LEAVING CERTIFICATE EXAMINATION, 1988

PHYSICS — HIGHER LEVEL

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) **On a certain day the height of the mercury column in a mercury barometer is 74·0 cm. Given that the density of mercury is $1{\cdot}36 \times 10^4$ kg m^{-3} and taking $g = 9{\cdot}81$ m s^{-2}, the atmospheric pressure is**

A. $9{\cdot}87 \times 10^6$ Pa
B. $9{\cdot}87 \times 10^5$ Pa
C. $9{\cdot}87 \times 10^4$ Pa
D. $1{\cdot}01 \times 10^5$ Pa
E. $1{\cdot}01 \times 10^6$ Pa.

Answer $\boxed{}$ (6)

(ii) **The resistance of a length of wire at the freezing point and boiling point of water is 4·6 Ω and 6·8 Ω, respectively. Its resistance at room temperature is 5·0 Ω. Room temperature, as measured on a Celsius temperature scale based on the resistance of the wire, correct to two significant figures, is**

A. 3·5 °C
B. 18 °C
C. 22 °C
D. 45 °C
E. 84 °C.

Answer $\boxed{}$ (6)

(iii) The unit of sound intensity is the

A. W
B. W m^{-2}
C. W m
D. Hz
E. dB.

Answer $\boxed{}$ (6)

(iv) When a beam of monochromatic light enters a block of glass from air

A. its speed decreases and its wavelength increases.
B. its speed decreases and its frequency increases.
C. its speed increases and its frequency remains the same.
D. its speed decreases and its wavelength remains the same.
E. its speed decreases and its wavelength decreases.

Answer $\boxed{}$ (6)

(v) The capacitance of a capacitor is 2·2 µF. When the potential difference between its plates is 10 V the energy stored in it is

A. $1{\cdot}1 \times 10^{-8}$ J

B. $1{\cdot}1 \times 10^{-5}$ J

C. $2{\cdot}2 \times 10^{-5}$ J

D. $1{\cdot}1 \times 10^{-4}$ J

E. $2{\cdot}2 \times 10^{-4}$ J.

$C = Q/V$

$CV = Q$

Answer $\boxed{D}$ (6)

QV

CV^2

(vi) The atomic number of a nucleus is Z and its mass number is A. In the nucleus there are Z p

A-Z N

A. Z neutrons and A protons
B. A neutrons and Z protons
C. Z neutrons and Z–A protons
D. A–Z neutrons and A protons
E. A–Z neutrons and Z protons.

Answer $\boxed{E}$ (6)

2. Answer *five* of the following.

(i) Define angular velocity Rate of change of angular Displacement. (6)

(ii) If a structure has a low U-value it is a good insulator. (6)

(iii) What type of source is associated with a line emission spectrum? monoatomic gasses eg Neon. (6)

(iv) What important phenomenon did Thomas Young demonstrate at the beginning of the nineteenth century? Interference of Light. (6)

(v) What is meant by mutual inductance? .... (6)

(vi) When $^{238}_{92}U$ decays to $^{226}_{88}Ra$ the number of α-particles emitted is 3 and the number of β-particles emitted is 2 (6)

238
226
12

3. Answer *five* of the following.

(i) Work may be defined as the product of Force and displacement. (6)

(ii) When a car of mass 1,000 kg is accelerated from rest to a speed of 20 m s^{-1} in 8 s the average power developed by the engine is 25 kW (6)

(iii) According to the kinetic theory of gases the average kinetic energy of the molecules of a gas is proportional to the ~~K~~ temperature of the gas. (6)

(iv) State Joule's law P = I²R P: Power I: Current R: Resistance (6)

(v) The energy of a photon is proportional to frequency
The constant of proportionality is known as plank's constant. (6)

(vi) Fission and fusion are two processes by which energy may be released in nuclear reactions. What is the difference between them? fission is the splitting of a neclem into two smaller neculi. Fusion is the joining of two smaller nuclei into 1 larger. (6)

4. Fig. 1 shows the basic structure of a moving coil galvanometer. Answer *five* of the following.

(i) Name the parts labelled A, B and C.

