GENERAL CERTIFICATE OF EDUCATION (GCE) BOARD

General Certificate of Education Examination

Physics 2
0780

JUNE 2021

ADVANCED LEVEL

Subject Title	Physics
Paper No	Paper 2
Paper Code	0780

Two and a half hours

Answer ALL questions

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

SECTION I

(One hour)
Answer all Questions

1. a) The force per unit length, F, between two current-carrying conductors kept a distance, a, apart in vacuum is suggested by an engineering physicist to be given by: $F = (\mu_0 I_1 I_2) / 2a$
Where μ_0 is the permeability of vacuum, I_1 and I_2 are the currents in the conductors. Determine whether the equation is homogeneous or not.
b) State with the aid of an example why an equation can be homogeneous but incorrect.
(6 marks)

2. State and explain how the electrical resistance of each of the following will be affected by an increase in temperature;
a) pure semiconductor
b) pure metal wire
(4 marks)

3. Figure 1 shows how three capacitors are connected in a circuit. One of the capacitors has an unknown capacitance, X. Given that the total charge stored on the capacitors is 1500 μC with the switch closed and the potential difference between A and B is 12.0 V.

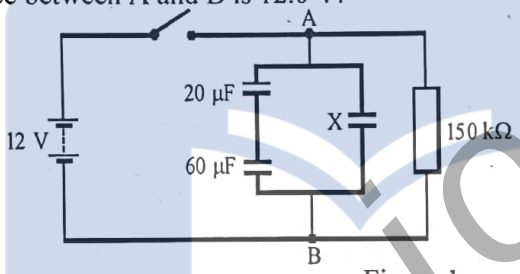


Figure 1

a) Calculate the
i) total capacitance in the circuit
ii) value of X
iii) potential difference across the 60 μF capacitor.
b) The supply is disconnected and the capacitors discharged through the 150 kΩ resistor. Calculate the time taken for the potential difference between A and B to fall to 6.0 V. **(8 marks)**

4. A force of 40 N acts on a body at an angle of 110 ° to another force of 50 N acting on the same body. Calculate the resultant force acting on the body. **(5 marks)**

5. Two narrow slits which are closed to each other are illuminated with **coherent** **monochromatic** light.
a) i) Give the meaning of the underlined words
ii) Explain why a pattern of fringes is observed on a screen placed at some distance from the slits
b) In one such experiment light of wavelength 500 nm gives fringes separated consecutively by 2.5 mm. If the screen is 1.55 m from the slits, what is the distance between the slits? **(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 work function **(2 marks)**

ii. Describe an experiment to determine plank's constant. Your description should include a diagram, procedure, precaution, observation and a conclusion. **(8 marks)**

(b) i. State the laws of electromagnetic induction **(4 marks)**

ii. A coil of area 0.25 m^2 with 100 turns is placed at right angles to a magnetic field of $3x10^{-3}$ T. calculate the magnetic flux linkage in the coil. **(2 marks)**

c) i. Calculate the period of rotation of the moon round the earth if the mean radius of the moon's orbit is 3.0×10^8 m. **(3 marks)**

ii. State one difference between the magnetic force and the gravitational force. **(1 mark)**

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

6 d) i. Define specific latent heat of vaporisation. **(2 marks)**

ii. Describe an experiment to determine the specific latent heat of vaporisation of water. Your description should include a diagram, procedure, precaution, observation and a conclusion. **(8 marks)**

(e) i. State Kirchhoff's laws for electric circuits. **(4 marks)**

ii. Consider the circuit diagram in figure 2

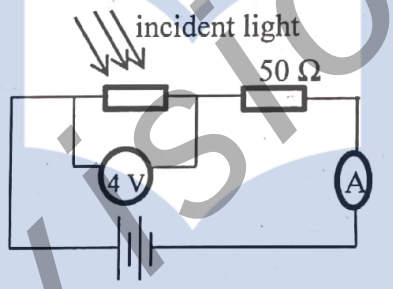


Figure 2

Determine the reading of the ammeter when light of constant intensity falls on the light dependent resistor (LDR) and the voltmeter reads 4 V. **(3 marks)**

(f) i. Calculate the quantity of solar energy which can be captured per unit time by a photovoltaic plate measuring 6.0 m by 2.0 m if the solar constant is 1.4×10^3 W m^{-2} **(2 marks)**

ii. Why can all this energy not be converted to electrical energy? **(1 mark)**

SECTION II (30 minutes)

DATA ANALYSIS

7 The current, I, through a certain electrical device is related to the potential difference, V, across its terminals by the equation: $I = I_o\, e^{-eV/2\beta T}$

Where, e. is the electronic charge, T is the temperature at which the current is flowing and equals 298 K and β is a constant.

