Atomic Structure and Molecular Architecture

1. Provide the electron configuration for the following:
   Ar, Fe, Sn, Pb, U

2. Predict bonding, shape and polarity of the following:
   NH_3 PCl_5 CO_3^{-2} SO_4^{-2}

3. Arrange the following in order of increasing melting point.
   H_2O CCl_4 Cl_2 H_2 NaCl C(s) (graphite)

4. Explain why metals conduct both heat and electricity and are shiny and malleable.

5. Explain why CO_2 is a soft solid with a very low m. p. and SiO_2 is a hard crystal even at high temperatures.

Intermolecular Attraction

1.Which is expected to have the higher boiling points: C_5H_{12} or C_9H_{20}? Explain.

2. Why does H_2O have a much higher boiling point than H_2S?

3.Explain what type of solid columbium forms based on the following properties: shiny, soft, ductile. Melts at 2468° and conducts electricity.

4. What kind of attractive forces exist between particles in a) molecular solids b) ionic solids c) covalent crystals?

5. Tin (IV) chloride, $SnCl_4$, has soft crystals with melting point of -30.1°C. The liquid is nonconducting. What type of crystal is formed by $SnCl_4$?

6. What kind of intermolecular attractive forces are present in these substances?
   a) HF b) CS_2 c) PCl_3 d) SF_6 e) Mg f) C diamond g) $BaCl_2$

ORGANIC

Draw structures for the following:

a) 3-methylhexane b) 4-chloro-2,3-dimehyloctane, 4-chloro-2,3-dimethyloctane

c) 3-octene d) 2-pentanol e) 2-chloro-2,4-dimethyl-3-hexanone

f) 2, 2-diaminobutanoic acid g) 2-methylpropyl pentanoate

h) 4-chloro-2-methylaminobutanol i) 3-bromopentanol

j) 1, 2-dinitrobenzene k) p-chlorotoluene l) 2, 4, 6-trinitrotoluene

Write equations, using structural formulas, for the following reactions:

A) propene + chlorine
B) 2-butene + hydrogen
C) octane + oxygen (high temp)
D) 2-hexyne + one mole of $H_{2(g)}$
E) 2-pentene + HCl
F) benzoic acid + ethanol
G) oxidation of butanal

PROBLEMS

1. One mole of NaCN reacts with one mole of bromoethane to form one mole of cyanoethane. Given 8.53 g of NaCN and 10.98 g of bromoethane, find the volume of liquid C_2H_5CN (d = 0.783 g/mL).

2. A sample of a liquid consisting of only C, H, and O and having a mass of 0.5438 g was burned in pure oxygen and 1.039 g of CO_2 and 0.6369 g of H_2O were obtained. What is the empirical formula of the compound?

3. How many oxygen atoms are there in 3.15 mol of Manganese (IV) oxide?

5. How many moles of sodium carbonate are there in 53 g of that substance?

7. What is the mass of 2.50 mol of H_2SO_4?

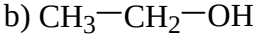
8. Calculate the % composition of Ammonium nitrate.

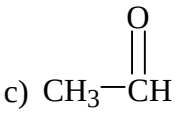
10. The composition of barium carbonate is:
Ba – 69.58% C – 6.09% O – 24.32%
What is its empirical formula?

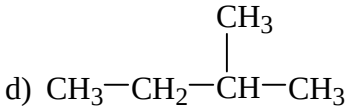
11. Analysis of styrene, showed it contained 7.7% hydrogen and 92.3% carbon. Its molar mass was 104 g/mol. What is its molecular formula?

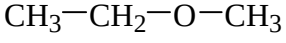
12. Name the following:

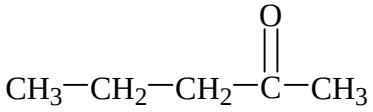
a) 

b) 

c) 

d) 

e) 

f) 

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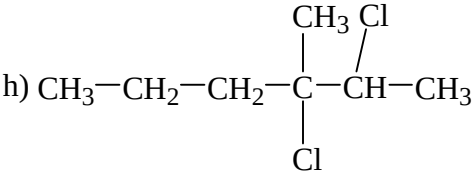
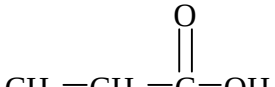
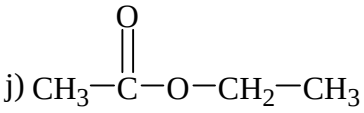
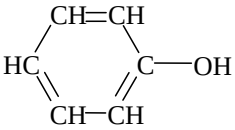
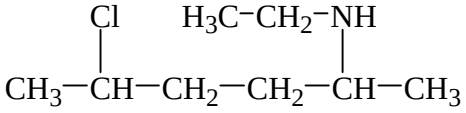
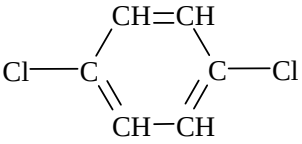
h) 

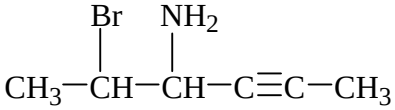
i) 

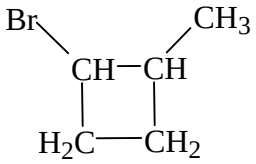
j) 

n) 

o) 

p) 

q) 

r) 

<u>THERMOCHEMISTRY</u>

1. The fundamental reaction for photosynthesis is:
   $6CO_2(g) + 6H_2O(l) \longrightarrow C_6H_{12}O_6(s) + 6O_2(g)$
   If ΔH_f° $C_6H_{12}O_6(s)$ = -1265.4 kJ/mol, calculate the ΔH for the reaction.

