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**1 SEM TDC CHMH (CBCS) C 2**

**2024**

( November )

**CHEMISTRY**

( Core )

Paper : C-2

( Physical Chemistry )

Full Marks : 53

Pass Marks : 21

Time : 3 hours

*The figures in the margin indicate full marks  
for the questions*

1. Choose the correct answer from the following : 1×3=3

(a) The temperature at which ethane molecule has the same root-mean square velocity of methane molecule at 27 °C is

(i) 292.5 °C

(ii) 289.5 °C

(iii) 280.0 °C

(iv) 294.0 °C

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- (b) Which of the following liquids will have highest boiling point?
- (i)  $\text{CH}_3\text{OH}$
  - (ii)  $\text{CHCl}_3$
  - (iii)  $\text{H}_2\text{O}$
  - (iv)  $\text{CH}_3\text{COCH}_3$
- (c) Potassium crystallizes in a b.c.c. lattice. The number of unit cells present in 2 mole of K metal is
- (i)  $2 \times 6.02 \times 10^{23}$
  - (ii)  $6.02 \times 10^{23}$
  - (iii)  $3 \times 6.02 \times 10^{23}$
  - (iv) None of the above

2. Answer any *four* questions from the following : 2×4=8

- (a) Define van der Waals' constants  $a$  and  $b$  and give their significance.
- (b) Explain why heat capacities of gases at constant pressure are more than at constant volume.
- (c) Explain the structure of NaCl crystal from X-ray crystallography.

- (d) Dissociation of ethanoic acid increases when concentration decreases. Explain why.
- (e) What is the relation between solubility and solubility product of a  $A_xB_y$  type of electrolyte?

UNIT—I

3. Answer any *two* questions from the following : 7×2=14

- (a) (i) Deduce the reduced equation of state from van der Waals' equation of states and define the law of corresponding states from it. 3+1=4
- (ii) Deduce Boyle's law from kinetic gas equation. What is Boyle's temperature? 2+1=3

Or

Define viscosity of gases. Viscosity of gases increases as temperature is increased. Explain. 3

- (b) (i) Describe critical phenomenon from Andrew's isotherm. 2
- (ii) Define the critical constants  $P_c$ ,  $T_c$  and  $V_c$ . 3

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(iii) Show that

$$\frac{RT_c}{P_c V_c} = \frac{8}{3}$$

2

(c) (i) What are mean-free path, collision diameter and collision frequency of a gas molecule? Explain the effect of temperature on mean-free path.

$$1\frac{1}{2} + 1 = 2\frac{1}{2}$$

(ii) State and explain law of equipartition of energy taking a suitable example.

$$1 + 2\frac{1}{2} = 3\frac{1}{2}$$

(iii) What is compression factor  $z$  of gases?

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### UNIT—II

4. Answer any one question from the following : 5

(a) (i) What are the different kinds of intermolecular forces present in liquids? Discuss in detail. 3

(ii) Boiling point of  $\text{CH}_3\text{OH}$  is more than  $\text{CH}_3\text{COCH}_3$ . Give reasons. 2

(b) (i) Name two factors on which viscosity of liquid depend. What is the SI unit of coefficient of viscosity? 1+1=2

- (ii) Describe a method of determination of viscosity of a liquid at laboratory. 3

Or

The time of flow of  $H_2O$  is 59.2 seconds at  $25^\circ C$  and for a liquid is 46.2 seconds at the same temperature. If the densities of water and the liquid are  $1.0 \text{ g cm}^{-3}$  and  $0.867 \text{ g cm}^{-3}$  respectively, what is the viscosity of the liquid? (Given,  $\eta_{H_2O} = 0.00895$  poise)

### UNIT—III

5. Answer any two questions from the following :  $4\frac{1}{2} \times 2 = 9$

(a) (i) State the law of rational indices. What are Miller indices? If a crystal plane intersects the crystallographic axes in the ratio  $1:-1:2$ , what is its Miller indices?  $1+1+\frac{1}{2}=2\frac{1}{2}$

(ii) What do you understand by point group in crystal system? What is the total number of point groups present in crystal lattice?  $1+1=2$

(b) What are nematic and smectic liquid crystals? Discuss their differences. Mention two applications of liquid crystals.  $2+1\frac{1}{2}+1=4\frac{1}{2}$

(c) (i) What are the various axes of symmetry and plane of symmetry present in simple cubic system?  $1+1\frac{1}{2}=2\frac{1}{2}$

(ii) Define *p*-type and *n*-type semi-conductors with suitable examples. 2

UNIT—IV

6. Answer any two questions from the following :  $7 \times 2 = 14$

(a) (i) Solubility product of  $\text{Ag}_2\text{CrO}_4 = 1.3 \times 10^{-11} \text{ M}^3$ . What is its solubility? 2

(ii) In salt analysis in group II  $\text{H}_2\text{S}$  is passed in presence of  $\text{HCl}$ , while in group IV  $\text{H}_2\text{S}$  is passed in alkaline medium. Explain. 3

(iii) What is common ion effect? Discuss with a suitable example. 2

- (b) (i) Equal volumes of 0.08 M  $\text{CaCl}_2$  and 0.02 M  $\text{Na}_2\text{SO}_4$  solutions are mixed at room temperature. Will there be precipitation of  $\text{CaSO}_4$ ?  
[ $K_{\text{sp}} \text{CaSO}_4 = 2.4 \times 10^{-5} \text{ M}^2$ ] 2
- (ii) What are acid base indicators? Name one indicator to be used in a titration of weak acid with a strong base. 2
- (iii) Derive an expression for degree of hydrolysis, hydrolysis constant and pH for an aqueous solution of a salt of weak acid and strong base. 3
- (c) (i) Calculate pH of an aqueous solution of 0.02 M  $\text{CH}_3\text{COONa}$ .  
[Given,  $\text{p}K_a = 4.74$ ] 2
- (ii) pH of a  $10^{-7}$  M HCl is less than 7. Give reasons. 2
- (iii) What are buffer solutions? Derive an expression for pH of an acidic buffer. 1+2=3

Or

Discuss the mechanism of acidic buffer. What is buffer capacity?

2+1=3

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