KEY

CHEM 101- Work Sheet Ch# 9, 10, 11

Q1:

Which of the following is paramagnetic?

A. Li_2

(B.) C_2^+

C. B_2^{2+}

D. H_2

E. C_2^{2-}

C_2^+ : v.ē = 2(4) − 1 = 7ē

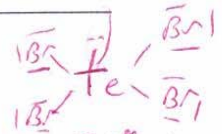
$(\sigma_{2s})(\sigma_{2s}^*)^2 \cdot (\pi_{2p})^3$

⇅ ↿ unpaired ē ⇒ paramag.

Q2:

The correct hybridization of (Te) in ($TeBr_4$) is ---dsp³---------

v.ē = 6 + 4(7) = 34 ē



5 effective pairs

Q3:

Iridium crystallizes in a face-centered cubic unit cell. If the atomic radius of the iridium is 0.135 nm, the volume of a unit cell is,

$d = \frac{4}{\sqrt{2}} r = 0.3818$ nm

$V = d^3 = 0.0557$ nm³ $= 5.57 \times 10^{-23}$ cm³

1 m = 10^9 nm

1 m = 10^2 cm

⇒ 1 cm = 10^7 nm

Q4:

Calculate the radius of a barium atom if the length of the edge in a body-centered cubic unit cell of crystalline barium is 0.513 nm?

$d = \frac{4}{\sqrt{3}} r \Rightarrow r = \frac{\sqrt{3}}{4} d = 0.222$ nm

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Q5:

A liquid can be made to boil if the external pressure is,

A. Increased at constant temperature.

B. Increased while the temperature is decreased.

(C.) Decreased at constant temperature.

D. Held constant while the temperature is decreased.

E. Held constant above the triple point at constant temperature.

$\ln \frac{P_1}{P_2} = \frac{\Delta H}{R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$

$\ln \frac{400}{760} = \frac{32.2 \times 10^3 \text{ J/mol}}{8.314 \text{ J/mol}\cdot\text{K}}\left[\frac{1}{T_2} - \frac{1}{314 \text{ K}}\right]$

Q6:
The vapor pressure of liquid bromine is 400 mm Hg at 41.0 °C. If the enthalpy of vaporization of bromine is 32.2 KJ/mol, estimate the normal boiling point of bromine.

$\Rightarrow T_2 = 331.36 \text{ K} - 273$ at 1atm = 760mmHg

$T_2 = 58.2\ ^\circ\text{C}$

Q7:
3.75 M Sulfuric acid has a density of 1.230 kg/L. What is the molality of H_2SO_4?

$\text{Molality} = \frac{n}{\text{kg (solvent)}} = \frac{3.75 \text{ mol}}{0.8625 \text{ kg}} = 4.35 \frac{\text{mol}}{\text{kg}}$

$m_{H_2SO_4} = n \cdot MM = (3.75)(98 \text{ g/mol}) = 367.5 \text{ g}$

$m_{solvent} = m_{solution} - m_{solute} = 1.23 \text{ kg} - 0.3675 = 0.8625 \text{ kg}$

Q8:
Which of the following molecules can be best dissolved in water? polar

A. CH_4

B. SF_6

C. C_4H_{10}

(D) C_4H_9OH → polar

E. CCl_4

Polar dissolved in polar

like dissolved like

Q9:
Which of the following aqueous solutions will have **the smallest** vapor pressure lowering? (Assume there are always 55 mol of water in 1 L solution) ⇒ the highest V.P

$\Delta T_b = i \cdot K_b \cdot m$

	i	effective molal	
(A) 2.0 m Sugar ($C_{12}H_{22}O_{11}$)	1	2 m	→ highest V.P
B. 1.5 m NaCl	2	3 m	
C. 1.0 m Na_3PO_4	4	4 m	→ lowest V.P
D. 3.0 m Sugar ($C_{12}H_{22}O_{11}$)	1	3 m	
E. 1.8 m CsF	2	3.6	

Q10:
The molal freezing-point depression constant for benzene is 5.12 °C.kg/mol and the freezing point of benzene is 5.50 °C. After dissolving 0.273 g of a substance in 7.50 g of benzene the freezing point of the solution was 5.26 °C. What is the molar mass of the substance in g/mol?

