Final Exam Review (Solutions)

1.) $\rho = \dfrac{n A}{V_C N_A}$

n: # of atoms in unit cell

A: atomic weight (g/mol)

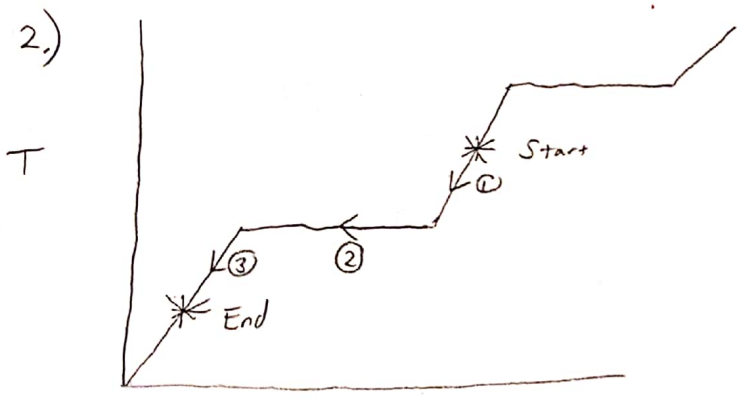
V_C: Volume of unit cell

N_A: Avagadro's #

$$\rho = \frac{4(197)}{(407\times10^{-9})^3 (6.022\times10^{23})} = 0.0194 \frac{g}{m^3}$$

$$\boxed{\rho = 19.4 \frac{g}{cm^3}}$$

2.)



$q_T = q_1 + q_2 + q_3$

$= -22{,}073$ J

$q_T \approx -22$ kJ

① : $q_1 = m C_{p,liq} \Delta T$

$= (70.8)(1.73)(5.5^{\circ}C - 48.6^{\circ}C)$

$= -5279$ J

"Removed" implies magnitude

$\Rightarrow \boxed{q_T = 22 \text{ kJ}}$

② $70.8\,g \times \dfrac{1\,mol}{78.11\,g} = 0.906$ mol C_6H_6

$q_2 = n \Delta H_{fus}$

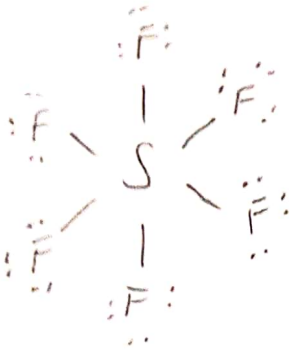
$= (0.906)\left(-9800 \frac{J}{mol}\right) = -8883$ J

③ $q_3 = m C_{p,s} \Delta T$

$= (70.8)(1.51)(-68.5^{\circ}C - 5.5^{\circ}C) = -7911$ J

3) III

4)

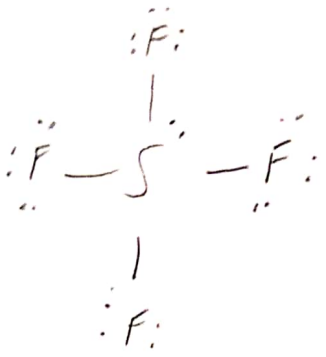


↑

larger than SiH_4

London dispersion

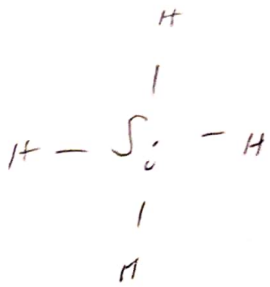
(middle)



↑

Dipole

(Strongest)



(weakest)

$SiH_4 < SF_6 < SF_4$

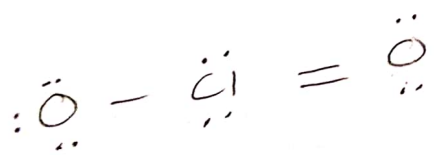
(3)

5.) (2) Lithium

6.) ClO_2^- ⇒ ClO_3^-

ClO_2^-: +3 (-4)

ClO_3^-: (+5) (-6)

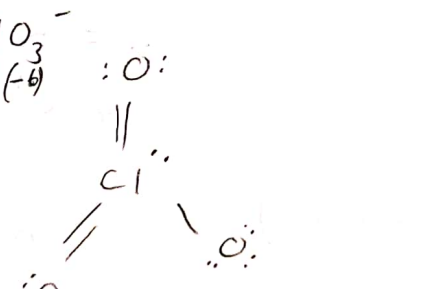


Molecular: Bent

Electron: Tetrahedral

sp^3

BO = 1.5



Molecule: Trigonal pyramidal

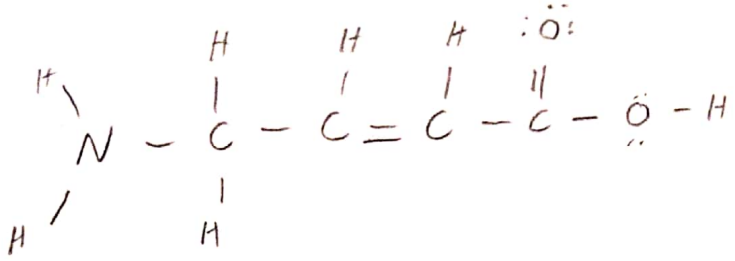
Electron: Tetrahedral

sp^3

BO = 1.67

(4)

7.)



