GENERAL CERTIFICATE OF EDUCATION BOARD

General Certificate of Education Examination

Physics 2
0780

JUNE 2022 **ADVANCED LEVEL**

Subject Title	**Physics**
Paper No	**Paper 2**
Paper Code	**0780**

Two and a half hours.

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 booklets are allowed.

SECTION I

(One hour)

Answer all Questions in this Section.

1. The energy generated per unit time by a wind turbine is given by the equation $E = \frac{1}{2}\rho A K v^3 N$ where ρ is the air density, A is the area swept by the blade, v is the wind velocity, K is the coefficient of performance and N is the generator efficiency.

(a) Explain with the help of an example why homogeneity of a physical equation is not a sufficient condition for the correctness of the equation.

(b) Determine the base units of K. **(6 marks)**

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2. An electric circuit is made by connecting in series a resistor of resistance 80 Ω, an inductor of inductance 0.4 H and a capacitor of capacitance 125 μF to an alternating power source of Vrms = 220 V and frequency 50 Hz.

(a) State any one use of such a circuit in daily life.

(b) Calculate the impedance, Z, and the root mean square value of the current in the circuit.

(c) Calculate the resonant frequency f_o, and the current in the circuit at resonance. **(6 marks)**

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3. (a). What is meant by "the moment of a force"?

(b). State one condition necessary for a body to be in equilibrium on a plane.

(c). Figure 1 shows a uniform plank of weight 6 N and length a, inclined at an angle θ. Calculate θ given that the system is in equilibrium.

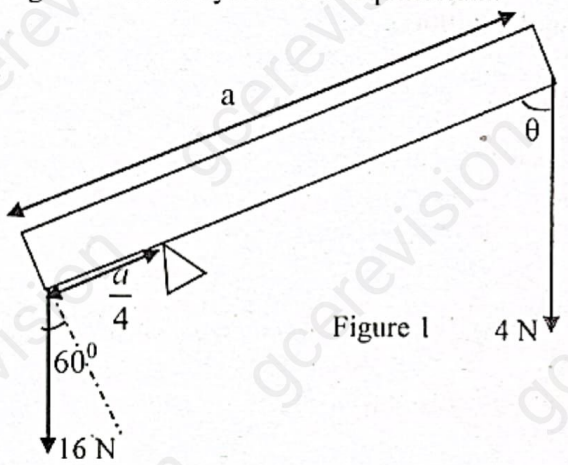

Figure 1

(6 marks)

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4. (a) Define self-inductance.

(b) A solenoid of 500 turns and diameter 10 cm is made from a conducting wire of diameter d = 1mm. If there are no spaces between the turns, calculate the,

i) total length of the coil needed for the solenoid.

ii) current that must flow in the turns to produce a field strength of 0.15 T at the centre of the solenoid.

iii) flux linking the turns of this solenoid when it is supplied with the current calculated. **(7 marks)**

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5. Figure 2 shows a circuit diagram.

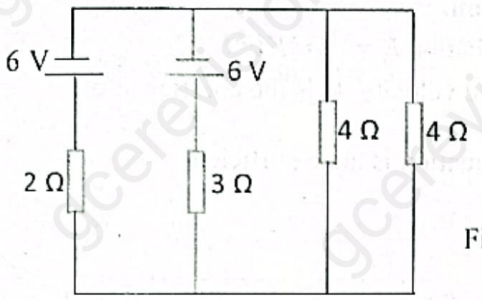

Figure 2

Determine the size of the current through the 3 Ω resistor. **(5 marks)**

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

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

(a) Distinguish between transverse and longitudinal waves, stating an example of each type of wave. **(4 marks)**

(b) Describe an experiment to determine the speed of sound in free air. Your account should include a diagram, procedure, precautions, observation and conclusion. **(8 marks)**

(c) (i) Define simple harmonic motion **(2 marks)**

(ii) A small mass M is attached to the free end of helical spring on a smooth horizontal table. The other end of the spring is fixed. The mass is pulled through a distance of 5.0 cm from its initial rest position and then released so that it vibrates with a frequency of 30 Hz. If the spring constant is 10 N m^{-1}, show that the motion is simple harmonic and calculate the mass M. **(4 marks)**