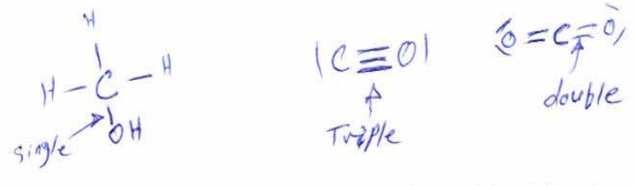
$\Delta T = 5.5 - 5.26 = 0.24$

$\Delta T = K \cdot m_{solute}$

$m_{solute} = \frac{\Delta T}{K} = \frac{0.24}{5.12} = 0.0469 \text{ m}$

$m = \frac{n}{\text{kg (solvent)}} \Rightarrow n = m \cdot \text{kg} = (0.0469 \text{ m})(7.5 \times 10^{-3} \text{ kg}) = 3.52 \times 10^{-4} \text{ mol}$

$MM_{solute} = \frac{\text{mass}}{n} = \frac{0.273 \text{ g}}{3.52 \times 10^{-4} \text{ mol}} = 776 \text{ g/mol}$



Q11:
Arrange CH_3OH, CO and CO_2 in order of decreasing C-O bond length.

$CH_3OH > CO_2 > CO$

Q12:
A mixture of gases contains a 2.10 g of N_2 and 5.35 g of H_2. If the total pressure of the mixture is 2.15 atm, what is the partial pressure of H_2?

$X_{H_2} = \frac{2.675}{2.675 + 0.075} = 0.973$

$P_{H_2} = X_{H_2} \cdot P_{total}$
$= (0.973)(2.15 \text{ atm})$
$= 2.09 \text{ atm}$

Q13:
The interlayer spacing in a crystal lattice is 310 pm. At what angle will first order diffraction occur if the wavelength of the x-ray used is 1.98 Å? (1Å = 10^{-10} m)

$(n = 1)$

$n\lambda = 2d\sin\theta \Rightarrow \sin\theta = \frac{n\lambda}{2d} = \frac{1(1.98 \times 10^{-10} m)}{2(310 \times 10^{-12} m)} = 0.319$

$\theta = 18.6°$

Q14:
The vapor pressure of water is 23.8 torr at 25°C and 93.7 torr at 50°C. What is heat of vaporization of water?

P_1, T_1, P_2, T_2

$\ln\frac{23.8}{93.7} = \frac{\Delta H_v}{R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right] \Rightarrow \Delta H_v = 43.9 \text{ KJ/mol}$

Q15:
A 0.87 m sucrose ($C_{12}H_{22}O_{11}$) solution has a density of 1.12 g/mL. Calculate the molarity of the solution.

$M = \frac{n}{V(L)\ solution} = \frac{0.87 \text{ mol}}{1.1585 L} = 0.75 M$

solvent, solute

$V_{solution} = \frac{m}{d} = \frac{1 + 0.298 \text{ kg}}{1.12 \times 10^{-3} \text{ kg/L}} = 1.1585 L$

Q16:
Calculate the vapor pressure at 25°C of a solution made of 500.0 g water and 80.0 g of glycerine ($C_3H_8O_3$). The vapor pressure of pure water at 25°C is 23.8 torr.
(Assume that glycerine is a non-volatile liquid at 25°C)

$P_{solution} = X_{solvent} \cdot P^{o}_{solvent}$
$= (0.97)(23.8 \text{ torr}) = 23.1 \text{ torr}$

Q17:
Water is added to 25.0 mL of a 0.866 M KNO_3 solution until the volume of the solution is exactly 750 mL. What is the concentration of the final solution?

V_1, M_1, M_2

$M_1 V_1 = M_2 V_2$

$M_2 = \frac{M_1 V_1}{V_2} = \frac{(0.866M)(25 mL)}{(75 mL)} = 0.0289 M$