

GENERAL CERTIFICATE OF EDUCATION BOARD
General Certificate of Education Examination

Physics 2
0780

JUNE 2023

ADVANCED LEVEL

Subject Title	Physics
Paper No	Paper 2
Paper Code	0780

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 booklet are allowed.

Turn Over

SECTION I

(One hour 30 minutes)

Answer all Question

1. Explain what makes an equation relating physical quantities to be:
- homogeneous.
 - physically correct.

The thermoelectric emf, E generated in a thermocouple when the cold junction is placed in contact with melting ice and the hot junction placed in a bowl of water at a temperature, θ is given by the equation

$$E = E_0(1 + \alpha\theta + \beta\theta^2 + \dots)$$

Where E_0 is the emf at $\theta = 0^\circ\text{C}$ and α and β are constants.

The above equation is homogeneous. Determine the base units of

- $\alpha\theta$ and $\beta\theta^2$
- α and β .

(6 marks)

2. The volume of a gas changes from $1.80 \times 10^{-6} \text{ m}^3$ to $3.20 \times 10^{-3} \text{ m}^3$ as it expands adiabatically against the atmosphere which exerts a pressure of $1.10 \times 10^5 \text{ Pa}$.

- Calculate the total work done by the gas
- State and explain how the temperature of the gas changes in the process.
 - Name one practical situation in which this change can be experienced.

(6 marks)

3. In the process of producing LASERS, atoms of the active medium are excited from the ground state, $n = 1$ (of energy $E_1 = -11.2 \text{ eV}$) to $n = 3$ (of energy $E_3 = -1.38 \text{ eV}$). These atoms then fall back momentarily to $n = 2$ (of energy $E_2 = -5.82 \text{ eV}$). They are then stimulated by a suitable energy photon to fall back to the $n = 1$ level. Define the following words and expressions used in relation to LASERS

- Optical pumping;
- Population inversion as used in the production of LASERS.
- Explain why the LASER beam has a high intensity and calculate the wavelength of the light produced.

(6 marks)

4. When a 0.8 kg mass is hanging from a helical spring, it produces an extension of 5.2 cm in it. The object is then suspended from two such identical springs as shown in figure 1 below. If the mass is then pulled down through a

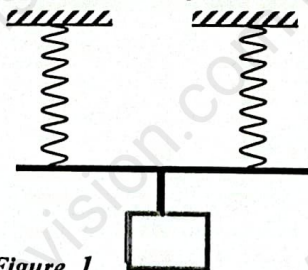


Figure 1.

further distance of 4.8 cm and allowed to oscillate freely in a vertical plane:

- determine the period of oscillation of the mass;
- sketch a graph to show how the mechanical energy of the mass varies with its displacement from the rest position.

(5 marks)

5. Some electrical components are connected together in a circuit energized by 3.00 V battery as shown in figure 2. The capacitors are initially uncharged. The contact point Z of the switch is closed at point X until the $1.00 \times 10^2 \mu\text{F}$ capacitor is fully charged. When Z is now moved to make contact with Y, determine

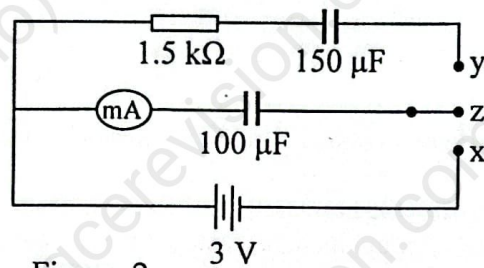


Figure 2

- (a) The initial current in the circuit.
 (b) The maximum charge that will be stored in the $150 \mu\text{F}$ capacitor. (7 marks)

Answer EITHER 6 (a), (b) and (c) OR 6 (d), (e) and (f).

EITHER 6 (a), (b) and (c)

6. (a) (i) Define the temperature coefficient of resistance of a material. (4 marks)
 (ii) State and explain the type of temperature coefficient of resistance copper has i.e. whether it is positive or negative. (4 marks)
 (iii) Describe an experiment to measure the temperature coefficient of resistance of copper. Your description should include a setup, measurements taken, how the measurements are processed to reach a conclusion and at least one precaution. (8 marks)
- (b) A 12.0 V steady power supply of negligible internal resistance, energizes a circuit comprising 4 resistors, as shown in figure 3.

