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UNIVERSITY EXAMINATIONS 2023/2024

SECOND YEAR, SECOND SEMESTER EXAMINATION FOR THE DEGREE OF
BACHELOR OF SCIENCE (MATHEMATICS AND PHYSICS) AND BACHELOR OF
EDUCATION SCIENCE

SPH 3252: THERMAL PHYSICS I

DATE: APRIL 2024

TIME: 2 HOURS

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

- A system receives 125 kJ of energy while the work done by the system is to the surroundings is 94 J. Find the change in internal energy (3 Marks)
- A chemical reaction leads to expansion of a gas from 6.8 L to 12.6 L at constant pressure of 1.2 atm- Find the work done by the gas to the surroundings (4 Marks)
- If 2000 J of heat are added to 200 mL of ethanol [density (ρ) = 789 Kg/m³ initially at 10°C, calculate the final temperature of the sample given that the specific heat capacity of ethanol is 2440J/kg/K (5 Marks)
- is there enough heat in 100 cm³ of water at 25°C to completely melt 50g of ice at 0°C? (Heat of fusion of ice = 334 KJ•Kg⁻¹ and the Specific heat capacity of water =4200J/kg. show your working (5 Marks)



MUST is ISO 9001:2015 and



ISO/IEC 27001:2013 CERTIFIED

- e) A mole of hydrogen molecules, each of mass 3.3×10^{-27} kg, is contained in a cylinder of volume 0.050 m^3 . The molecules have an root mean square speed of 800 m s^{-1} . Calculate the pressure of the gas. (Avogadro constant $N_A = 6.0 \times 10^{23} \text{ mol}^{-1}$) (4 Marks)
- f) The filament of a 75 W light bulb may be considered as a black body radiating into a black enclosure at 70°C . The filament diameter is 0.10 mm and length is 5 cm. considering the radiation, determine the filament temperature (4 Marks)
- g) A long pipe of 0.6 m outside diameter is buried in earth with axis at a depth of 1.8 m. the surface temperature of pipe and earth are 95°C and 25°C respectively. Calculate the heat loss from the pipe per unit length. The conductivity of earth is 0.51 W/Mk . (5 Marks)

QUESTION TWO (20 MARKS)

- a) A mild steel tank of wall thickness 10 mm contains water at 90°C . The thermal conductivity of mild steel is $50 \text{ W/m}^\circ\text{C}$, and the heat transfer coefficient for inside and outside of the tank area are 2800 and $11 \text{ W/m}^\circ\text{C}$, respectively. If the atmospheric temperature is 20°C , calculate:
- The rate of heat loss per m^2 of the tank surface area (8 Marks)
 - The temperature of the outside surface tank (4 Marks)
- b) Two large parallel planes with emissivities of 0.3 and 0.5 are maintained at temperatures of 527°C and 127°C respectively. A radiation shield having emissivities of 0.05 on both sides is placed between them. Calculate;
- Heat transfer rate between them without shield (4 Marks)
 - Heat transfer rate between them with shield (4 Marks)

QUESTION THREE (20 MARKS)

- a) Find the quantity of heat required to heat 1 Kg of water at 40°C to steam at 300°C ($\Delta H_v = 2260 \text{ KJ}\cdot\text{Kg}^{-1}$; specific heat capacity of water is 4200 J/kg/K ; specific heat capacity of ice is 2100 J/kg/K) (8 Marks)



- b) An ideal gas is compressed adiabatically so that its volume becomes 30% Of the original volume. If the molar heat capacity at constant volume is $12\text{J/mol}\cdot\text{K}$. Find the ratio of the initial to final pressure (7 Marks)
- c) A block of copper of mass 800 g at 473K is immersed in melting ice find the quantity of water formed given that latent heat of fusion of ice $2260\text{ KJ}\cdot\text{Kg}^{-1}$ (5 Marks)

QUESTION FOUR (20 MARKS)

- a) A gas occupies a volume of 12 cm^3 at pressure of 1.8 atmospheres at temperature of 300K . if the molar mass of the gas is 32g , Calculate ($1\text{ atm}=101325\text{N/m}^2$, molar gas volume at STP 22400cm^3)
- The number of moles of the gas (3 Marks)
 - Root mean square speed of the molecules (5 Marks)
 - The average translational kinetic energy of the gas (3 Marks)
- b) At a temperature of 200 K , the volume of 1.5 moles of gas in a cylinder with a smoothly fitting piston is 0.0024 m^3 . The cylinder is heated while allowing the gas to expand at a pressure of 2.4 atm . Calculate
- The volume of the gas at a temperature of 300 k (3 Marks)
 - Work done by the gas (2 Marks)
 - The change in internal energy of the gas given that the molar heat capacity at constant pressure is $48.2\text{J/mol}\cdot\text{K}$ (2 Marks)
 - Total heat energy absorbed by the gas (2 Marks)