2. $CH_2O(g) \rightarrow H_2(g) + CO(g)$ ΔH = 5.4 kJ/mol. What is ΔH_f° for formaldehyde?

3. The "fuel value" of a fuel is defined as the heat released in combustion per gram of fuel. Compare the fuel value of $CH_4(g)$ [ΔH_f° = -74.9 kJ/mol] , $CH_3OH(l)$ [ΔH_f° = -238.5 kJ/mol] and $C_7H_{16}(l)$ [ΔH_f° = -224.2 kJ/mol]. Assume the products of combustion are $CO_2(g)$, $H_2O(l)$.

4. The standard heat of combustion of nitromethane in the reaction
   $CH_3NO_2(l) + \frac{3}{4} O_2(g) \rightarrow CO_2(g) + \frac{1}{2} Na(g) + 1.5 H_2(g)$ is -710 kJ/mol. Calculate ΔH_f^0 for nitromethane.

Answers: 1. 2811.6 kJ 2. -115.0 kJ/ mol 3. $CH_4 \rightarrow$ 55.7 kJ/g $C_7H_{15} \rightarrow$ 48.2 kJ/g $CH_3OH \rightarrow$ 22.7 kJ/g 4. -316.9 kJ/mol

RATES REVIEW

1. The following mechanism has been proposed for the reaction of NO with Br_2 to form NOBr.

$NO(g) + Br(g) \rightarrow NOBr_2(g)$
$NOBr_2(g) + NO(g) \rightarrow 2NOBr(g)$

a) Identify the intermediate.
b) Write the rate law for each step.
c) What is the overall rate law if the first step is slow, and the second step is fast?
d) The observed rate law is actually $R = k\ [NO]^2\ [Br_2]$. If the proposed mechanism is correct, what can be concluded about the relative speeds of steps one and two?

2. For the reaction $A + 2B \rightarrow C$, whose rate law is $R = k\ [A]^2\ [B]$, by what factor would the reaction rate increase if
a) [A] and [B] were both doubled
b) [A] was doubled and [B] was held constant.
c) [A] was doubled and [B] was halved.

3. An exothermic reaction has the following mechanism in the gas phase:
$2NO \rightarrow N_2O_2$ fast
$N_2O_2 + H_2 \rightarrow N_2O + H_2O$ slow
$N_2O + H_2 \rightarrow N_2 + H_2O$ fast

a) What is the overall equation for this reaction?
b) Sketch a potential energy diagram. Identify the intermediates.
c) Write the rate law for the overall reaction.

EQUILIBRIUM

1. Write the eq'm expression for the following reactions:

a) N_2 (g) + $3H_2$ (g) ← → $2NH_3$ (g)

b) 2HCl (aq) + Mg (s) ← → $MgCl_2$ (aq) + H_2 (g)

c) Ag^{+3} + $3Cl^-$ (aq) ← → $AgCl_3$ (aq)

2. State what will happen to the following reaction when the stated changes are carried out:

H_2 (g) + I_2 (g) ← → 2HI (g) $\Delta H = -52$ kJ

a) an increase in pressure b) an increase in temperature

c) volume decreased d) [H_2(g)] is increased

e) catalyst added

3. When 0.750 mol/L of CO and 0.275 mol/L of H_2O (g) are placed in a container, the following occurs:

CO (g) + H_2O (g) ← → CO_2 (g) + H_2 (g)

After equilibrium is reached, 0.25 moles/L of CO_2 was formed. Calculate the Keq.

4. The above reaction has a Keq = 4.06 at 500°C. If 0.1 mol of CO and 0.1 mol of H_2O were placed in a 1L reaction vessel at this temperature, what were the concentrations of the reactants and products when the system reached equilibrium?

5. a) Give an example of a macroscopic property.

b) Give an example of a microscopic property.

SOLUBILITY PRODUCT (Eq'm Applications)

6. For each of the following, write

a) a balanced chemical equation

b) an full ionic chemical equation

c) a net ionic chemical equation

i) sodium chloride sol'n mixed with a silver nitrate sol'n

ii) phosphoric acid mixed with sodium hydroxide sol'n

iii) magnesium chloride sol'n with sodium nitrate sol'n

iv) barium nitrate sol'n with aluminum sulphate sol'ns

7. If 25.0 g of MnS are mixed into 1L of water and allowed to settle out, what is the concentration of Mn^{+2} ion in the solution.(Ksp_{MnS})= $5.6*10^{-16}$

8. a) Will a ppt form if 10 mL of $1*10^{-5}$ M $BaCl_2$ and 10 mL of $1.0*10^{-5}$ M H_2SO_4 are mixed?
b)What if 10 mL of $1.0*10^{-9}$ M $CaCl_2$ and 30 mL of $2.0*10^{-3}$ M NaF are mixed?

