysis and state what is meant by the electrochemical equivalent of an element. (9)

Draw a diagram to show how one metal may be plated onto another metal using electrolysis. (9)

A layer of silver 0.02 mm thick is deposited by electrolysis onto a spoon of total surface area 20 cm^2. Electroplating with silver costs £21.50 per hour when a current of 1.0 A is used. Calculate:

(i) the volume of silver required;

(ii) the mass of silver required;

(iii) the cost of silver plating the spoon. (15)

(Density of silver = 1.05×10^4 kg m^{-3}; electrochemical equivalent of silver = 1.12×10^{-6} kg C^{-1}.)

(*d*) Name the three currents flowing through a bipolar transistor and give the relationship between them. (9)

The circuit in Fig. 4 contains a thermistor T and a relay R. Explain why the lamp L lights when the thermistor is heated. (18)

What is the purpose of the diode in the circuit? (6)

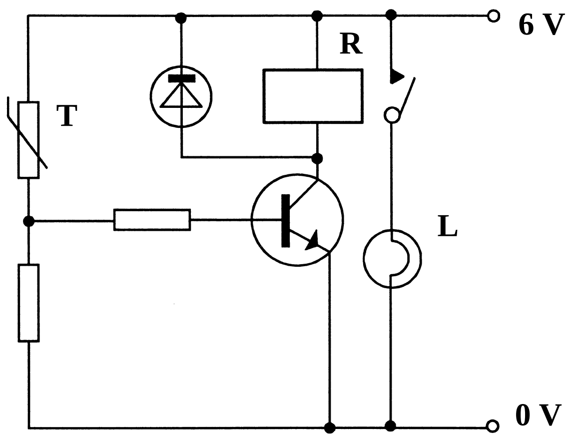

Fig. 4