



MACHAKOS UNIVERSITY

University Examinations 2022/2023

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF ENVIRONMENTAL SCIENCES

ENS 130: ENVIRONMENTAL PHYSICS

DATE: 12/4/2023

TIME: 11:00 – 1:00 PM

INSTRUCTIONS:

- The paper consists of **TWO** sections.
- Section **A** is **Compulsory**.
- Answer any **two** questions from section **B**.

Useful constant

$R = 8.315 \text{ J/mol.K}$, Avogadro number 6.022×10^{23} particles/mol

SECTION A (COMPULSORY)

QUESTION ONE (30 MARKS)

- a) A single molecule of a substance has normal chemical properties as the mother substance. Elaborate with an example. (3 marks)
- b) Distinguish between x-rays and gamma rays (4 marks)
- c) If we break a molecule of a substance “A”, we get two different substances and neither of them is substance “A”. Explain the phenomenon with an example. (3 marks)
- d) Molecules are always in motion, therefore, there are forces which cause this motion. Name the forces and explain why one of them can be ignored. (4 marks)
- e) Residents within 300 m radius, during the nuclear bomb strike in Hiroshima Japan, were exposed to neutron radiation with an RBE of 18. Calculate the dose in mSv for a 70 kg resident. (4 marks)
- f) On the molecular scale, electromagnetic forces exert attractive force causing two neighbouring molecules to come nearer but do not come together completely. Give a reason. (3 marks)
- g) Matter can exist in three states, solid, liquid and gas. Although there is a fourth state being considered. State, describe and give the occurrence of the fourth state of matter. (3 marks)
- h) Explain the two meaning of the phrase “energy conservation” (3 marks)
- i) For any given substance, the solid state of the substance exists at a lower temperature than the liquid state. Explain this with an example. (3 marks)

QUESTION TWO (20 MARKS)

- a) Solids can be classified as metals and nonmetals or crystalline and non-crystalline. Distinguish between metals and crystalline solids. (3 marks)
- b) State three differences and two similarities between a mechanical wave and an electromagnetic wave (5 marks)
- c) Given that N is the number of molecules and N_A is the Avogadro constant. Show that $PV = nN_A k_B T$ (6 marks)
- d) A medical worker is exposed to a radioactive isotope which provides a dose of 0.30 Gy. By calculation, show which type of radiation will give the highest dose equivalent in mSv among gamma, beta and alpha? (6 marks)

QUESTION THREE (20 MARKS)

- a) Calculate the frequency of sound in air at 23 °C if its wavelength λ is 0.98 m. Take speed of sound as 330 m/s. (3 marks)
- b) Show that for small solid falling in a viscous fluid, its terminal velocity is given by (7 marks)

$$V_t = \frac{2r^2(\rho_s - \rho_f)}{9\eta}g$$

- c) Describe an experiment that can be used to determine terminal velocity of a small spherical solid in a viscous fluid. (5 marks)
- d) An ideal gas occupies a volume of 100 cm³ at 20°C and 100 Pa. Find the number of moles of gas in the container. (5 marks)

QUESTION FOUR (20 MARKS)

- a) While doing 500 J of work, a system of ideal gas compresses adiabatically to 1.5 times its volume. With a reason state whether temperature of the gas i) increases? ii) remains same or iii) decreases. (2 marks)
- b) Two blocks $m_1 = 1500g$ and $m_2 = 500g$ rest on a frictionless surface and are connected by a light string, see figure 1. A horizontal force F of 8 N is applied to m_1 . Calculate the magnitude of
- i) acceleration of the masses (3 marks)
- ii) force T (3 marks)

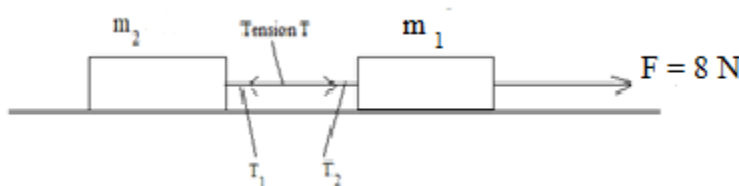


Figure 1

- c) An ideal gas occupies a volume of 200 cm³, at a pressure of 4.0×10^7 Pa and contains $1.800664245 \times 10^{24}$ molecules, calculate its temperature in °C. (6 marks)
- d) 300 J of energy are transferred to a system in the form of heat while the thermal energy increases by 150 J. Determine how much work is done on or by the system? (6 marks)

QUESTION FIVE (20 MARKS)

- a) A sample of helium gas expands to triple its initial volume adiabatically in one case and isothermally in another. In both cases, it starts from the same initial state. The sample contains 2 moles of helium, initially at 20 °C and at 1 atm. Calculate the work done during each process. (8 marks)
- b) Geothermal Development Company (GDC) is discharging three wells into the atmosphere. The wells produce sounds of different levels of power $2.0 \times 10^{12}\text{W}$, $16.0 \times 10^8\text{W}$ and $2.6 \times 10^4\text{W}$ respectively. Calculate the intensity level of sound they exert onto a nearby village 2 km away. (8 marks)
- c) In an adiabatic process, there is no heat exchange but the temperature of the gas changes. How can this be explained? (4 marks)