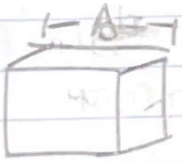
Fall 2024 Final EXAM Solution CHM2045

1. 

$A = 3.18 \times 10^{-10} m$

$A = \frac{4r}{\sqrt{3}}$ for body centered

$r = \frac{\sqrt{3} \cdot A}{4} = \frac{3.18 \times 10^{-10} m (\sqrt{3})}{4} = 1.38 \times 10^{-10} m$

$= 1.38 Å$

(B)

2. $P_{CO_2} = 5.5 atm$

$K_H = 3.7 \times 10^{-2} mol/Latm$

$S_{gas} = K_H \times P_{CO_2}$

$= 3.7 \times 10^{-2} \frac{mol}{Latm} (5.5 atm) = 0.204 mol/L$

(A)

3. molality $= \frac{\text{mol solute}}{\text{kg solvent}}$

mol C_6H_6 : $44 mL\ C_6H_6 \cdot \frac{0.877 g}{1 mL} \cdot \frac{1 mol\ C_6H_6}{78.11 g\ C_6H_6} = 0.494 mol\ C_6H_6$

=

Kg C_6H_{14} : $167 mL\ C_6H_{14} \cdot \frac{0.660 g}{1 mL} \cdot \frac{1 kg}{1000 g} = 0.110 kg\ C_6H_{14}$

$m = .494 mol\ C_6H_6 / 0.110 Kg\ C_6H_{14} = 4.48 m$ (B)

4) $\Delta T = K_f m i$ freezing point depression (c 1m sucrose)

↑i ↓F.P.

c $MgBr_2$ (3) b (3) (c (1)) d (2)

5. $P^0 = 68.8\ mmHg$

$\chi_{solvent} = 4.44 / (4.44 + .058)$

$= 0.987$

$P_{solvent} = \chi_{solvent} P^0$

$80g\ H_2O \cdot \frac{1mol}{18.02g} = 4.44mol$

$P_{solvent} = 0.987\ (68.8\ mmHg)$

$= 67.9\ mmHg$

$20g\ sucrose \cdot \frac{1mol}{342.3g} = 0.058mol$

(D)

6. $\frac{Rate\ x}{Rate\ y} = \frac{K[A_x]^x[B_x]^y[C_x]^2}{K[A_y]^x[B_y]^y[C_y]^2}$

$Rate\ 3/2 = \frac{1.94 \times 10^{-9}}{9.69 \times 10^{-10}} = \frac{K[.001]^x[.002]^y[.002]^2}{K[.001]^x[.001]^y[.001]^2}$

$2 = 2^z$

$z = 1$ C 1st order

$Rate\ 2/1 = \frac{9.15 \times 10^{-10}}{9.69 \times 10^{-10}} = \frac{K[.001]^x[.002]^y[.001]^1}{K[.001]^x[.001]^y[.001]^1}$

$1 = 2^y \quad y = 0$ B 0 order

$Rate\ 4/3 = \frac{1.55 \times 10^{-8}}{1.94 \times 10^{-9}} = \frac{K[.002]^x[.004]^0[.004]^1}{K[.001]^x[.002]^0[.002]^1}$

$8 = 2^x \cdot 2$

$4 = 2^x \quad x = 2$

A 2nd order

$rate = K[A]^2[B]^0[C]^1$

① $9.69 \times 10^{-10} = K[.001]^2[.00]^0[.001]$

$0.969 = K$

7. 1st order eq $\ln[A]_t = -Kt + \ln[A]_0$

$K = 8.7 \times 10^{-3} s^{-1}$

40% decompose = 60% left

assume $1M = [A]_0$ 60% of $1 = 0.6$

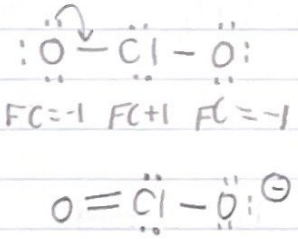
$$\ln[0.6]_t = -8.7 \times 10^{-3}(t) + \ln[1]$$

$$-0.5108 = -8.7 \times 10^{-3} t$$

$$t = 58.7 s$$ (A)

8. $ClO_2^- \rightarrow ClO_3^-$

$Ve = 7 + 12 + 1 = 20$



Bond order $= 2+1/2 = 1.5$

FC Cl - O

OX: $x + -4 = -1$

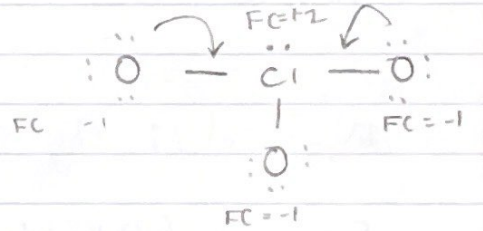
$x = +3$

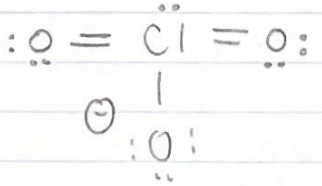
sp^3 hybrid

e^- geo: tetrahedral

answer (4)

$Ve = 7 + 18 + 1 = 26$





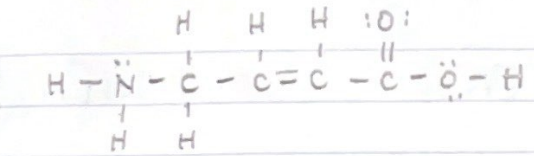
Bond order $= \frac{2+2+1}{3} = \frac{5}{3} = 1.67$

