Total No. of printed pages = 6

3 (Sem-1) CHM M2 (BU)

2018

CHEMISTRY

(Major)

Paper : 1.2

(Physical Chemistry)

Full Marks – 60

Time – Three hours

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

1. Answer the following questions : 1×7=7

   (a) What is compressibility factor ? Name one gas which shows positive deviation at all temperature.

   (b) What is Boyle temperature ?

   (c) State when surface tension of a liquid vanishes.

   (d) The Weiss indices of a crystal plane is a : – b : c. What are the corresponding Miller indices of this plane ?

(e) When the buffer capacity of a buffer is maximum ?

(f) What is the effect of temperature on ionic product of water and why ?

(g) Calculate root mean square velocity of CO_2 gas at 300K.

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

(a) Deduce an expression for root mean square velocity from Maxwell's distribution law of molecular velocities.

(b) Calculate the mean free path of O_2 at $1{\cdot}01325 \times 10^5$ Pa and 300 K, given that its collision diameter is $2{\cdot}4\times10^{-10}$ m.

(c) Define viscosity of a liquid. How viscosity of a liquid varies with temperature ?

(d) Calculate the pH of the solution which is 0·06M in acetic acid and 0·04M in CH_3COONa. Given, the dissociation constant of acetic acid is $1{\cdot}6\times10^{-5}$.

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

(a) Deduce the expression for critical constants Pc, Tc and Vc in terms of the Van der Waal's constants. Can a Van der Waal's gas be liquified for which the value of Van der Waal's constant 'a' is zero? 4+1=5

(b) Why was Van der Waal's equation of state necessary ? Derive the equation describing the corrections introduced for 'pressure' and 'volume' of an ideal gas. 1+4=5

(c) (i) Write in brief about Dietrici equation of state. 2

(ii) Find out the number of different degrees of freedom of CO_2 molecule. 3

(d) Explain any *two* of the following elements of symmetry with example : 2½×2=5

(i) Centre of symmetry

(ii) Plane of symmetry

(iii) Rotation axis of symmetry.

(e) Explain buffer action with the help of an example. Write one application of buffer in Chemistry and Biology. 3+2=5

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

(a) (i) What is collision frequency ? Obtain its expression for bimolcular collisions between the molecules of two gases. 1+4=5

(ii) State and explain the principle of equipartition of energy. Using this principle, show that the molar heat capacity of helium is $\frac{5}{2}R$. 2+3=5

(b) (i) Define surface tension. Describe a method for the determination of the surface tension of a liquid. 1+4=5

(ii) What is liquid crystal ? Describe the important physical features and uses of liquid crystals. 1+4=5

(c) (i) Write two postulates of kinetic theory of gases. Derive kinetic gas equation. 1+4=5

(ii) Discuss the effect of temperature on the distribution of molecular velocity of a gas. Give graphical representations to show this effect. 3

(iii) Calculate the diameter of a nitrogen molecule at 298·15 K at the pressure 101·325 kPa. Given that Van der Waals constant $b = 3{\cdot}183\times10^{-2}$ dm^3 mol^{-1} for the gas. 2

(d) (i) Define buffer solution. Deduce Henderson-Hasselbalch equation for both acidic and basic buffer. 1+2+2=5

(ii) Write short notes on : 2½×2=5

(a) Common ion effect

(b) Solubility product.

(e) (i) Explain Schottky and Frenkel defects of solids with example. 4

(ii) Derive Bragg's equation. 3

(iii) A solid crystallizes in orthorhombic system with unit cell dimensions a = 542 pm, b = 917 pm and c = 645 pm. Given that $\frac{1}{(dhkl)^2} = \left(\frac{h}{a}\right)^2 + \left(\frac{k}{b}\right)^2 + \left(\frac{l}{c}\right)^2$

Calculate the diffraction angle for 1st order X-ray reflection from (100) plane for $\lambda = 154{\cdot}1$ pm. 3

(f) (i) Determine the hydrolysis constant and degree of hydrolysis for the hydrolysis of the salt of weak acid and strong base. Also obtain the expressions for the pH of the hydrolysis. 5

(ii) Define pH. At 298 K, show that pH+ pOH = 14. 1+1=2

(iii) Should precipitation occur when 50 ml of a 5×10^{-4} M of $Ca(NO_3)_2$ solution is mixed with 50 ml of a 2×10^{-4} M solution of NaF ? Given that Ksp of CaF_2 is $3{\cdot}2\times10^{-11}$. 3