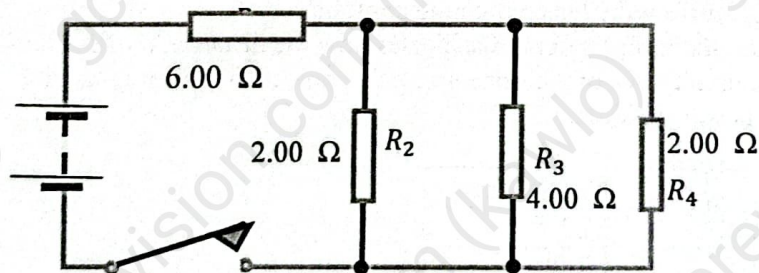


Figure 3

When the switch is closed, calculate:

- (i) the combined resistance of the circuit;
 (ii) the change in the current in the circuit when the 4.00Ω resistor is disconnected. (4 marks)

- (c) A Physics student in a village that is not electrified uses a 12.0 V motorcycle battery to charge his mobile phone battery of emf 4.6 V. He connects two filament bulbs in series with the phone battery to ensure that the high voltage does not destroy his phone battery.

Turn Over

- (i) If the charging current in the circuit is 0.8 A, determine the resistance of each filament bulb.
- (ii) Explain why the bulbs go off when the phone battery is fully charged. (4 marks)

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

- 6 (d) (i) Define uniform acceleration.
- (ii) State and explain a situation where an object in uniform motion is accelerating. (4 marks)
- (iii) Describe an experiment to measure the acceleration of free fall of an object close to the earth's surface. Your description should include a setup, measurements taken, how the measurements are processed to reach a conclusion and at least one precaution that when taken improves the results. (8 marks)
- (e) A ball released at the top of long ramp inclined at an angle $\theta = 30.0^\circ$ to the horizontal rolls down the ramp with negligible friction. If the length of the ramp is 8.00 m and the mass of the ball is 0.500 kg, calculate:
- (i) its acceleration down the ramp;
- (ii) the time it takes to reach the base of the ramp;
- (iii) The friction on the floor after the ramp which brings the ball to rest 15.0 m from the base of the ramp. (4 marks)
- (f) A football player takes a spot kick 40.0 m from a 2.2 m high empty goal post during training. If she kicks the ball with a velocity of 40.0 m s^{-1} at an angle of 10.0° to the ground:
- (i) show by calculation whether she hits the target; and
- (ii) explain why the path of the ball is parabolic. (4 marks)

SECTION II (40 minutes)

DATA ANALYSIS

7. A pupil photographer is told that to get photographs of the same size from objects of different sizes, the photographer has to move towards or away from the object thereby adjusting the distance between the object and the lens of the camera or the distance of the lens from the screen has to be adjusted with the distance of the object from the lens remaining constant.
- Taking the second option, the student investigates how the distance, d of the lens from the screen can be adjusted to obtain pictures of the same size using objects of different heights, h_0 .
- The following data was obtained.

h_0/cm	d/cm
15.0	22.5
16.1	22.0
18.1	21.2
20.5	20.5
23.9	19.7
29.6	18.8
37.5	18.0
45.0	17.5
62.5	16.8
93.8	16.2

The two quantities above are related by the equation

$$d = f \cdot \left(\frac{h_i}{h_0} + 1 \right)$$

where f is the focal length of the lens and h_i is the fixed height of the image formed in each case.

- (a) Plot a suitable graph from which f and h_i can be calculated. (10 marks)
- (b) Calculate f and h_i . (7 marks)
- (c) (i) What is the name given to the ratio $\frac{h_i}{h_0}$? (3 marks)
- (ii) Determine the value of d when $h_i = h_0$? (3 marks)

(Total 20 marks)

SECTION III (50 minutes)

OPTIONS

Answer any two questions from the four options

OPTION 1: ENERGY RESOURCES AND ENVIRONMENTAL PHYSICS

- 8 (a) (i) What is the difference between an energy source and an energy resource. (5 marks)
- (ii) What is energy security?
- (iii) State two steps Cameroon can take to work towards energy security. (7 marks)
- (b) (i) Draw a block diagram of a nuclear power plant highlighting the energy changes in each block. (7 marks)
- (ii) Nuclear fusion is a very popular but non-exploitable source of energy at moment. Explain why it is rather nuclear fission that is used to produce energy. (7 marks)
- (c) (i) State the meaning of acid rain. (3 marks)
- (ii) Explain how acid rain is formed and outline two of its adverse effects (3 marks)

OPTION 2: COMMUNICATION.