FC Cl = O

OX# $x + -6 = -1$

$x = +5$

sp^3 hybrid geo: tetrahedral

9 

$\sigma = 13 \quad \pi = 2$ (A)

10. C_xH_y

$CO_2 - 3.14g \cdot \frac{1 mol CO_2}{44.0g} \cdot \frac{1 mol C}{1 mol CO_2} = 0.07135 mol C$

$H_2O - 1.28g \cdot \frac{1 mol H_2O}{18.02g} \cdot \frac{2 mol H}{1 mol H_2O} = 0.142 mol H$

$\frac{C_{0.0714}}{0.0714} \frac{H_{0.142}}{0.0714} = CH_2$

molar mass $= 14.03 g/mol\ CH_2$

$60 g/mol / 14.03 g/mol \approx 4.3$

ratio $= 4$

$50 g/mol / 14.03 g/mol = 3.6$

$4(CH_2) = \underline{C_4H_8}$ (C)

11. $2AgNO_3 + CaCl_2 \rightleftharpoons 2AgCl + Ca(NO_3)_2$

$2AgNO_3$	$CaCl_2$
50 mL	50 mL
0.200 M	0.100 M
$T_i = 25^\circ C$	$T_i = 25^\circ C$
$T_f = 26^\circ C$	$T_f = 26^\circ C$

$\Delta H = \frac{q_{rxn}}{mol\ AgCl}$

$100 mL\ soln \cdot \frac{1.05g}{1mL} = 105g = m$

$C = 4.20 J/g^\circ C \quad \Delta T = 1^\circ C$

$q = mC\Delta T$

$= 105g\ (4.20 \frac{J}{g^\circ C})(1^\circ C)$

$q_{rxn} = 441 J$

11 contd

$$2\,AgNO_3 + CaCl_2 \rightleftharpoons 2AgCl + Ca(NO_3)_2$$

50 mL .2M 50 mL .1M

limit reactant

$AgNO_3$: $50\,mL \cdot \frac{L}{1000\,mL} \cdot \frac{.20\,mol\,AgNO_3}{1\,L} \cdot \frac{2\,mol\,AgCl}{2\,mol\,AgNO_3} = .01\,mol\,AgCl$

$CaCl_2$: $50\,mL \cdot \frac{L}{1000\,mL} \cdot \frac{.10\,mol\,CaCl_2}{1\,L} \cdot \frac{2\,mol\,AgCl}{1\,mol\,CaCl_2} = .01\,AgCl$

both same 0.01 AgCl mol

$\Delta H = q_{rxn} / mol\,AgCl = 441\,J / .01\,mol\,AgCl$

$= \frac{44100\,J}{mol\,AgCl} \cdot \frac{kJ}{1000\,J} = 44.1\,\frac{kJ}{mol}$

(C)

12. $V_1 = 25\,mL$ $V_2 = 31.1\,mL$

$P_1 = 1\,atm$ $P_2 = 0.75\,atm$

$T_1 = 25^\circ C = 298K$ $T_2 = ?$

$$\frac{V_1 P_1}{T_1} = \frac{V_2 P_2}{T_2}$$

$$\frac{.025\,L\,(1\,atm)}{298K} = \frac{.0311\,(0.75atm)}{T_2}$$

$T_2 = 278K - 273K = 5.04^\circ C$ (A)

13 CN^-

ve = 4+5 = 10 ve⁻

:C≡N:

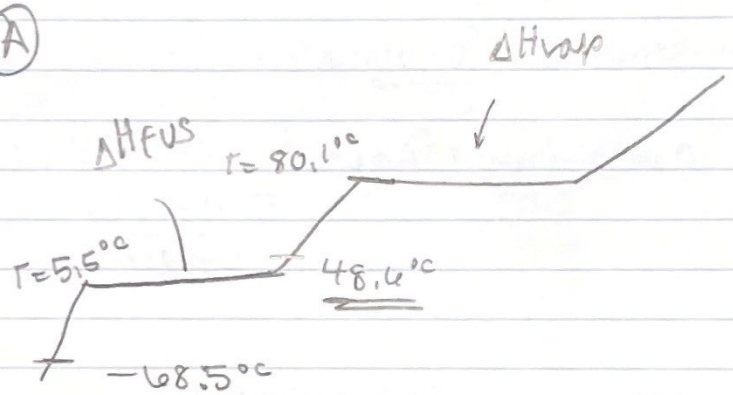
BO $\sigma 2s$ $\sigma^* 2s$ $\pi 2p_x = \pi 2p_y$ $\pi^* 2p_x = \pi^* 2p_y$ $\sigma^* 2$

BO $\frac{1}{2}(6-4) = 1$

2 unpaired e⁻

(A)

14.



① q liquid
② ΔH_{fus} (a)
③ q solid

① $m_e C_e \Delta T$

$q = 70.8g \left(\frac{1.73J}{g°C}\right)(5.5°C - 48.6°C)$

$q = -5279\,J$

(B)

③ $m C_s \Delta T$

$70.8g\,(1.51J/g°C)(-68.5-5.5°C)$

$= -7911.19\,J$

② $q = n\,\Delta H_{fus}$

$= 70.8g\,C_6H_6 \frac{1mol\,C_6H_6}{78.11g}$

$= 0.906\,mol \left(9.8\,\frac{KJ}{mol}\right)$

$= 8.88\,KJ \frac{10^3 J}{KJ} = 8882.9\,J$

$q_{total} = -5279 - 8882.9 - 7911.19 = -22073\,J = -22.1\,KJ$