

GENERAL CERTIFICATE OF EDUCATION BOARD

General Certificate of Education Examination

JUNE 2025

ADVANCED LEVEL

Subject Title	Physics
Paper No	Paper 2
Paper Code	0780

Duration: Three Hours

Answer ALL questions

Section I is designed to be answered in 1 hour, Section II in 30 minutes and Section III in 1 hour.

You are advised to divide your time accordingly.

You are reminded of the necessity for good English and orderly presentation in your answers.

In calculations you must show all the steps in your working, giving your answer at each stage.

Calculators and formulae booklets are allowed.

## SECTION I

(One Hour)

Answer all Questions

1. (a) The specific charge  $\delta$  of an ion that is accelerated through a potential difference  $U$  into a uniform magnetic field  $B$  is given by  $\delta = \frac{2U}{B^2 r^2}$  where  $r$  is the radius of the circular path of the ion in the magnetic field. Show that this equation is homogenous.
- (b) All correct equations must be homogeneous but not all homogeneous equations are physically correct. Using a suitable example explain the meaning of this statement. **(6 marks)**
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2. 75 g of steam at  $100^\circ \text{C}$  are passed into a quantity of pure melting ice in an insulated calorimeter. If the heat given out by the steam in condensing to water at  $100^\circ \text{C}$  is just sufficient to melt the ice, calculate the;
- (a) mass of the ice
- (b) equilibrium temperature of the mixture in the calorimeter. **(4 marks)**
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3. Figure 1 shows how three resistors, three batteries with internal resistances and ammeters are connected in a network.

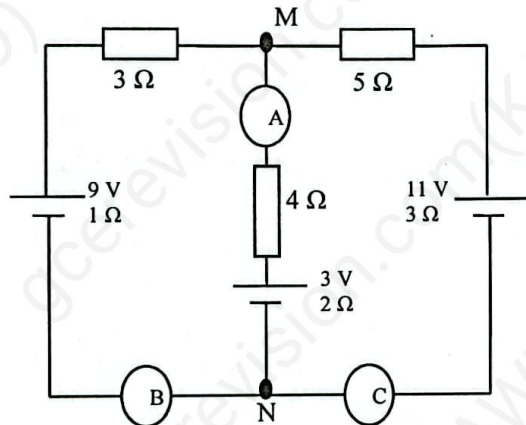


Figure 1

Calculate the;

- i) readings of the meters A, B and C.
- ii) potential difference between M and N.
- iii) power dissipated as heat in the  $5\ \Omega$  resistor

**(8 marks)**

4. Figure 2 shows a cylindrical container holding a sample of an ideal gas of molar mass  $0.024\ \text{kg}$  at a pressure of  $1.40 \times 10^5\ \text{N m}^{-2}$  and temperature of  $78^\circ \text{C}$ .

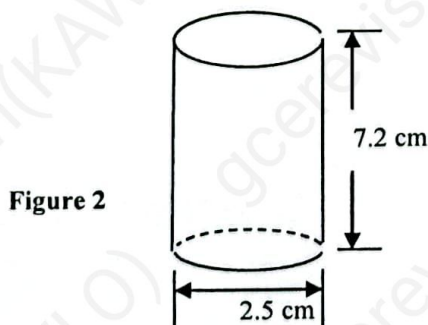


Figure 2

- (a) i) What mass of gas is present in the container?
- ii) How many molecules of the gas are present in the container?
- (b) Calculate the average kinetic energy of the gas molecules. **(6 marks)**
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5. i) State two experimental results of the photoelectric effect which cannot be explained by the classical wave theory and explain them using the quantum theory.
- ii) The ionisation energy of mercury is 10.4 eV. Calculate the maximum wavelength required by incident radiation to emit an electron from a mercury atom.