9. Explain what happens to the CO_2 content in a sealed pop bottle as you gradually increase the temperature.

10. The molar solubility of Cu $(OH)_2$ is $3.42*10^{-7}$ mol/L. What s the Ksp for Cu $(OH)_2$.

11. Calculate the solubility of Ag_2CO_3 at 25°C in
a) pure water
b) 0.1 mol/L Na_2CO_3 (Ksp $Ag_2CO_3 = 8.4*10^{-12}$)

ACIDS and BASES

12. Define Acid and Base according to Arrehnius and Bronsted/Lowry.

13. Given $HCN + H_2O \leftarrow\rightarrow H_3O + CN^-$
Identify the acid of the forward reaction
Identify the base of the forward reaction
Identify the conjugate acid-base pairs.

14. In a titration of 50 mL of 0.1 M HCl with 0.15 M NaOH, calculate the pH at i) 0 mL NaOH added ii) 20 mL NaOH added iii) 40 mL NaOH added.

15. A 0.1 M sol'n of acetic acid has a pH of 2.87. Calculate Ka.

16. What is the pH of 0.2 M sodium acetate?

17. Calculate the pH of 0.15 M NH_4Cl. $K_{bNH3} = 1.8*10^{-5}$

18. How many grams of ammonium chloride must be added to 300 mL of 0.250 M NH_3 to make a buffer sol'n with pH = 9.00?

19. Find the dissociaton constant of an acid if a 0.1 M sol'n of the acid has a pOH of 10.59.

OXIDATION – REDUCTION

20. a) balance using oxidation numbers

i) $MnO_4^- + H_2SO_3 \rightarrow Mn^{+2} + HSO_4^- + H_2O$ (acid)

ii) $ClO_3^- + I_2 + H_2O \rightarrow IO_3^- + Cl^-$ (acid)

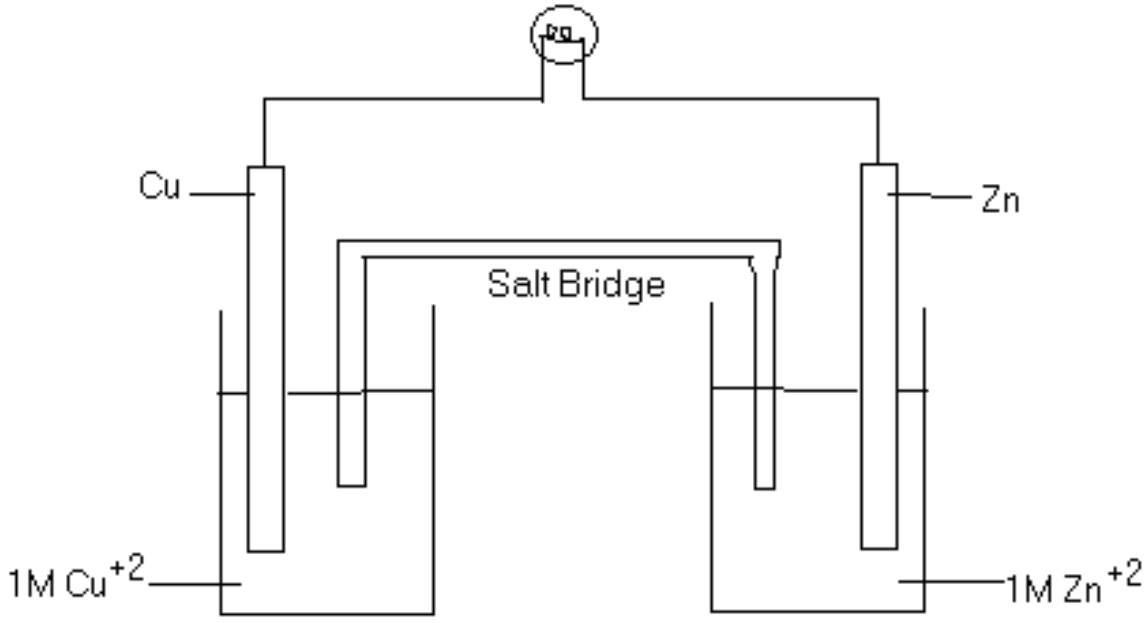
b) balance using half cell

i) $Cu_{(s)} + HNO_3 \rightarrow Cu^{+2} + NO_2$ (acid)

ii) $NO_3^- + Zn \rightarrow NH_3 + Zn(OH)_4^{-2}$ (basic)

21) What do the positive and negative signs of reduction potentials tell us?

22) a) What is the voltage of the cell shown?



b) What direction does the current flow?

b) Label the anode and cathode.

c) Indicate the positive and negative electrode.

22) Redo assignments and problems out of the back of the book.

23) Get a good night's sleep before the exam.

GOOD LUCK !!!!