3 (Sem–1/CBCS) CHE HC 2

2023

CHEMISTRY

(Honours Core)

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) Write *one* postulate of kinetic molecular theory of gas.

   (b) Define most probable velocity of a gas.

   (c) Explain the term coefficient of viscosity.

   (d) What is compressibility factor ?

   (e) Define critical temperature.

   (f) Write the significance of van der Waals constant '*a*' and '*b*'.

   (g) How surface tension of liquid varies with temperature ?

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

(a) Why real gases deviate from ideal behaviour ?

(b) Prove that $PcVc = \frac{3}{8}RTc$.

(c) Define mean free path. Does it depend upon the velocity of the molecule ?

(d) Explain qualitatively the structure of liquid water.

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

(a) Derive the expression for critical constants in terms of van der Waals constants.

(b) Using the expression for Maxwell distribution of speed. Show that the average kinetic energy of a gas molecule is given by $\frac{3}{2}KT$.

(c) The compressibility factor for hydrogen gas is always greater than 1. Explain. Calculate the root mean square velocity of sulphur dioxide molecule at 427°C. 2+3=5

(d) Discuss the impurity defect in crystal with the help of a suitable example. Write *two* points to distinguish between Frenkel defect and Schottky defect. 2+3=5

(e) Define co-efficient of viscosity.

Write the theory of determination of co-efficient of viscosity of a liquid by Ostwald viscometer method. 2+3=5

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

(a) Define surface tension of a liquid.

What are its units ?

How surface tension of a liquid is determined ?

What is the effect of temperature on the surface tension of a liquid ?

2+1+5+2=10

(b) (i) Derive Henderson equation for acid and basic buffer solution. 5

(ii) Calculate the change in pH when $0{\cdot}05 cm^3$ of $1M$ $NaOH$ solution is added to one litre of buffer solution containing $0{\cdot}1M$ acetic acid and $0{\cdot}1M$ sodium acetate at $300K$.

Given that Ka for acetic acid at $300K$ is $2{\cdot}0 \times 10^{-5}$. 5

(c) Define Collision diameter.

Obtain an expression for bimolecular collision frequency of a pure gas.

Explain how collision diameter of a gas can be calculated from measurement of co-efficient of viscosity of the gas.

1+5+4=10

(d) (i) What is meant by ionic product of water? Show that $pH = \frac{1}{2} pkw$ for pure water. If $K_w = 4{\cdot}0 \times 10^{-14}$ for pure water at $317K$, calculate p^{OH}.
1+2+2=5

(ii) Discuss the buffer action of an aqueous solution of ammonium acetate and a mixture of acetic acid and sodium acetate in water.
5

(e) Define Mean free path of a gas molecule. Does it depend upon the velocity of the molecule? Calculate the Mean free path of O_2 molecule at $25°C$ and a pressure of $10^{-3} mm\ Hg$, given that the collision diameter is $361pm$. Express the effect of temperature and pressure on Mean free path.
2+1+4+3=10

(f) Define Buffer capacity. Express in Mathematical form. If 0·001 mole of acid is added to $500ml$ of buffer solution, its pH decreases by 0·01 unit. Calculate the buffer capacity of the buffer solution. How do you know that buffer index is always positive? Write *two* applications of Buffers in Chemistry and Biology. 2+1+3+2+2=10