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1 SEM TDC CHMH (CBCS) C 2

2019

(December)

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 critical temperature is that temperature

(i) at which a gas behaves ideally

(ii) above which a gas can be easily liquefied

(iii) below which a gas can be liquefied by pressure alone

(iv) at which a gas cannot be liquefied

(b) The gases which have the same kinetic energy at a given temperature and pressure are

(i) H_2 and N_2

(ii) N_2 and CH_4

(iii) CH_4 and N_2

(iv) All of the above

(c) Water is a liquid at room temperature because it

(i) has high dipole moment of 1·85 *D*

(ii) is a symmetrical molecule

(iii) is extensively H-bonded with other molecules

(iv) has large dispersion forces

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

(a) Xe has $P_c = 58{\cdot}0$ atm and $T_c = 289{\cdot}7$ K. Determine its van der Waals' constants a and b.

(b) Out of *n*-pentane and neo-pentane (both are isomers of pentane) which has higher boiling point and why?

(c) Silver crystallizes in a face-centred cubic lattice with all the atoms at the lattice points. The length of the edge of the unit cell as determined by X-ray diffraction studies is found to be $4{\cdot}077\times10^{-8}$ cm. The density of silver is $10{\cdot}5$ g cm^{-3}. Calculate the atomic mass of silver.

(d) Explain ionic product of water. What is the effect of temperature on it?

(e) Derive the relation $P_cV_c = \frac{3}{8}RT_c$.

(f) A buffer solution contains 0·4 mole of NH_4OH and 0·5 mole of NH_4Cl per litre. Calculate the pH of the solution. Dissociation constant of NH_4OH at the room temperature is $1{\cdot}81\times10^{-5}$.

UNIT—I

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

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

(ii) Show that the excluded volume b is four times the actual volume of the molecule. 3

(b) (i) From the kinetic gas equation, derive the expression for root-mean-square velocity. 2

(ii) Derive the relationship between most probable, average and root-mean-square velocity. 2

(iii) Calculate the temperature at which the average velocity of oxygen equals that of hydrogen at 20 K. 3

(c) (i) What are reduced pressure, temperature and volume? Derive the reduced equation of state. Write its significance. 1½+2½+1=5

(ii) The reduced volume and temperature of a gas are 10·2 and 0·7. What will be its pressure if its critical pressure is 4·25 MPa? 2

UNIT—II

4. Answer any *one* question from the following : 5

(a) (i) Explain three different inter-molecular forces present in liquids. Give examples. 3

(ii) What structural part of a liquid makes it flow? Explain briefly how a liquid flows. 2

(b) (i) Describe drop number method for determining the surface tension of a liquid. 3

(ii) In the determination of surface tension of a liquid using stalagmometre, the liquid gave 58 drops while water gave 24 drops, the volume of the liquid and water being the same. The density of water is $0{\cdot}998\ g\ mol^{-1}$ while that of the liquid is $0{\cdot}795\ g\ mol^{-1}$. The surface tension of water at the given temperature is 70·8 dynes cm^{-1}. What is the surface tension of the liquid? 2

UNIT—III

5. Answer any *two* questions form the following : 4½×2=9

(a) What are liquid crystals? Name the different types and how do they differ in their molecular arrangement. Write any one application of liquid crystal. 1+3+½=4½

(b) (i) Derive Bragg's equation for crystal structure determination. 3

(ii) Sodium metal crystallizes in b.c.c. lattice with the cell edge 4·29 Å. What is the radius of sodium atom? 1½

(c) (i) What are Miller indices? Illustrate (111) plane in cubic system. 1+1½=2½

(ii) Electrical conductivity of semi-conductor increases with increase in temperature. Explain from band theory. 2

UNIT—IV

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

(a) (i) Define the terms solubility and solubility product of a substance. Explain the use of solubility product in qualitative analysis. 2+3=5

(ii) 0·00094 gm of AgCl is dissolved in 500 ml of water at 25 °C to form a saturated solution. Calculate the solubility product of AgCl. (Ag = 108, Cl = 35·5). 2

(b) (i) What is buffer solution? Derive Henderson's equation for acidic buffer. Write three applications of buffer solution. 1+2½+1½=5

(Continued)

(ii) Calculate the pH value of a solution obtained by mixing 0·083 moles of acetic acid and 0·091 moles of sodium acetate and making the volume 500 ml. K_a for acetic acid is $1{\cdot}75\times10^{-5}$. 2

(c) (i) What is salt hydrolysis? For a salt of weak base and strong acid, prove that $K_h = \frac{K_w}{K_b}$. Deduce an expression for pH of such salt solution. 1+2+2=5

(ii) Explain why phenolphthalein is not a suitable indicator in the titration of ammonium hydroxide and HCl. 2

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