LEAVING CERTIFICATE EXAMINATION, 1986

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) The unit of work, the joule, is equivalent to the

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

Answer ☐ (6)

(ii) When a particle is executing simple harmonic motion its

A. displacement is proportional to its velocity
B. velocity is inversely proportional to its displacement
C. velocity is proportional to its acceleration
D. displacement is inversely proportional to its acceleration
E. displacement is proportional to its acceleration.

Answer ☐ (6)

(iii) Monochromatic light falls normally on a diffraction grating. The first order image is formed at an angle θ to the normal to the grating. The value of θ would be increased by

A. increasing the distance between the lines on the grating
B. increasing the wavelength of the light
C. decreasing the number of lines/mm on the grating
D. increasing the frequency of the light
E. decreasing the distance between the grating and the light source.

Answer ☐ (6)

(iv) When a capacitor of capacitance 10 μF holds a charge of 40 μC the energy stored in the capacitor is

A. 8,000 μJ
B. 400 μJ
C. 200 μJ
D. 80 μJ
E. 4 μJ.

Answer ☐ (6)

(v) In an electrolyte 0·6 g of an element are liberated by a current of 4 A in 10 minutes. The electrochemical equivalent of the element, in $kg\ C^{-1}$, is

A. $2{\cdot}5 \times 10^{-7}$
B. 1·44
C. $2{\cdot}5 \times 10^{-4}$
D. $2{\cdot}4 \times 10^{-2}$
E. $1{\cdot}5 \times 10^{-5}$.

Answer ☐ (6)

(vi) Which of the following statements is correct?

A. α-particles and γ-rays are deflected in magnetic fields.
B. γ-rays and β-particles are deflected in electric fields.
C. α-particles and β-particles are charged.
D. β-particles and γ-rays travel at the speed of light.
E. γ-rays and α-particles travel at the speed of light.

Answer ☐ (6)

2. Answer *five* of the following.

(i) What is meant by the coefficient of dynamic friction?.....

.....(6)

(ii) Archimedes' principle states that.....

.....(6)

(iii) The American physicist R. A. Michelson is remembered for .....

.....(6)

(iv) What is the unit of sound intensity?.....(6)

(v) On what principle is the operation of an electromagnetic relay based?.....

.....(6)

(vi) In a cathode ray tube the brightness of the spot on the screen is controlled by the .....

while the position of the spot is controlled by the..... (6)

3. Answer *five* of the following.

(i) What is a semiconductor?.....

.....(6)

(ii) Using the axes provided in Fig. 1 sketch a graph showing how the resistance of a piece of semiconductor material varies with its temperature. (6)

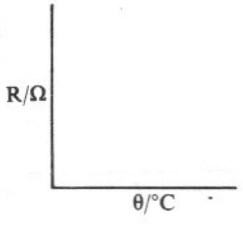

Fig. 1

(iii) The .....of a cadmium sulphide (CdS) cell .....as the intensity of the light falling on it increases. (6)

(iv) In a photodiode the number of free charge carriers is increased by .....

..... (6)

(v) Why should a light-emitting diode (LED) always have a resistor connected in series with it? .....

..... (6)

(vi) An AND gate has two inputs, A and B. In what circumstances will the output of the gate be "high"?

..... (6)

4. Fig. 2 shows a constant volume gas thermometer. Answer *five* of the following.

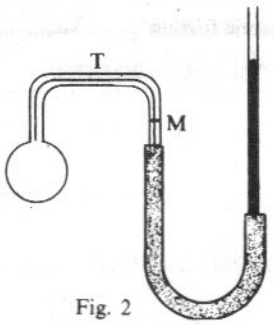

Fig. 2

(i) What is meant by a thermometric property?.....

.....(6)

(ii) On which thermometric property is the constant volume gas thermometer based?.....

.....(6)

(iii) Why is it used as the standard thermometer?.....

.....(6)

(iv) What is the significance of the mark, M?.....

.....(6)

(v) Why is T a capillary tube?.....

.....(6)

(vi) Give two measurements which must be taken when using a constant volume gas thermometer.....

.....(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.

5. In an experiment to measure the specific latent heat of vaporisation of water steam was passed into cold water in an aluminium calorimeter. The following results were obtained.

Mass of calorimeter	= 30·5 g
Mass of calorimeter + water	= 81·1 g
Temperature of cold water	= 16°C
Temperature of steam	= 100°C
Mass of calorimeter + water + steam	= 82·2 g
Final temperature of water	= 28 °C.

