UGANDA MARTYRS UNIVERSITY

UNIVERSITY EXAMINATION

FACULTY OF SCIENCE

DEPARTMENT OF NATURAL SCIENCES

SEMESTER I EXAMINATIONS, 2023/2024

FIRST YEAR EXAMINATION FOR BACHELOR OF SCIENCE WITH EDUCATION

PHY1102 PROPERTIES OF MATTER

DATE: 12/12/2023
TIME: 9:30am-12:30pm
DURATION: **3Hours**

Instructions:

1. *Carefully read through ALL the questions before attempting*
2. *Attempt ANY five questions*
3. *All Questions carry equal marks*
4. *No **names** should be written anywhere on the examination book.*
5. *Ensure that your **Reg number** is indicated on all pages of the examination answer booklet.*
6. *Ensure your work is **clear** and **readable**. Untidy work shall be penalized*
7. *Any type of examination Malpractice will lead to automatic disqualification*
8. *Do not write anything on the questions paper.*

Where necessary assume

Planck's constant	$h = 6.63 \times 10^{-34}\ J\,s$
Boltzmann's constant	$K_B = 1.38 \times 10^{-23} JK^{-1}$
Mass of electron	$m_e = 9.11 \times 10^{-31}\ kg$
Electronic charge	$e = 1.60 \times 10^{-19}\ C$
Speed of light	$c = 3.0 \times 10^{8}\ ms^{-1}$
Avogadro's number	$NA = 6.02 \times 10^{23}\ mol^{-1}$
Luminosity	$L_O = 3.9 \times 10^{33} erg/s\ L_O = 3.9 \times 10^{26} J/s$
Luminosity Mass	$M_O = 1.99 \times 10^{30} Kg$
Luminosity Radius	$R_O = 6.96 \times 10^{8} m$
Luminosity Temperature	$T_O = 5780K$
Astronomical Unit	$AU = 1.496 \times 10^{11} m$
Universal gas constant	$R = 8.31\ JK^{-1}mol^{-1}$
Acceleration due to gravity	$g = 9.81 ms^{-2}$
1 standard atmosphere	$= 1{:}01 \times 10^{5} Nm^{-2}$
Radius of Earth	$R_e = 6.38 \times 10^{6}\ m$
Solar constant	$S = 1.37 \times 10^{3}\ Js^{-1}m^{-2}$

PTO

1. (a) (i) Distinguish between a crystalline solid and an amorphous solid. (02 marks)

(ii) Compare the forces in a crystalline solid with those in rubber. (02 marks)

(b) Define the following terms

(i) Tensile stress

(ii) Linear strain

(iii) Young's Modulus (@1 marks)

(c) A copper wire of natural length 1.0m and diameter 2.0mm is hanging from the ceiling. A mass of 200kg is tied to its end. The wire is found to stretch by 0.4mm. Determine

(i) The stress

(ii) The strain

(iii) Young's Modulus of the copper wire

(iv) Define a ductile material and a brittle material. (08 marks)

(d) Discuss the deformation properties in terms of inter atomic forces for

(i) A ductile material

(ii) A brittle material

(iii) Rubbers (05 marks)

2. (a) (i) Write short notes about the two types of bonds between atoms (04 marks)

(ii) Describe the two sources from which repulsive forces arise (02 marks)

(b) Sketch a Force-Distance Curve for the resultant force of attractive and repulsive in a molecule (03 marks)

(c) (i) Define the term potential energy of an atom and write its expression? (02 marks)

(ii) Describe what happens during the process of change in state (phase change) (04 marks)

(d) A long rod insulated to prevent heat losses, consists of a 1.0 m section of copper joined end-to-end to a length l_2 of steel. The copper end is immersed in steam, and the steel end is immersed in a water-ice mixture. Both sections of the rod have cross sectional areas of 5.0 cm^2. After steady state conditions have been achieved, the copper-steel junction is at a temperature of 70^0C

