

WOURI MOCK EXAMINATION

0780 PHYSICS 2

MARCH 2022

ADVANCED LEVEL

Subject Title	Physics
Paper No	Paper 2
Paper Code	0780

2 ½ Hours

Answer ALL questions

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.

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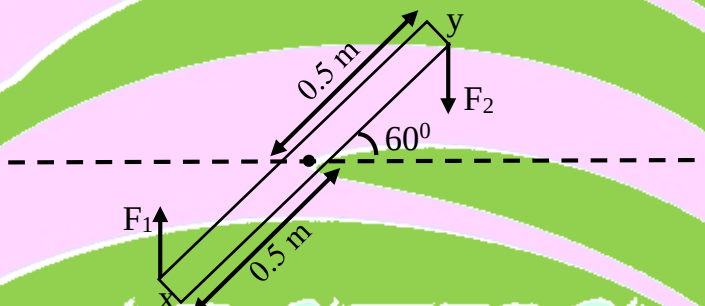


SECTION I (ONE HOUR)

Answer all Questions

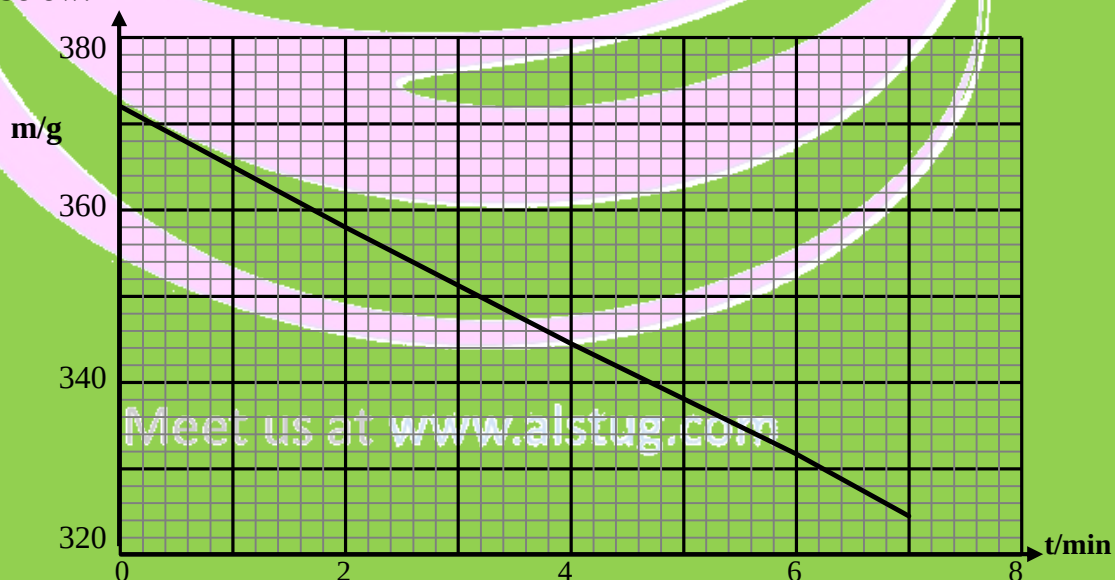
- 1) a) Explain how you will test the physical correctness of an equation.
 b) The following physical equation gives a variation of electric charge Q through a capacitor of capacitance C with time t . $Q = aC \left(1 - e^{-\frac{t}{bc}}\right)$, where a and b are physical constants. The equation is homogenous.
 i) Find the base units of a and b .
 ii) What is the physical significance of bc ? (6 marks)

- 2) a) Define torque of a couple.
 b) The figure below shows two forces F_1 and F_2 of equal magnitude acting on the rod xy of length 1.0m .



If the torque produced is 2Nm , then calculate the value of F_1 and F_2 . (5 marks)

- 3) a) Explain what is meant by the statement that “two terms are in thermal equilibrium”.
 b) A heater of power 226 W is immersed in a beaker of water placed on a balance. The heater is switched on and when the liquid is boiling, the balance readings m are taken at corresponding times t . A graph of the variation with time t of the balance reading m is shown below.

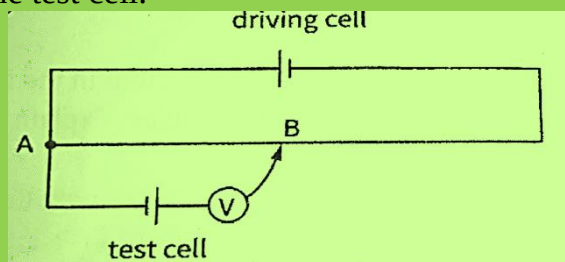


- i) State the feature of which suggest that the liquid is boiling at a steady rate.
 ii) Use the graph to determine the value of the specific latent heat of vaporization of the water.
 iii) State, with a reason, whether the value determined in (ii) is consistent with the normally accepted value for the specific latent heat of vaporization of the water.