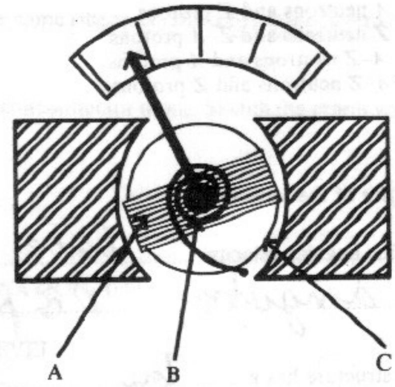

Fig. 1

A. Coil

B. Spring

C. Soft Iron Core (6)

(ii) What is the basic principle on which the moving coil galvanometer depends? Force on a current carrying coil in a magnetic field can cause a Torque (6)

(iii) Name one other device (other than a meter) which is based on the same principle Electric motor. (6)

(iv) How may a galvanometer be converted to an ammeter? a resistor may be connected in // (6)

(v) When a galvanometer has been converted to an ammeter, the ammeter cannot normally be used to measure alternating current. If the ammeter is to be used for this purpose name a device which must be connected in series with it rectifier. (6)

(vi) When a galvanometer is to be used as an ohmmeter it has a rheostat and a p.d. connected to it. (6)

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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 verify Newton's second law a constant force was applied to a body of mass 200 g and the resulting acceleration was determined. Additional masses, *m*, were placed on the body and the acceleration was found in each case, the applied force being kept constant throughout. The following results were obtained.

1.48 1.02 .68 .58 .52 .40 .34

a/cm s^{-2}	.148	102	68	58	52	40	34
m/g	0	100	200	300	400	500	600

.675

200 300 400 500 600 700 800

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

From the graph calculate the magnitude of the force applied to the body. (12)

Sketch a labelled diagram of an apparatus which might have been used in this experiment. (6)

6. In order to compare the specific heat capacities of copper and paraffin oil experimentally a student added hot copper to cold paraffin in a copper calorimeter. The following results were obtained by the student.

Mass of calorimeter .... = 60·5 g
Mass of calorimeter + oil.................................... = 94·8 g
Temperature of calorimeter + cold oil................ = 16 °C
Mass of copper .... = 12·4 g
Temperature of hot copper .... = 100 °C
Final temperature of calorimeter + oil + copper .. = 20 °C

Calculate the ratio of the specific heat capacity of paraffin oil to that copper. (21)

Explain how it may be concluded that the rise in temperature of the calorimeter and oil is the least accurate quantity used in calculating the final result. Give two ways in which the accuracy of this quantity could have been improved. (18)

7. The length, diameter and resistance of a nichrome wire were measured in an experiment to determine the resistivity of nichrome. The following values were obtained.

Length ....85·6 cm
Diameter... 0·22 mm
Resistance.. 27·9 Ω

Calculate a value for the resistivity of nichrome. (12)

Mention two precautions which should be taken, when determining the length of the wire, to ensure a more accurate result. (6)

Explain the steps involved in determining the diameter of the wire. (12)

Name two instruments which might have been used to measure the resistance of the wire and mention one precaution which should be taken to improve the accuracy of this measurement. (9)

SECTION C (200 marks)

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

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8. Define (i) energy, (ii) momentum. (12)

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

A radioactive nucleus, initially at rest, emits an alpha particle of mass $6{\cdot}68 \times 10^{-27}$ kg to produce a new nucleus of mass $3{\cdot}67 \times 10^{-25}$ kg. Explain how the principles of conservation of momentum and energy apply to this reaction. (12)

Calculate the ratio of the speed of the alpha particle to the speed of the new nucleus. Given that their total mass, when at rest, is $9{\cdot}50 \times 10^{-30}$ kg less than the mass of the original nucleus, calculate their total initial kinetic energy and hence the speed of each.
(Speed of light in vacuum, $c = 3{\cdot}00 \times 10^{8}$ m s^{-1}.) (21)

9. (*a*) State the laws of reflection of light. (6)

Use a ray diagram to show how an image is formed by a convex mirror. (9)

A concave mirror has a focal length of 20 cm. Find two positions at which an object may be placed so that the image formed may be twice the size of the object. (18)

(*b*) Draw a ray diagram to show how the final image is formed in an astronomical telescope in normal adjustment. (12)

An astronomical telescope of magnifying power 20 is to be used in normal adjustment to observe the moon. Given that the distance from the surface of the earth to the surface of the moon is $3{\cdot}7 \times 10^{8}$ m and that the radius of the moon is $1{\cdot}7 \times 10^{6}$ m calculate (i) the angle subtended by the moon at the objective lens of the telescope, (ii) the angle subtended at the eyepiece lens of the telescope by the final image of the moon. (21)

10. Define electric field intensity. (6)

Describe how an electric field pattern may be demonstrated in the laboratory. (15)

Fig. 2 shows three equal positive charges, A, B and C, situated at the vertices of a right angled, isosceles triangle. If the magnitude of the force exerted by C on A is F, what is the magnitude of the force exerted by C on B? (12)

Given that the magnitude of each of the charges is 4 μC and that the distance between B and C is 20 cm, calculate the value of F. (12)

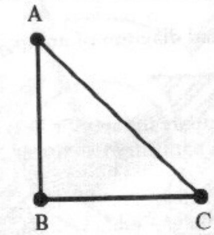

Fig. 2

Hence, or otherwise, determine the magnitude and direction of the total field intensity at B due to A and C. ($\varepsilon_0 = 8{\cdot}9 \times 10^{-12}$ F m^{-1}.) (21)

