3 (Sem–1/CBCS) CHE HC 2

2021

(Held in 2022)

CHEMISTRY

(Honours)

Paper : CHE–HC–1026

(Physical Chemistry–I)

Full Marks : 60

Time : Three hours

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

1. Answer the following as directed : 1×7=7

   (a) The compressibility factor for hydrogen and helium gases is less than one at all pressures. *(State True* ***or*** *False)*

(b) A real gas obeying the van der Waals' equation will closely resemble an ideal gas, if

(i) the parameters a and b are small

(ii) a is large but b is small

(iii) a is small but b is large

(iv) both a and b are large

(Choose the correct option)

(c) A free falling liquid drop is spherical. Explain why.

(d) Define the term 'plane of symmetry' in crystal system.

(e) State the law of constancy of interfacial angles.

(f) Explain why an aqueous solution of Na_2CO_3 is alkaline.

(g) pH of $1{\cdot}0 \times 10^{-8} M\, HCl$ solution is not 8. Explain.

2. Answer the following questions : 2×4=8

(a) Explain why real gases deviate from ideal behaviour.

(b) Viscosity of liquids generally decreases while that of gases increases with increase in temperature. Give reasons.

(c) A crystal plane has intercepts on the three axes of crystal in the ratio $\frac{1}{2} : \frac{2}{3} : \infty$. What are Miller indices of the plane ?

(d) Calculate pH of a $1{\cdot}0 \times 10^{-5} M$ *NaOH* solution at 298*K*.

3. Answer ***any three*** of the following questions : 5×3=15

(a) (i) Derive van der Waals' equation for *n* moles of a gas. 4

(ii) Under what conditions a van der Waals' gas behaves ideally ? 1

(b) Define critical constants of a gas. Derive the relations expressing the critical constants of a gas in terms of van der Waals' constants. 5

(c) (i) Define surface tension of a liquid. Give the SI unit of surface tension. How does surface tension of a liquid vary with temperature ? 3

(ii) At $293K$, $1{\cdot}0 \times 10^{-5} m^3$ of water gave 29 drops and same volume of diethyl ether gave 86 drops from the same stalagmometer. At the same temperature density of water is $1{\cdot}0 \times 10^3 kg\, m^{-3}$ and that for diethyl ether is $7{\cdot}0 \times 10^2 kg\, m^{-3}$. Also at $293K$ surface tension for water is 72 dyne cm^{-1}. Calculate the surface tension of diethyl ether at $293K$. 2

(d) Explain the symmetry elements of crystal belonging to simple cubic system. 5

(e) Write the dissociation equilibria for a dibasic acid H_2A in aqueous solution. Establish a relation for the dissociation equilibria constant. 5

4. Answer ***any three*** of the following questions : 10×3=30

(a) (i) Enumerate the assumptions of kinetic theory of gases. 3

(ii) Derive the fundamental kinetic gas equation. 4

(iii) Calculate the temperature at which root mean square velocity of N_2 molecules will be $1000 ms^{-1}$. 3

(b) (i) Derive the reduced equation of state from van der Waals' equation. What is the law of corresponding states? 4+2=6

(ii) The reduced volume and reduced temperature of a gas are 10·2 and 0·7 respectively. If the critical pressure of the gas is 42·56 *bar*, calculate its pressure. 4

(c) (i) Explain the theory of experimental determination of surface tension of a liquid by drop number method. 4

(ii) Explain the effect of addition of various types of solutes on the surface tension of a liquid. 4

(iii) Explain why at the boiling point of a liquid temperature does not rise although this is being heated. 2

(d) (i) Derive Bragg's equation. 4

(ii) X-rays of wavelength 0·15*nm* are used in an X-ray diffraction experiment. First order diffraction is observed when the angle of incidence is 10·02°. Calculate the interplanar distance in the crystal used. 3

(iii) What are liquid crystals ? Mention *one* use of liquid crystal. 3

(e) (i) What is point defect in a crystal ? Explain Schottky and Frenkel defects. Give examples. 2+(2+2)+1=7

(ii) Sketch 100 planes of a cubic lattice. 2

(iii) Explain why Schottky defects decrease the density of crystals. 1

(f) (i) Show the variation of pH with volume of base added during titration of strong acid with strong base and titration of weak acid with strong lease. 4

(ii) What are acid-base indicators? Explain a theory to explain the behaviour of indicator in acid-base titration. 2+4=6