(7 marks)



- 4) A student is asked to compare E.m.f.s of a standard cell and a test cell. He sets up the circuit as shown using the test cell.



- Explain why he is unable to find a balance point.
- State how he would recognize the balance point if he finally realized his error.
- He achieves balance when the distance AB is 22.5 cm. He repeats the experiment with a standard cell of E.m.f of 1.434 V. The balance point using this cell is at 34.6 cm. calculate the E.m.f of the test cell. **(6 marks)**

- 5) The separation between the plates of a capacitor with cross sectional area 0.163 m^2 is 0.35mm. The capacitor is charged to a p.d of 1.2 kV. Calculate:
- The energy stored in the capacitor.
 - The capacitor is discharged through a $670 \text{ k}\Omega$ resistor. Calculate the time the capacitor takes to lose half its charge.
 - Explain briefly whether or not the time the capacitor takes to lose half its energy is longer or shorter than your answer to (b). **(6 marks)**

ANSWER EITHER 6 a, b and c, OR 6 d, e and f

EITHER 6 a, b and c.

- 6) a) i) Define magnetic flux density **(2 marks)**
- ii) Describe an experiment to measure the specific charge of an electron (e/m). Your account should include a diagram, observations and how you would use the observations to reach a conclusion. **(8 marks)**
- b) Blue light of wavelength $5.9 \times 10^{-7} \text{ m}$ is incident normally on a slit of width 0.10 mm.
- Calculate the angle at which the first minima occurs in the diffraction pattern.
 - What difference would be observed in the pattern by changing the blue light to red light? Explain.
 - Sketch a graph to show how the intensity of the diffraction pattern produced by the slit varies with direction. **(5 marks)**
- c) A beam of alpha particles is directed onto a very thin gold film of proton number 79. Each alpha particle has a kinetic energy of 4.8 MeV.
- Explain why the majority of alpha particles are not scattered.
 - Calculate the distance of closest approach for an alpha particle that has been deflected by 180° .
 - What is the kinetic energy of the alpha particle at the distance of closest approach? **(5 marks)**

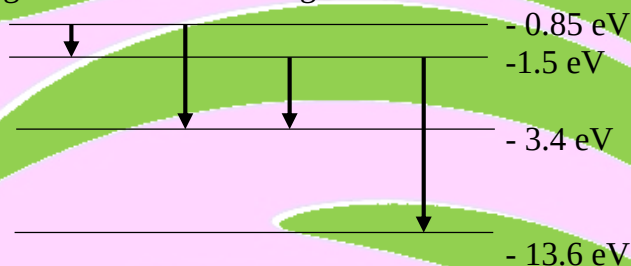
OR 6 d, e and f

- 6) d) i) State the law of conservation of linear momentum. **(2 marks)**
- ii) Describe an experiment to verify the law of conservation of linear momentum. Your description should include a diagram, procedure, observations, calculations, precaution and conclusion. **(8 marks)**



- e) Some helium gas is contained in a flask of volume $7.00 \times 10^{-5} \text{ m}^3$. Each helium atom has a mass of $6.65 \times 10^{-27} \text{ kg}$, and there are 2.17×10^{22} atoms present. The pressure of the gas is $1.03 \times 10^5 \text{ Pa}$.
- Calculate the r.m.s speed of a typical helium atom in the flask.
 - If the absolute temperature of the gas is doubled, explain what will happen to r.m.s speed of its atoms.
 - On the same axes, sketch labeled graphs to show how the speeds of the molecules in an ideal gas are distributed at T_1 and T_2 where $T_1 > T_2$. **(5 marks)**

- f) The energy level diagram of an element is given below



- Explain why the energy values are negative.
- Identify by doing necessary calculations, which transition corresponds to the emission of a spectral line of wavelength 102.7 nm .
- A student is researching the properties of the element. The student finds the emission and the absorption line spectra for the element. Explain what the line spectra indicate about the structure of an atom. **(5 marks)**

DATA ANALYSIS (30 Minutes)

- 7) The following table shows how the stopping potential (V_s) of a metal surface varies with the frequency (f) of the electromagnetic radiation falling on it.