11. State (i) Faraday's law of electromagnetic induction, (ii) Lenz's law. (12)

Describe an experiment to illustrate *one* of these laws. (12)

A square coil of side l contains N turns of wire of total resistance, R (Fig. 3). It is travelling in a direction parallel to the side EH, as shown in the diagram, when it enters a magnetic field which is perpendicular to the plane of the coil and is of uniform magnetic flux density, B. Given that the two terminals of the coil are connected together explain why the coil slows down as it is entering the field. (12)

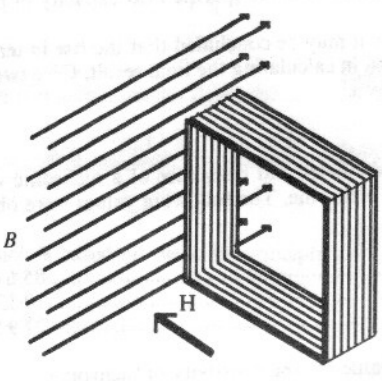

Fig. 3

Use Faraday's law to show that the e.m.f. induced in the coil at any instant while it is entering the field is given by $E = NBlv$, where v is the speed of the coil at that instant. (12)

Hence, derive an expression, in terms of v, for (i) the current in the coil, (ii) the force on the coil. (18)

12. Draw a diagram showing the structure of (i) a bipolar transistor, (ii) a field effect transistor, labelling the terminals in each case. (18)

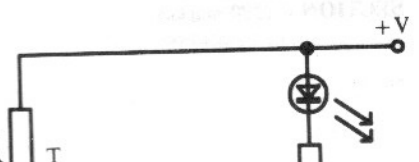

Fig. 4

Fig. 4 shows a temperature controlled switch based on a bipolar transistor. T is a semiconductor thermistor. Explain why the light-emitting diode (LED) comes on when the thermistor is warmed. (12)

Explain the function of each of the resistors R_1 and R_2. (18)

Draw a circuit diagram for a NOT gate, labelling the input and output terminals, and give its truth table. (18)

13. Answer any *two* of the following.

(*a*) Define simple harmonic motion. (6)

Fig. 5 shows a simple pendulum in a position where its displacement from the vertical is θ. Show, on a sketch, the forces acting on the bob of the pendulum in this position. Hence, derive an expression for the acceleration of the bob in a direction perpendicular to AB (Fig. 5).

(15)

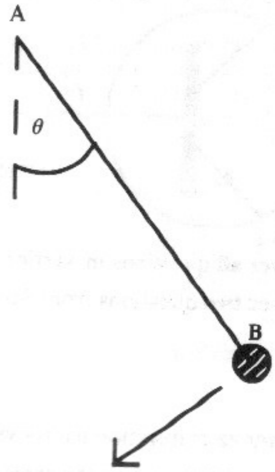

Fig. 5

Given that the maximum angular displacement from the vertical of the pendulum in Fig. 5 is 2·50° explain why its motion may be considered to be simple harmonic motion. If the maximum acceleration of the bob in a direction perpendicular to AB is $0{\cdot}427 \text{ m s}^{-2}$, calculate, correct to three significant figures, the acceleration due to gravity, g. (12)

(*b*) What is meant by resonance? (6)

Describe an experiment to investigate the relationship between the natural frequency of a string and its length. (18)

Name two factors, in addition to length, on which the natural frequency of a string depends and give the relationship between the frequency and one of these factors. (9)

(*c*) The following is an extract from a report of a famous discovery which was made towards the end of the nineteenth century. Read the passage carefully and answer the questions which follow it.

"The most striking feature of this phenomenon is the fact that an active agent here passes through a black cardboard envelope which is opaque to the visible and ultra-violet rays of the sun or of the electric arc; an agent, too, which has the power of producing active fluorescence. The active agent proceeds from that spot where, according to the data obtained by different investigators, the cathode rays strike the glass wall."

(Adapted from "Source Book in Physics", Harvard University Press.)

(i) What was the name given to the "active agent"? (6)

(ii) Who was the physicist who discovered this phenomenon? (6)

(iii) In what way does the "active agent" differ from the "visible and ultra-violet rays of the sun"? (6)

(iv) What are cathode rays? Explain how a beam of cathode rays may be produced. (15)

(*d*) State the law of radioactive decay and explain what is meant by the half-life of a radioactive isotope. (12)

Describe an experiment to determine the half-life of a short-lived radioactive isotope. (15)

The decay constant of a certain radioactive isotope is $1{\cdot}7 \times 10^{-10} \text{ s}^{-1}$. What is the half-life of the isotope? (6)