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Higher Technological Institute (6th October Branch)
Engineering Chemistry (CHM 001) – Fall 2019

Midterm examination

November 6th 2019 **Time allowed**: 1 h

الاسم: ..... **المجموعة:** ..... **رقم الكود:**.....

Constants: (g/mol: H = 1, Ar = 40, He = 4, C = 12, O = 16, Na = 23, Cl = 35.5, N=14), R = 0.082 L atm mol^{-1} K^{-1}, R = 8.314 J mol^{-1} K^{-1}

Answer the following four questions and explain your answers wherever possible

Section I: Choose the correct answer for only 5 questions: [5 marks]

1. $V_1n_2 = V_2n_1$ (at constant P and T) is a mathematical expression of _____ law.
   (a) Avogadro's (b) Gay-Lussac's (c) Charles's (d) Boyle's

2. _____is the temperature above which vapors of a given substance cannot be liquified, no matter how much pressure is applied.
   (a) Boiling point (b) Critical temperature
   (c) Absolute Zero (d) None of theses

3. The compressibility factor of an ideal gas equals to_____.
   (a) 0 (b) <1 (c) >1 (d) 1

4. The vapor pressure of liquids _____ by increasing temperature.
   (a) remains unchanged (b) decreases (c) increases (d) cannot tell

5. _____ is the solution containing the maximum amount of a solute dissolved in a given amount of the solvent at a specific temperature.
   (a) Unsaturated solution (b) Saturated solution
   (c) Supersaturated solution (d) Ideal solution

6. The solubility of gases in liquids _____ with increasing temperature
   (a) remains unchanged (b) decreases (c) increases (d) cannot tell

Section II: Complete the followings: [5 marks]

7. Conversion of –40°F to the Celsius temperature gives **–40°C**.

$$^oC = \frac{5}{9}(\,^oF - 32)$$

8. The mathematical formula of Van der Waals equation that explain the behavior of real gases is _____ $\left[P_{obs} + \frac{an^2}{V^2}\right](V - nb) = nRT$

9. $(V_1n_2 = V_2n_1)$ (at constant P and T) is a mathematical expression of **Avogadro's** _____ law

10. The number of moles of solute in 1 kg of the solvent is called "**molality**" _____ .
11. The selective passage of solvent molecules through a porous membrane from a dilute solution to a more concentrated one is called _____**osmosis**.

Section III: Give reasons for the followings: **[5 marks]**

12. Gases tend to deviate تحيد from the ideal behavior at high P.
    at high P (small V) ⇒ Significant particles' volume, Gas moves in a volume << V ⇒ (Real behavior).
13. The boiling point of 0.5 mol/L NaCl aqueous solution is expected to be higher than 100°C.
    Because the addition of a non-volatile solute to a solvent increases its boiling point.
14. If the temperature (T) of a given quantity of an ideal gas is doubled in the same vessel, the gas pressure (P) will be doubled as well?
    Because at constant n and V, P α T
15. Claude process is more efficient than Linde process for air liquefaction.
    Because it merges the two principles of cooling
16. The osmotic pressure of 0.1 M aqueous NaCl solution is lower than that of 0.1 M aqueous $MgCl_2$ solution.
    Because the Vant' Hoff factor (i) of $MgCl_2$ (=3) is higher than that of NaCl (=2)

Section IV: Solve two of the following problems: **[5 marks]**

17. Estimate the mass of Na_2CO_3 required to prepare 100 mL 0.1 mol/L Na_2CO_3 aqueous solution at 25°C? **1.06 g**

$$\boldsymbol{W\ (g) = M(0.1) \times V(0.1) \times MWt(106) = 1.06\ g}$$

18. The normal boiling point of liquid ammonia is –33.4°C (its latent heat of vaporization = 23.5 kJ/mol). Calculate the vapor pressure of ammonia at –50.0°C? **316 torr**

$$\ln P = -\frac{\Delta H_{vap}}{RT} + C \qquad \ln\frac{P_1}{P_2} = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

P_1 =760 torr

$$\ln\frac{760}{P_2} = \frac{23.5 \times 1000}{8.314}\left(\frac{1}{-50+273} - \frac{1}{-33.4+273}\right) = 0.876$$

P_2 = 316 torr

19. A 0.562 g of nonelectrolyte solute was dissolved in 17.4 g benzene. The freezing point of this solution was 4.075°C. If the freezing point of pure

benzene is 5.455°C and K_f (benzene) = 5.065 °C m^{-1}, calculate the molar mas of this solute? **<u>118 g</u> mol^{-1}.**

$$\boldsymbol{\Delta T_f} = (5.455 - 4.075°\text{C}) = \mathbf{1.38}°\text{C} = \boldsymbol{i\, K_f\, m_{solute}}$$
$$= \mathbf{1} \times \mathbf{5.065}\ \boldsymbol{^oC/m} \times \boldsymbol{m_{solute}}$$

$$\boldsymbol{m_{solute}} = \frac{\mathbf{1.38}°\text{C}}{\mathbf{5.065}\ \boldsymbol{^oC/m}} = \mathbf{0.27}\ \boldsymbol{m}$$

$$\boldsymbol{m} = \mathbf{0.27}\ \boldsymbol{m} = \frac{\boldsymbol{w_{solute}}}{\boldsymbol{Mwt_{solute}}} \times \frac{\mathbf{1000}}{\boldsymbol{w_{solvent}}\ (\boldsymbol{g})}$$

$$\mathbf{0.27}\ \boldsymbol{m} = \frac{(\mathbf{0.562}\ \boldsymbol{g})\ \mathbf{1000}}{(\boldsymbol{Mwt_{solute}}\ \boldsymbol{g\ mol^{-1}})(\mathbf{17.4}\ \boldsymbol{g})}$$

$$\boldsymbol{Mwt_{solute}} = \mathbf{118.5}\ \boldsymbol{g\ mol^{-1}}$$

[End of Questions] GOOD LUCK