V_s/mV	$f/10^{13}\text{Hz}$
1310	80
1360	100
1410	1200
1460	1400
1510	1600
1560	1800
1600	2000
1650	2200
1700	2400

Experiment shows that the frequency of the electromagnetic radiation is related to the stopping potential by the expression:

$$hf = \Phi + eV_s; \text{ where } \Phi \text{ and } h \text{ are constants, } c = \text{speed of electromagnetic radiations in a vacuum} = 3.0 \times 10^8 \text{ m s}^{-1} \text{ and } e = 1.6 \times 10^{-19} \text{ C}$$

- Plot a suitable graph that can be used to determine the values of the constants h and Φ . **(10 marks)**
- Use the graph to determine the values of h and Φ . **(6 marks)**
- What is the physical significance of Φ ? **(2 marks)**
- What is the threshold frequency of the metal? **(2 marks)**

SECTION III (1 HOUR)

OPTIONS

Answer any two of the four options.

OPTION 1: ENERGY RESOURCES AND ENVIRONMENTAL PHYSICS

- 1) a) What is an alternative energy source?
b) A wind turbine, as shown in the figure below, has blades of length 22 m. When the wind speed is 15 m s^{-1} its output power is 1.5 MW.



- i) Calculate the mass of air that passes through the blades each second. Assume the density of air = 1.2 kg m^{-3} .
ii) Calculate the kinetic energy of the air reaching the blades every second.
iii) By means of a block diagram, explain how electrical energy can be harnessed from the wind turbine. **(8 marks)**
- c) The increase in greenhouse emission worldwide, especially in industrialized countries is causing increase global warming of the planet earth.
i) Explain the meaning of each of the underlined phrases.
ii) State one source of greenhouse emissions.
iii) State and explain two adverse effects of global warming to human civilization on planet earth. **(7 marks)**

OPTION 2: COMMUNICATION

- 2) a) The superheterodyne radio receiver offers improved selectivity and sensitivity compared to the simple radio receiver.
i) Define the underlined terms in radio systems.
ii) The tuned RF amplifier of a superheterodyne receiver has been tuned to a frequency of 1.3 MHz. The local oscillator output is measured at 1.77 MHz. Determine the immediate frequency present at the output of the mixer. **(6 marks)**
- b) State two reasons why a signal is modulated before transmission. **(2 marks)**
- c) For a particular channel of communication having low attenuation, the input power is 6.5 mW and the attenuation per unit length is 1.8 dB km^{-1} .
i) Suggest the name of this channel of communication.
ii) Calculate the distance over which the power of the signal reduces to $1.5 \times 10^{-15} \text{ W}$. **(3 marks)**
- d) i) Explain the role of the base station and the cellular exchange when a mobile phone is switched on and when a call is made or received.
ii) Write the full meaning of the following acronyms; PSTN and GSM **(4 marks)**

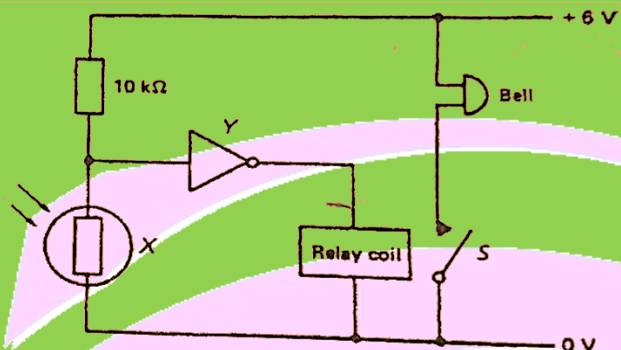


OPTION 3: ELECTRONICS

3) a) Explain;

- i) The formation of a depletion layer in a p-n junction.
- ii) The difference between a p-n junction diode and a Zener diode. **(5 marks)**

b) In the circuit shown below the switch S is closed when the relay coil is energized.



- i) Name the component labelled X and Y.
- ii) State the function of the relay coil in the circuit.
- iii) What happens to the input voltage of the logic gate when light shines on the component X? Explain your answer.
- iv. Explain what happens in the rest of the circuit as a result of light shining on the component X.
- v. What is the value of the input voltage at the logic gate if the resistance of the component X is $20\text{ k}\Omega$? **(10 marks)**

OPTION 4: MEICAL PHYSICS

4) a) Magnetic resonance imaging (MRI) is a non-invasive technique.

- i) Explain the meaning of non-invasive technique. State two other examples of this technique.
- ii) Outline the use of MRI to obtain diagnostic information about internal body structures. **(6 marks)**

b) When an ultrasound pulse reflects from the front and back edges of a bone, it produces two peaks on an A-scan. The time interval between these two peaks is $13\text{ }\mu\text{s}$. The speed of the ultrasound in bone is 4000 m s^{-1} .

- i) Calculate the thickness of the bone.
- ii) Describe how a B-scan differs from an A-scan. **(5 marks)**

c) Describe how the image produced during CT scanning differs from that produced by X-ray imaging.



END



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