9. (a) (i) State what is meant by a signal. (5 marks)
- The signals television stations transmit as space wave are mostly VHF and UHF signals.
- (ii) Write out the full meanings of VHF and UHF.
- (iii) State and explain whether it is VHF or UHF signals that transmit more energy. (5 marks)
- (b) (i) A radio receiver has many component parts, some of which are the LC loop and the Demodulator. State the uses of the underlined components of a simple radio receiver. (5 marks)
- (ii) In terms of *noise interference*, *broadcast range* and *bandwidth*, state how AM signals differ from FM signals. (5 marks)
- (c) (i) In front of a certain tall concrete building backing a cell site, cell phone reception is very poor. List two reasons for this observed fact. (5 marks)
- (ii) What does it mean to say that a cell phone is roaming? (5 marks)

OPTION 3: ELECTRONICS

10. (a) Figure 4 shows a simple circuit containing a device, D connected in series with a cell and a milliammeter.

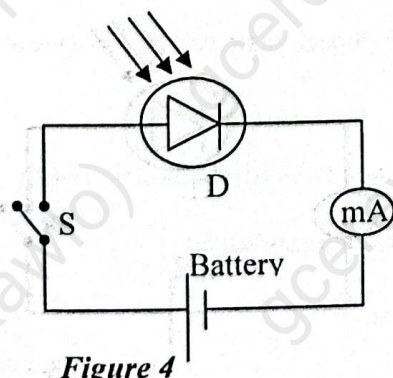


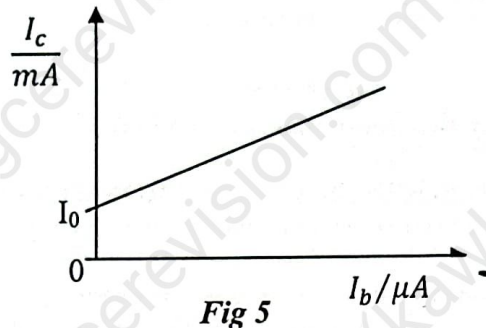
Figure 4

(6 marks)

Turn Over

- (i) What is the name of the device, D?
 (ii) State and explain the steps that can be taken to cause the reading of the milliammeter to rise.
 (iii) What is avalanche breakdown? (5 marks)

- (b) Figure 5 is a graph showing the transfer characteristic of a bipolar junction transistor connected in the common emitter mode.



- (i) Explain the origin of I_0 shown on the graph.
 (ii) What is the significance of the slope of this graph?
 (iii) Draw a diagram of a circuit in which this transistor is functioning as a light-operated switch. Such a switch turns lights on when the intensity of the light in the environment is low. Explain why this switch comes on when the light intensity is low. (5 marks)

- (c) A two-door car has a safety light bulb that comes on when any of the doors is open.

- (i) Complete the table below to show whether the bulb “lights” or “doesn’t light”

Door 1	Door 2	Bulb
Closed	Closed	
Open	Closed	
Closed	Open	
Open	Open	

- (ii) Taking closed door for low input and bulb lights for high output, draw a truth table for the system.
 (iii) Give the name of the logic gate depicted by this system. (5 marks)

(Total 15 marks)

OPTION 4: MEDICAL PHYSICS

11. (a) (i) Explain why patient with a heart pace maker is not qualified to take a magnetic resonance imaging (MRI) test.
 (ii) Explain how optical fibres assist in keyhole surgery.
 (iii) Ultrasound and X – rays are tools used in medical diagnosis. State two advantages of X – rays over ultrasound in this domain. (7 marks)
- (b) (i) What is persistence of vision ?
 (ii) Cite one situation in which persistence of vision can be observed and explain how it happens.
 (iii) State the cause of myopia and briefly explain how it can be corrected. (6 marks)
- (c) What is a heart - pacemaker? (2 marks)

(Total 15 marks)