

INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH KOLKATA

SEMESTER 2

CH-1201: General Physical Chemistry

End Semester Examination

Maximum mark: 50

Time: 2.5 hr.

Date: 30.04.2019

Answer any five questions, each question carries equal mark.

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- (a) Explain mathematically and from molecular point of view why  $C_p$  is greater than  $C_v$ . (b) Show that  $C_p$  of an ideal gas is independent of pressure at a given temperature. (6+4).
- (a) How does the value of  $\mu_{JT}$  controls whether cooling or heating will happen for a gas? (b) Show and explain that entropy vs. temperature plot will have a higher slope for a constant pressure process than for a constant volume process. (5+5)
- How does the concentration of starting material, intermediate and product will vary with time depending on the relative magnitude of rate constants in case of consecutive first order reaction. Explain mathematically and graphically. (6+4)
- (a) Explain mathematically the dependence of equilibrium constant on temperature for an exothermic and for an endothermic reaction? (b) Plot and explain the following: (i) rate constant vs. temperature for explosion reaction, quantum mechanical tunneling process. (6+4).
- (a) Gas phase isomerisation reaction generally follows the rate equation:  
$$\text{rate} = k[\text{reactant}] \text{-----}(\text{eq. 1})$$
Explain mathematically and graphically employing a suitable mechanistic model under what physical condition of the reaction the above equation is followed and not followed. (b) Comment on the following: "Activation energy of a composite reaction can be negative". (6+4)
- (a) What are the five criteria for spontaneity and equilibrium? Explain mathematically. (b) Explain graphically why (i) ice exists below  $0^\circ\text{C}$ , (ii) liquid water exists in between  $0^\circ\text{C}$  and  $100^\circ\text{C}$  and (iii) steam exists above  $100^\circ\text{C}$ , (iv) show sublimation point in the plot. (6+4)
- The rate constant for the decomposition of a certain substance is  $1 \times 10^{-2} \text{ dm}^3 \text{ mol}^{-1} \text{ s}^{-1}$  at  $24^\circ\text{C}$  and  $2 \times 10^{-2} \text{ dm}^3 \text{ mol}^{-1} \text{ s}^{-1}$  at  $37^\circ\text{C}$ . Evaluate Arrhenius parameters (activation energy and pre-exponential factor) of the reaction. (b) Show that  $C_v$  of an ideal gas is independent of volume at a given temperature. (6+4)
- (a) The enthalpy of formation of ethane, ethylene, and benzene from the gaseous atom are (-) 2839.2, (-)2275.2, (-)5536.0  $\text{kJ mol}^{-1}$  respectively. Calculate the resonance energy of benzene compared with one Kekule structure. Given: the bond enthalpy of C-H bond is  $410.87 \text{ kJ mol}^{-1}$ . (b) Calculate the change in entropy when 4 mol of a monoatomic perfect gas with  $C_{p,m} = (5/2)R$  is heated from 300 K to 900 K and simultaneously heated from 20 L to 60 L. (5+5).

(All terms and symbols have their usual meaning. IUPAC convention should be followed)

PM.