The following results were obtained using the device:

$I / x10^{-2}$ A	$V / x10^{-2}$ V
29.2	2.9
25.9	3.5
23.0	4.1
20.8	4.6
19.2	5.0
17.6	5.5
15.7	6.0
14.2	6.6
13.1	7.0

a) Plot a suitable graph from which β and I_o can be obtained. **(11 marks)**

b) Hence determine the values of β and I_o **(8 marks)**

c) What is the significance of I_o? **(1 mark)**

SECTION III (1 hour)

OPTIONS

Answer any two questions from the four options

OPTION 1: ENERGY RESOURSES AND ENVIRONMENTAL PHYSICS

8 (a) Differentiate between renewable energy sources and non-renewable energy sources, giving one example in each case. **(4 marks)**

b) For a wind mill, the kinetic energy per unit time, $P = \frac{1}{2}\pi r^2 \rho v^3$

where r is the radius of the blades, ρ the density of air and v the speed of the wind. The diameter of the blades of an aero-generator of the mill is 4 m. What is the power output of the wind mill on a day when air has a density of 1.2 kg m^{-3} and the wind is blowing with a velocity of 144 km per hour if the efficiency of the wind mill is 25%? **(3 marks)**

c) (i) Draw an energy-flow diagram of a hydroelectric power plant. **(3 marks)**

(ii) State one environmental problem that arises from the construction of a hydroelectric power plant. **(1 mark)**

d) (i) Explain what is meant by global warming.

(ii) State and explain one effect of global warming on human beings. **(4 marks)**

OPTION 2: COMMUNICATION.

9 (a) Differentiate between;
(i) digital and analogue signals
(ii) encoding and decoding **(6 marks)**

(b) Optical fibres are increasingly being used in modern day communication. Write down two advantages of optical fibre communication over other communication systems. **(2 marks)**

(c) Draw a labelled diagram of a simple tuning circuit. **(2 marks)**

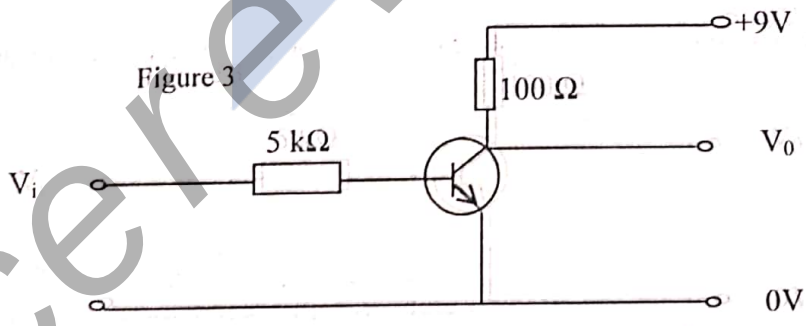
(d) A **communication** channel is characterized by a **bandwidth** that determines the volume of information it can transmit in a given time.
(i) Define the words in underlined **(2 marks)**

(ii) A radio station uses a carrier frequency of 200 kHz to transmit an amplitude modulation wave. The transmission consists of audio signals within the frequency range of 50 Hz - 9 kHz. Calculate the minimum frequency sideband and the bandwidth. **(3 marks)**

OPTION 3: ELECTRONICS

10 (a) Draw the circuit symbol and the truth table of an OR gate. **(4 marks)**
(b) The diagram below shows a circuit which has a transistor whose current amplification, h_{fe} is 100:

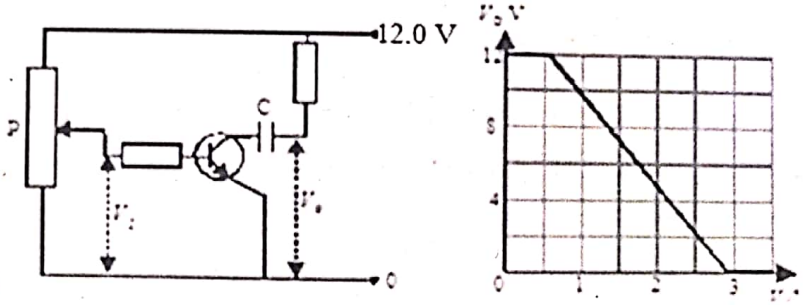
Figure 3



i) For a base-emitter voltage of 0.7 V, calculate the base current and the emitter current when the input voltage V_i is 2.0 V. **(2 marks)**
ii) What is the output voltage, V_0? **(2 marks)**

Turn Over

(c) Figure 4 (a) shows a transistor circuit in the CE arrangement. The input voltage (V_i) is varied using the potential divider, P. The corresponding output voltage (V_o) is shown graphically in figure 4(b).



(a) **figure 4** (b)

For this circuit to be used as an alternating voltage amplifier, the input voltage must be fixed at a suitable value by adjusting P.

(i)What is the most suitable value for this fixed input voltage, explain your answer.

(ii)What is the use of the capacitor C?

(d) A sinusoidal alternating voltage of amplitude 0.5 V is superimposed on this fixed voltage.

(i) What will the amplitude of the output voltage be?

(ii) Explain how the above set-up can be used as an electronic switch. **(7 marks)**

OPTION 4: MEDICAL PHYSICS

11 (a) (i) Draw a simple labelled diagram of the human ear. **(4 marks)**

(ii) Name one factor that causes hearing to deteriorate. **(2 marks)**

(b) MRI is one form of non-invasive diagnostic imaging.

(i) Write in full MRI. **(1 mark)**

(ii) Write down two advantages and two disadvantages of MRI. **(4 marks)**

(c) (i) During ultrasonic probe a gel is often applied on the spot where it is performed? Explain why this is done.

(ii) Explain why ultrasound is not likely to replace-rays completely in medical diagnoses. **(4 marks)**