Given that the specific heat capacity of aluminium is 910 J kg^{-1} K^{-1} and that of water is 4,180 J kg^{-1} K^{-1} calculate the specific latent heat of vaporisation of water. (24)
What would be the advantage of cooling the water before adding the steam? (9)
Give two other precautions which might have been taken to ensure a more accurate result. (6)

6. A ray of light was passed through a rectangular glass block and the angles of incidence, i, and refraction, r, were measured. The following table shows the measurements obtained in the experiment.

i/degrees	12	21	29	40	49	62	70	79
r/degrees	8	14	19	26	30	36	39	41

Draw a suitable graph and explain how this verifies Snell's law. (21)
From the graph determine the refractive index of the glass. (9)
Outline an experimental procedure for determining the position of the refracted ray and hence finding the angle of refraction. (9)

7. A potentiometer and a standard resistor of resistance 5·0 Ω were used in an experiment to measure the internal resistance of a cell. When the cell was connected to the potentiometer without the resistor the galvanometer was found to read zero when the sliding contact was in the position shown in the photograph of Fig. 3(a). (The end of the wire was at the zero mark on the metre stick.) With the resistor connected in parallel with the cell the balance point shown in Fig. 3(b) was found.

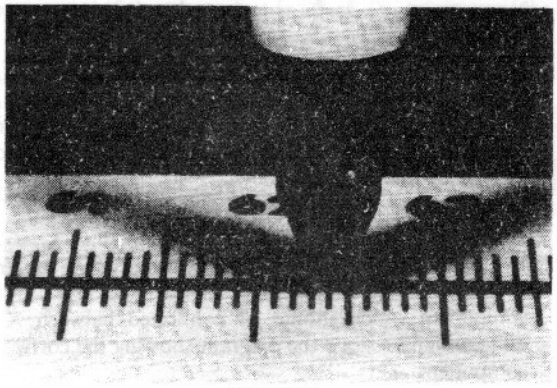


Fig. 3(a)

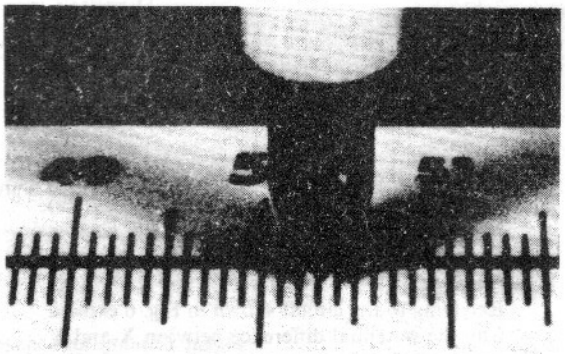


Fig. 3(b)

(i) From the readings in the photographs calculate the internal resistance of the cell. (24)

(ii) Draw a circuit diagram for this experiment. (9)

(iii) How might further values for the internal resistance of the cell be obtained in order to get a more accurate result? (6)

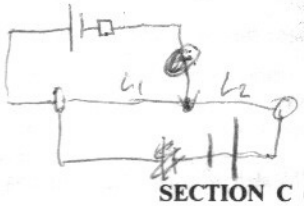
$E = V + I_r$

$V = I\left(\frac{L_1}{k}\right)$

$E = V + I_2 r$

$V = I\left(\frac{L_2}{k} + 5\right)$

use different Resistors.



$E = V + Ir$

$R = 0 \quad V = IR$

$E = I_1$

SECTION C (200 marks)

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

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8. Give an expression for (i) Newton's law of gravitation, (ii) the relationship between G, the gravitational constant, and g, the acceleration due to gravity. (12)
Describe an experiment to determine the value of g. (15)
Explain what is meant by centripetal force. (6)
Derive an expression for the periodic time of a satellite in a circular orbit around the earth in terms of its height above the earth and the radius and mass of the earth. (18)
The radius of the orbit of the planet Neptune around the sun is 30 times the radius of the earth's orbit. Calculate the time taken for Neptune to make one complete orbit of the sun. (15)

9. Describe an experiment to show that sound is a wave motion. (15)
Explain the physical principles underlying each of the following:
(i) Sounds can be heard more clearly on a cold night than on a warm day. (12)
(ii) A glass can be shattered by a singer singing a high note. (12)
When the source of a note moves past a stationary observer the pitch of the note seems to change. What is the name given to this phenomenon? (6)
A whistle which is emitting a note of 1 kHz is whirled in a horizontal circle on the end of a string 1·2 m long at a constant angular speed of 50 rad s^{-1}. What are the highest and lowest frequencies heard by a person standing some distance away? (Speed of sound in air = 340 m s^{-1}.) (21)