(6 marks)

**ANSWER EITHER QUESTION 6 (a), (b) and (c) OR (d), (e) and (f).**

**Either 6 (a), (b) and (c)**

- (a) i) State Newton's law of universal gravitation. (2 marks)
- ii) Describe an experiment to measure the acceleration due to gravity near the earth's surface. Your description should include a diagram, procedure, precaution, observation and conclusion. (8 marks)
- (b) i) Sketch a graph to show the variation of gravitational field strength,  $g$ , with distance,  $r$ , from the center of a spherical uniformly dense planet of radius  $R_0$ . (3 marks)
- ii) Explain the shape of the above graph when  $r > R_0$ . (1 mark)
- (c) Figure 3 shows water flowing horizontally from a hose of diameter 5.0 cm with a speed of  $12.0 \text{ m s}^{-1}$  on to a vertical wall.

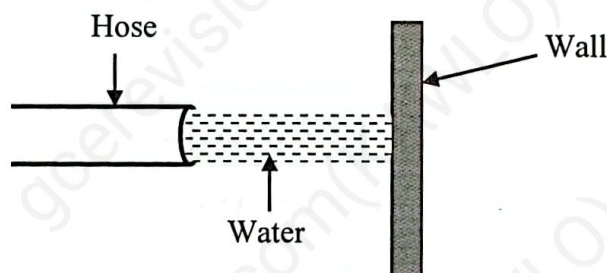


Figure 3

- i) Calculate the mass of water hitting the wall each second.
- ii) If the water comes to rest on the wall, determine the force exerted by the water on the wall. (6 marks)

## OR 6 (d), (e) and (f)

- (d) i) State Coulomb's law. (2 marks)
- ii) Describe an experiment to measure the capacitance of a capacitor. Your description should include a diagram, procedure, precaution, observation and conclusion. (8 marks)
- (e) i) Sketch a graph showing how the electric field strength,  $E$  varies with distance,  $r$ , from the centre of a positively charged spherical solid metal conductor of radius  $R_0$ . (3 marks)
- ii) Explain the shape of the above graph when  $r > R_0$ . (1 mark)
- (f) Figure 4 shows a single core transformer with a 4.0 H secondary coil wound on 1.5 H primary coil.

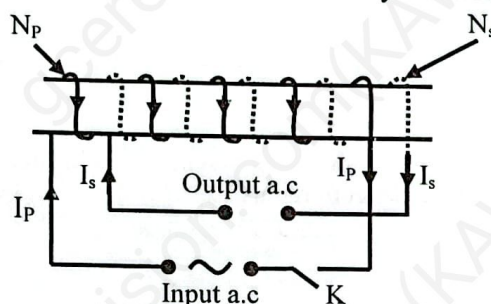


Figure 4

- i) Determine the mutual inductance of the transformer.
- ii) Calculate the voltage induced in the secondary coil if the current in the primary coil is increasing at the rate of  $0.02 \text{ A s}^{-1}$ . (6 marks)

## SECTION II (30 minutes)

## DATA ANALYSIS

7. In an experiment to investigate how pressure,  $P$ , varies with altitude,  $h$ , in the troposphere, a research physicist obtained the following values.

$P/\text{kPa}$	$h/\text{m}$
82.11	1500
71.39	2500
53.94	4502
46.74	5505
36.71	7250
30.82	8500
28.73	9000

The equation relating  $P$  and  $h$  is  $P = P_0 e^{-\beta h}$  where  $\beta$  and  $P_0$  are constants.

- (a) i) Plot a suitable graph to determine the value of  $P_0$  and  $\beta$  (9 marks)
- ii) Determine the values of  $P_0$  and  $\beta$  (8 marks)
- (b) Given that the average temperature of the troposphere is  $15^\circ\text{C}$  and the mean molar mass of the predominant ions is  $28.9 \text{ g}$ , determine the value for  $k$  given that  $\beta = \frac{mg}{kT}$  where  $m$  is mass of a molecule,  $T$  is the mean absolute temperature of the ions and  $g$  the gravitational field strength. (3 marks)