(i) How much heat per second flows from the steam bath to the water-ice mixture? (03 marks)

(ii) What is the length l_2 of the steel section? (02 marks)

3. (a) What is meant by the following

(i) Contact angle

(ii) Cappilary

(iii) Vapour pressure. (@1 mark)

(b) (i) Explain why the small drops of a liquid tend to take a spherical shape. (04 marks)

(ii) In a capillary tube determine the height of the liquid at a point where surface tension and gravitation surrounding energy of the raised liquid is a minimum. Define all the symbols used (04 marks)

(iii) Two mercury drops each of radius r merge to form one drop, Deduce an expression for the temperature change. (04 marks)

(c) State the mathematical expression for excess pressure inside an air bubble in a liquid compared to its surrounding. Define the symbols you have used. (05 marks)

4. (a) (i) Define surface tension. (03marks)

(ii) Give the molecular explanation of surface tension. (03marks)

(b) (i) Derive an expression for the pressure difference inside and a soap bubble of radius r and Surface tension γ . (03marks)

(ii) Two soap bubbles of radii 2.2cm and 3.0cm respectively coalesce under isothermal conditions. If the surface tension of the soap solution is $2.6 \times 10^{-2}\ Nm$. Calculate the excess pressure inside the soap bubbles. (04marks)

(c) (i) What is meant by the terms streamline flow and turbulent flow? (2marks)

(ii) Describe an expression to illustrate the two types of flow. (5marks)

PTO

(d) Define the coefficient of viscosity and hence deduce its dimensions. (4marks)

5. (a) (i) Write short notes about the two types of bonds between atoms (04 marks)

(ii) Describe the two sources from which repulsive forces arise. (02 marks)

(b) Sketch a Force-Distance Curve for the resultant force of attractive and repulsive in a molecule (03 marks)

(c) Define the term potential energy of an atom and write its expression? (02 marks)

(d) Describe what happens during the process of change in state (phase change) (04 marks)

(e) (i) What is meant by **coefficient of linear expansion** of material? (01 maks)

(ii) A metal wire of diameter 0.2mm is cooled from a temperature of 50^0C to 10^0C . find the longitudinal tension set up in the wire when allowed to contact. (04 marks

6. (a) Define **terminal velocity** (01mark)

(b) Explain **laminar** flow and **turblent** flow. (03marks)

(c) Describe an experiment to measure the coefficient of viscosity of water using poiselle's form (07marks)

(d) (i) State **Bernoulli's principal**. (01mark)

(ii) Explain why a person standing near a railway line is sucked towards the railway line when a fast moving train passes. (03marks)

(e) A horizontal pipe of cross-section area $0.4m^2$, tapers to a cross-sectional area of $0.2m^2$. The pressure at the large section of pipe is $8.0 \times 10^4 Nm^{-2}$ and the velcocity of water through the pipe is $1.2ms^{-1}$ .If atmospheric pressure is 1.01×10^5 Nm^{-2}, find the pressure at the small section of the pipe. (05marks)

7. (a) What is meant by;

(i) Brownian motion (01mark)

(ii) Kinetic theory of matter (01mark)

(iii) Ideal and real gas (01 mark)

(b) (i) State any assumptions of the kinetic theory of the ideal gases (03 marks)

(ii) Explain why the temperature of the gas increases when it is compressed. (04 marks)

(c) State the principle of equipartition of energy. (01 mark)

(d) Suppose we heat 1 mole of oxygen gas at a constant pressure of 1 atm, from 20^0C to 80^0C, and then cool it at a constant volume from 80^0C back to 20^0C.

(i) During the first step, calculate the heat absorbed by the gas. (02 marks)

(ii) Calculate the volume of the gas at the end of the first step. (02 marks)

(iii) How much work does the gas perform during the first step? (02 marks)

(e) Explain why C_p is greater than C_v (04 marks)

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