(iii) State an example of a critically damped system and its application in daily life. **(2 marks)**

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

6. (d) (i) Distinguish between the specific heat capacity and the specific latent heat of a substance. **(2 marks)**

(ii). Explain why the specific latent heat of vaporisation is higher than the specific latent heat of fusion for the same substance. **(2 marks**

(e) Describe an experiment to determine specific latent heat of fusion of ice. Your account should include a diagram, procedure, precautions, observation and conclusion. **(8 marks**

(f) (i) State Newton's law of universal gravitation. **(2 mar**

(ii) The expression for gravitational potential energy, U, of a mass m, at a height h above the surface of the earth is $U = -\frac{GMm}{R+h}$, where M is the mass of the earth, R is the radius of the earth and G is the universal gravitational constant. Show that when m is near the surface of the earth, the expression simplifies to U = mgh. **(3 marks)**

(iii) Calculate the least amount of kinetic energy a space craft of mass 1500 kg must have in order to be able to escape from the earth's surface. **(3 marks)**

SECTION II (30 minutes)

DATA ANALYSIS

7. In an experiment to determine the radius of curvature, r, of a convex lens, the lens is used to form images of an object on a screen. The image distance v from the lens is found for each object distance u from the lens and recorded on table 1:

v/m	1.00	0.50	0.27	0.22	0.18	0.15	0.14	0.12
u/m	0.11	0.13	0.17	0.20	0.25	0.36	0.50	1.00

Table 1

u and v are related by the equation $\frac{1}{u} + \frac{1}{v} = A$----------1

where A is a constant and is related to r by the equation $A = \frac{2}{r}$ ----------2

(a) Use equation 1 to plot a suitable graph from which the value of A can be obtained. **(13 marks)**

(b) Determine the value for A and hence r. **(5 marks)**

(c) What is the significance of A? **(2 marks)**

SECTION III (1 hour)

OPTIONS

Answer any two questions from the four options

OPTION 1: ENERGY RESOURSES AND ENVIRONMENTAL PHYSICS

8. a) The following diagram describes the energy flow sequence in the main components of a hydroelectric power plant.

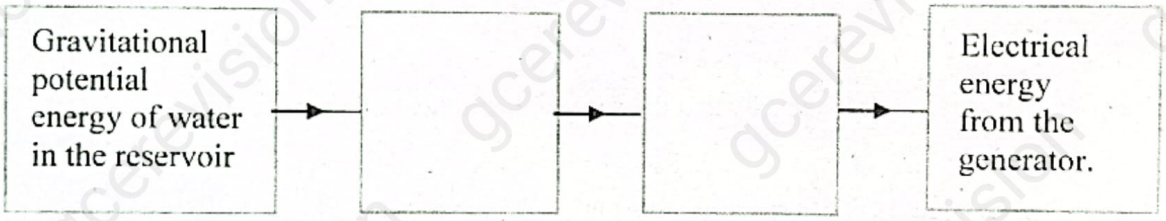

Figure 3

(i) Copy and complete the diagram.

(ii) In one hydroelectric power plant, the height of the reservoir above the tail race is 56 m. The average water discharged at the spiral casing every second is 150 cm^3. Determine the power output from the turbine if its efficiency is 72%.

(iii) Distinguish between fossil fuels and bio-fuels. **(7 marks)**

b) Large scale industrial energy production could be achieved through the fusion of small nuclei in which energy is released.

(i) State one advantage nuclear fusion has over nuclear fission as a means of large-scale energy production?

The following equation shows a typical fusion reaction.

$$^{2}_{1}H + ^{3}_{1}H \longrightarrow ^{4}_{2}He + ^{1}_{0}n + \Delta E$$

(ii) Calculate the energy, ΔE, that is released.

(Mass of $^{2}_{1}H = 2.015$ u, mass of $^{3}_{1}H = 3.017$ u, mass of $^{4}_{2}He = 4.004$ u, mass of $^{1}_{0}n = 1.009$ u)

(iii) Given that the mass of 1 mole of deuterium is 2.0 g, how much energy is released per kilogram of deuterium fuel? **(5 marks)**

c) (i) Explain the meaning of **greenhouse effect.**

(ii) Describe a method that can be used to reduce one of the consequences of greenhouse effect. **(3 marks)**

OPTION 2: COMMUNICATION.