13 σ

2 π

(1)

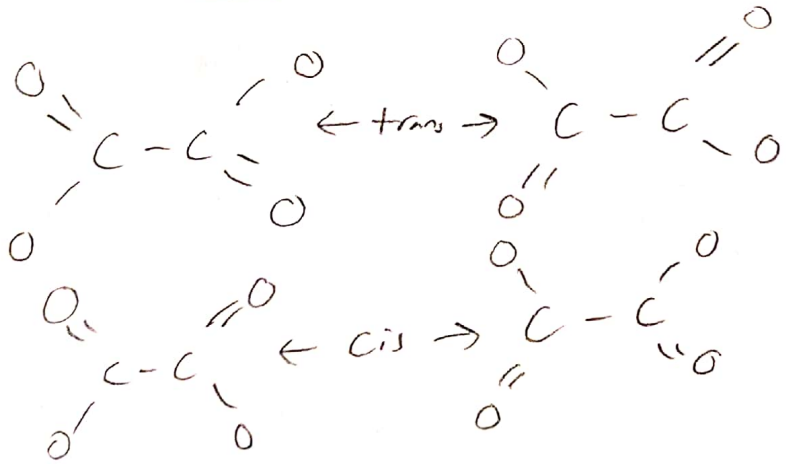
8.) $\frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2}$

$\frac{(1\ atm)(25\ ml)}{(298\ K)} = \frac{(0.75)(31.1\ ml)}{T_2}$

$T_2 = 278.034\ K$

$\boxed{T_2 = 5.03\ ^{\circ}C}$

9.)



(4)

10.)

(3)

11.)

C: $3.14\,g \times \frac{1\,mol}{44.02\,g} = 0.07135\,mol\ CO_2 = \frac{0.07135\,mol\ C}{0.07135} = 1$

H: $1.28\,g \times \frac{1\,mol}{18.02\,g} = 0.07103\,mol\ H_2O \times \frac{2\,H}{1\,H_2O} = \frac{0.1421\,mol\ H}{0.07135} = 2$

Empirical : CH_2

Empirical mass = 14.026

$\frac{55}{14.026} \approx 4 \Rightarrow C_4H_8$

12.)

$$X_eO_4 \rightarrow \underbrace{X_e + 2O_2}$$

760 mm Hg $\Rightarrow$ 760 mm Hg

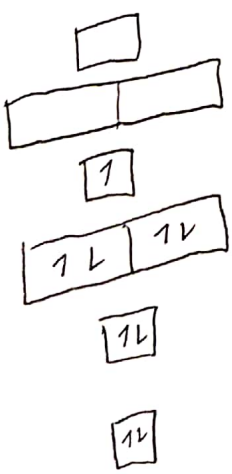
760 − 40 = 720 mm Hg

$P_{O_2} = X_{O_2} P_T$

$= \frac{2}{1+2}(720)$

$P_{O_2} = 480$ mm Hg

13.)



σ^*_{2p}

π^*_{2p}

σ_{2p}

π_{2p}

σ^*_{2s}

σ_{2s}

Bonding e⁻ ↓ anti-bonding e⁻ ↓

Bond order = $\frac{1}{2}(7-2)$

Bond order = 2.5

Unpaired = 1

14.) $2AgNO_3 + CaCl_2 \Rightarrow 2AgCl + Ca(NO_3)_2$

$AgNO_3$: $(0.2 \frac{mol}{L})(0.05\ L) = 0.01\ mol\ AgNO_3 \times \frac{2}{2} = 0.01\ mol\ AgCl$

$CaCl_2$: $(0.1 \frac{mol}{L})(0.05\ L) = 0.005\ mol\ CaCl_2 \times \frac{2}{1} = 0.01\ mol\ AgCl$

$q_{rxn} + q_{sol} = 0$

$q_{sol} = m C \Delta T$

$= (100\ ml)(1.05 \frac{g}{ml})(4.20 \frac{J}{g^{\circ}C})(26^{\circ}C - 25^{\circ}C)$

$= 441\ J$

$q_{rxn} = -q_{sol} = -441\ J$

$\Delta H_{rxn} = \frac{q_{rxn}}{AgCl\ mol} = \frac{-441}{0.01} = -44{,}100\ J$

$= -44 \frac{kJ}{mol}$

15.) $\frac{Exp\ 1}{Exp\ 3} \Rightarrow \frac{3.4 \times 10^{-4}}{8.5 \times 10^{-5}} = \frac{k[0.03]^x[0.01]^y}{k[0.015]^x[0.01]^y}$

$4 = 2^x$

$\Rightarrow x = 2$

① : $3.4 \times 10^{-4} = k(0.03)^2(0.01)$

$\Rightarrow k = 38$

$\frac{Exp\ 2}{Exp\ 3} \Rightarrow \frac{8.5 \times 10^{-5}}{3.4 \times 10^{-4}} = \frac{k[0.015]^2[0.01]^y}{k[0.015]^2[0.04]^y}$

$0.25 = 0.25^y$

$y = 1$

$\Rightarrow Rate = k[NO]^2[Cl_2]$

16.) $\Delta T_b = K_b m$

$$m = \frac{\text{mol solute}}{\text{kg solv.}} = \frac{0.1403 \text{ mol } C_{14}H_{10}}{0.075 \text{ kg } C_6H_6} = 1.87 \text{ m}$$

25% mass $\Rightarrow$ $25 \text{ g } C_{14}H_{10} \times \frac{1 \text{ mol}}{178.23 \text{ g}} = 0.1403 \text{ mol } C_{14}H_{10}$

$75 \text{ g } C_6H_6 = 0.075 \text{ kg } C_6H_6$

$\Delta T_b = K_b m$

$= (2.65)(1.87)$

$= 4.96^{\circ}C$

$\Rightarrow T_b = 80^{\circ}C + 4.96^{\circ}C$

$= 84.96^{\circ}C$

$\boxed{T_b \approx 85^{\circ}C}$