10. Define (i) electric field intensity, (ii) electric flux. Give the unit of each. (18)
State what is meant by the conservation of total electric flux and explain how this principle leads to the conclusion that the total charge on a conductor resides on its surface. (21)
Two positive point charges, each of 3 μC, are arranged at the vertices A and B of a right-angled triangle ABC as shown in Fig. 4. Calculate (i) the field intensity at C due to each of the charges, (ii) the total field intensity at C.
(Permittivity of free space, $\varepsilon_0 = 8{\cdot}9 \times 10^{-12}$ F m^{-1}.) (27)

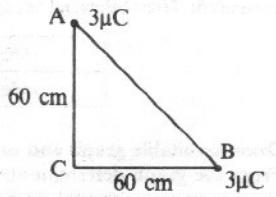

Fig. 4

11. Describe an experiment to show that a current-carrying conductor in a magnetic field experiences a force. (12)
Draw a labelled diagram of a simple d.c. motor and explain how it works. (24)
Explain how such a motor could be converted to work as an a.c. generator. (9)
Sketch a graph to show how the e.m.f. generated would vary with time and give the relationship between its peak value and its r.m.s. value. (12)

In a car an a.c. generator is used to recharge the battery. Fig. 5 shows a simple circuit which could be used for this purpose. Name the component which should be connected between X and Y in the diagram, and redraw the diagram showing the correct symbol for the component. (9)

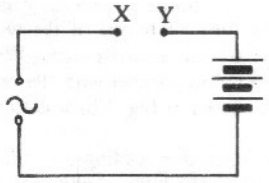

Fig. 5

12. (*a*) Describe the basic structure of a bi-polar transistor. (9)
Name the currents flowing through such a transistor and give the relationship between them. (12)
Referring to the circuit shown in Fig. 6 explain why the potential difference between X and Y drops when A is connected to B. (12)

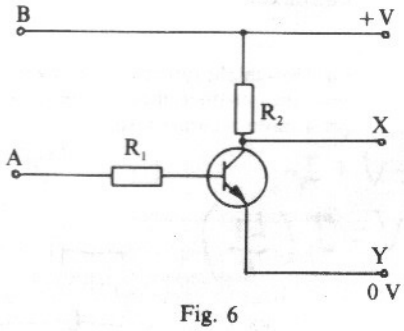

Fig. 6

(*b*) "Radioactivity was discovered by Henri Becquerel in 1896."
(i) What is meant by the term radioactivity? (6)
(ii) How did Becquerel make this discovery? (6)
A certain radioactive substance decays by α-emission with a half-life of 22 hours. At a certain time a sample of the substance is found to be emitting 150 α-particles per second. Given that one mole of the substance has a mass of 228 g calculate the mass of the substance present.
(Avogadro's constant = $6{\cdot}0 \times 10^{23}$ mol^{-1}.) (21)

13. Answer any *two* of the following.
(*a*) State the principle of conservation of momentum. (6)
Explain how this principle is applied in the acceleration of a rocket. (9)
A body of mass 80 g and travelling with a speed of 5 m s^{-1} collides with another body of mass 200 g at rest. After the collision both move together. Calculate
(i) the change in momentum of each body,
(ii) the average magnitude of the force exerted by each body on the other if the change in momentum occurs in 0·1 s. (18)

(*b*) Give *four* assumptions of the kinetic theory of gases. (12)
Show how the kinetic theory equation, $p = \frac{1}{3}\frac{Nmc^2}{V}$ is consistent with Boyle's law. (12)
Explain how Boyle's law is used in the definition of the Kelvin temperature scale. (9).

(*c*) Use a ray diagram to show how (i) a real image, (ii) a virtual image, is formed by a converging lens. (12)
Give the function of the collimator of a spectrometer and name the other essential parts of the spectrometer. (9)
Give *two* of the adjustments which should be made to the instrument before it is used. (6)
State *one* experimental determination which may be carried out with a spectrometer. (6)

(*d*) Read the following extract and then answer the questions below.

"The explanation of the photoelectric effect was the major work cited in the award to Albert Einstein of the Nobel Prize in Physics . . . . . Einstein's theory, proposed in 1905, played a major role in the development of atomic physics. The theory was based on a daring proposal. Not only were most of the experimental details still unknown in 1905, but the key point of Einstein's explanation was contrary to the classical ideas of the time."

("The Project Physics Course" Holt, Rinehart and Winston, New York.)

(i) What is the photoelectric effect? (6)
(ii) Give Einstein's explanation of the photoelectric effect. (9)
(iii) How was Einstein's explanation "contrary to the classical ideas of the time"? (6)
(iv) Outline an experimental procedure for the demonstration of the photoelectric effect. (12)