## SECTION III (1hour)

## OPTIONS

Answer any two questions from the four options

## OPTION 1: ENERGY RESOURCES AND ENVIRONMENTAL PHYSICS

8. (a) i) State one reason why energy crisis remains a serious problem in many developing countries despite the abundance of energy resources in these countries. (1 mark)
- Distinguish between;
- ii) fossil fuels and biofuels
- iii) primary and secondary sources of energy. (4 marks)
- (b) i) Draw a block diagram of a fossil fuel electricity generation scheme (4 marks)
- ii) In order to reduce the environmental problems resulting from the generation of electricity from fossil fuels, a community decides to build a facility to convert solar energy directly into electrical energy. If they require 1.0 MW of power and the photovoltaic panel to be installed has an efficiency of 20%, calculate the effective surface area of the panel given that the solar constant in the community is  $1.4 \text{ kW m}^{-2}$ . (2 marks)
- (c) Define each of the following phenomena and state a consequence of each.
- i) Greenhouse effect
- ii) Ozone depletion. (4 marks)
- (TOTAL = 15 marks)

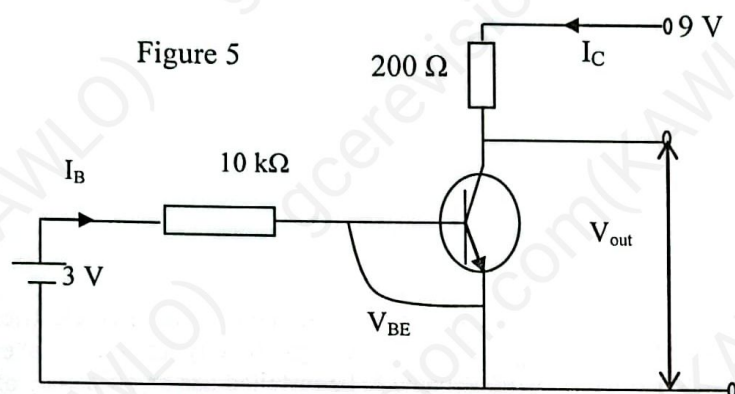
## OPTION 2: COMMUNICATION.

9. (a) Distinguish between
- i) FM and AM radio transmission (2 marks)
- ii) a radio transmitter and receiver (2 marks)
- (b) i) List two sources of power losses in optical fibres. (2 marks)
- ii) The speed of light in the core of an optical fibre is  $1.97 \times 10^8 \text{ m s}^{-1}$  and the critical angle of incidence at the core-cladding boundary is  $76.4^\circ$ . Calculate the refractive index of the cladding material. (3 marks)
- (c) i) Draw a block diagram of a radio receiver (4 marks)
- ii) State one advantage and one disadvantage of WhatsApp over SMS as communication channels. (2 marks)
- (TOTAL = 15 marks)

Turn Over

### OPTION 3: ELECTRONICS

10. (a) i) Distinguish between intrinsic and extrinsic semiconductors (2 marks)  
 ii) What do you understand by 'biasing a diode'? Explain the effect of this process on the diode? (3 marks)  
 (b) i) State in words and in form of truth table the action of a NAND logic gate. (2 marks)  
 ii) Draw a circuit diagram with two switches as inputs and a bulb as the output to illustrate the action of an AND gate. (2 marks)  
 (c) In the circuit in figure 5,  $V_{BE} = 0.70 \text{ V}$  and  $h_{fe} = 100$ .



Calculate

- i)  $I_B$   
 ii)  $I_C$   
 iii)  $V_{out}$

- (d) Explain how a transistor can be used as a switch and state one other use of a transistor. (4 marks)

(2 marks)  
**(TOTAL = 15 marks)**

### OPTION 4: MEDICAL PHYSICS

11. (a) i) Draw a simple diagram of the human heart. (4 marks)  
 ii) What is an electrocardiogram (ECG) in medical diagnosis? State one limitation of an ECG. (3 marks)  
 (b) Long-sightedness is an eye defect. Explain how this defect;  
 i) manifests  
 ii) can be corrected. (4 marks)  
 (c) i) Exposure to radiation can cause either genetic or somatic effect. What is the difference between genetic effect and somatic effect? (2 marks)  
 ii) Name one example of an effect due to exposure of a body organ to harmful level of radiation. (1 mark)  
 iii) Give one reason why X-ray radiology is not suitable for examining a fetus in the womb. (1 mark)  
**(TOTAL = 15 marks)**