9. a) For minimum distortion of the information signal, the maximum allowed frequency of deviation in FM transmission is ±75 kHz. A high-quality FM radio station in Cameroon contains audio signals varying from 50 Hz to 15 kHz.

(i) What do you understand by bandwidth?

(ii) Determine the bandwidth of the above radio station.

(iii) A bandwidth of 15 MHz is available for FM transmission in this country. How many radio stations can be broadcasted within this band simultaneously without any interference if the maximum audio frequency bandwidth is 15 kHz? **(6 marks)**

b) (i) State the functions of the following as used in telecommunication

- Encoder
- Demodulator
- Base station

(ii) State two differences between mobile telephone handset and a commercial radio transmitter like that of CRTV. **(5 marks)**

c) The following figure shows the tuning circuit of an <u>amplitude modulation</u> radio transmitter.

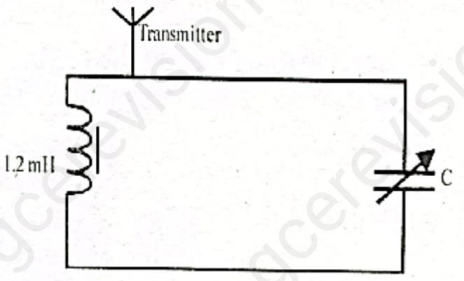

Figure 4

(i) Explain the meaning of the underlined phrase.

(ii) When the capacitor is set at 2.7 pF, a handset clearly picks the signals from this radio station. What is its transmitting frequency? **(4 marks)**

OPTION 3: ELECTRONICS

10. a) The transistor shown in figure 5 is part of a circuit in which the transistor is connected in the *<u>common-emitter mode</u>*.

Figure 5

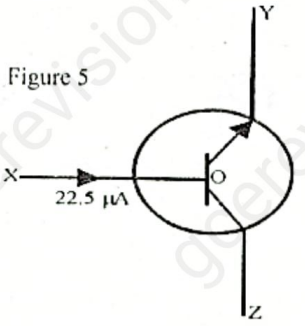

Figure 5

The transistor has a d.c. gain of 100.

(i) Explain the meaning of the underlined phrase.

(ii) If the base current in the circuit is 22.5 μA, determine the collector and emitter currents. **(5 marks)**

b) The table below shows the band gap for a number of materials.

Material	carbon	Gallium arsenide phosphide	Silicon	Germanium
Band gap/eV	5.3	1.8	1.1	0.7

Using the values given in the table

(i) Suggest a simple explanation why carbon is an insulator.

Light emitting diodes (LEDs) emit light when electrons in the conduction band drop into holes in the valence band.

(ii) Determine the wavelength of the electromagnetic radiation emitted when electrons in gallium arsenide phosphide fall from the conduction band to holes in the valence band.

(iii) Hence explain why gallium arsenide is used in making LEDs. **(6 marks)**

c) (i) How is a p-n junction formed?

(ii) Explain how a depletion layer arises at a p-n junction. **(4 marks)**

OPTION 4: MEDICAL PHYSICS

11. a) An endoscope contains two bundles of optical fibres.

(i) Name the two bundles. For each bundle state clearly the arrangement of the fibres and explain its purpose in the operation of the endoscope.

(ii) Each fibre has a core surrounded by cladding. Calculate the critical angle at the core – cladding interface of a fibre. (Refractive index of core and cladding equal 1.60 and 1.55respectively). **(6 marks)**

b) (i) Draw a simple diagram of the human eye, labelling clearly the features of the eye

- Responsible for bending of light
- On which images are formed
- Letting light into the eye

(ii) Describe clearly the changes that will occur to the eye if a person moves from bright light into dim light. **(5 marks)**

c) (i) What is the full meaning of MRI?

(ii) State two advantages MRI has over conventional X-ray imaging.

(iii) State one disadvantage of using MRI in medical diagnosis. **(4 marks)**

GO BACK AND CHECK YOURWORK