SCH4U -- FINAL REVIEW of each UNIT

1. a) Make a glossary of terms from each unit.
   b) State and explain each law or theory from each unit.
   c) Make a list of all formulas from each unit.
   d) Draw a sample diagram from each unit.
   e) Try the questions that follow.

THERMOCHEMISTRY

1. When 33.45 kJ of heat is applied to an aluminium calorimeter that has a mass of 244.0 g, the temperature rises from 31.8 ºC to 70.9 ºC.
   a) Calculate the specific heat of aluminium.
   b) Calculate the molar heat capacity of aluminium.

2. For the complete combustion of octane, $\Delta H = -4\,597$ kJ/mol according to the reaction

   $C_8H_{18}(g) + O_2(g) \rightarrow CO_2(g) + H_2O(l)$

   a) Balance the above reaction
   b) Use the above information and the table provided to find the standard heat of formation (ΔH_f°) of octane.

3. Using the following equations:

   $4\,FeO(s) + O_2(g) \rightarrow 2\,Fe_2O_3(s)$ $\quad \Delta H = -560.4$ kJ

   $CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(g)$ $\quad \Delta H = -371.5$ kJ

   $CH_4(g) \rightarrow C(s) + 2\,H_2(g)$ $\quad \Delta H = +74.8$ kJ

   $2\,FeO(s) \rightarrow 2\,Fe(s) + O_2(g)$ $\quad \Delta H = +544.0$ kJ

   $2\,CO(g) \rightarrow 2\,C(s) + O_2(g)$ $\quad \Delta H = +221.0$ kJ

   $H_2(g) + \frac{1}{2}\,O_2(g) \rightarrow 2\,H_2O(g)$ $\quad \Delta H = -241.6$ kJ

   find the ΔH for the following reaction:

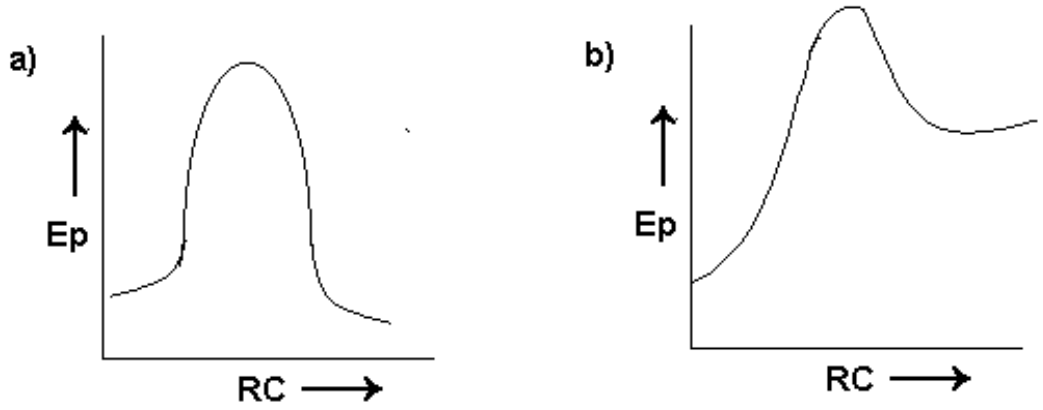
   $Fe_2O_3(s) + 3\,CO(g) \rightarrow 3\,CO_2(g) + 2\,Fe(s)$

4. a) What two conditions are necessary for a successful reaction to occur spontaneously?
   b) For the reaction:

   $2\,N_2O_5(g) \rightarrow 4\,NO_2(g) + O_2(g)$ $\quad \Delta H = +126.4$ kJ

   Is the reaction favourable in terms of : (support your answers)
   (i) enthalpy
   (ii) entropy

5. Consider the following potential energy diagrams:



Which of the above potential energy diagrams represents:
(i) an exothermic reaction
(ii) The fastest reaction (Assume equal scales)

RATES OF REACTION

1. Regarding the rates of chemical reactions:
a) What are **four** factors which affect reaction rates?
b) Use the collision theory to explain only **two (2)** of the above in part (a).

2. The mechanism for a complex reaction proceeds as follows:

I)	A	+ B	→	C + F	Ea = + 68 kJ /mol ΔH = - 42 kJ
II)	F	+ B	→	C + E	Ea = + 63 kJ /mol ΔH = - 21 kJ
III)	B	+ 2C	→	E + A	Ea = + 84 kJ /mol ΔH = + 32 kJ

a) Draw and fully label an accurate energy curve to represent the steps of this reaction, show your scale.
b) What is the overall equation for this reaction (show the catalyst) ?
c) What is the Δ H (forward) for the overall or net reaction?
d) Which step would be the rate determining step?
e) State the reaction intermediate (s) in this reaction.
f) State the catalyst(s) in this reaction.
g) Which step(s) is (are) exothermic?

3. Given the following reaction with experimental data:

$$C_4H_{11}CF\,(aq) + OH^-\,(aq) \rightarrow C_4H_{11}COH\,(aq) + F^-\,(aq)$$

Trial	Initial $[C_4H_{11}CF]$ (mol/L)	Initial $[OH^-]$ (mol/L)	Initial Rate of Formation of F^- (mol/L/s)
1	0.10	0.20	5.5×10^{-4}
2	0.20	0.20	1.1×10^{-3}
3	0.10	0.40	5.5×10^{-4}

a) Determine the order of the reaction with respect to $C_4H_{11}CF$
b) Determine the order of the reaction with respect to OH^-
c) What is the order of the reaction ?
d) Write the rate law expression for the reaction.
e) Determine the value of the rate law constant for the reaction, and state its units.
f) State the molecularity of the reaction

CHEMICAL EQUILIBRIUM

1. Given the equation:

$$CO\,(g) + H_2\,(g) \rightleftharpoons C\,(s) + H_2O(g) \qquad \Delta H = -131.3\ kJ$$

a) Write the equilibrium law expression (K_c) for the above reaction.
b) Determine the value of the equilibrium constant if at equilibrium.
$[CO] = 3.2 \times 10^{-3}$ mol/L $[H_2] = 2.5 \times 10^{-4}$ mol/L
$[C] = 6.35 \times 10^{2}$ mol/L $[H_2O] = 5.4 \times 10^{-4}$ mol/L

1. Write the equilibrium law expression for the following reactions:

a) $NaOH\,(s) + H^+(aq) + Cl^-(aq) \rightleftharpoons H_2O(g) + Na^+(aq) + Cl^-(aq)$
b) Dissolving aluminum sulfate $[Al_2(SO_4)_3]$ solid in water.

2. a) What is the difference between a physical and a chemical equilibrium ?
b) State whether each of the following is a homogeneous or heterogeneous equilibrium.

(i) $Br_2\,(g) + 5\,F_2(g) \rightleftharpoons 2BrF_5\,(g)$

(ii) $Ca_3(PO_4)_2\,(s) \rightleftharpoons 3\,Ca^{2+}\,(aq) + 2\,PO_4^{3-}(aq)$

3. Given the equation:

$$2\,A\,(g) + B(g) \rightleftharpoons 3\,C\,(g) + D(g) \qquad \Delta H = -315.9\ kJ$$

a) Write the equilibrium law expression (K_{eq}) for the above reaction.
b) When equal volumes of A and B are combined in a 3.5 L flask, their initial concentrations were each 1.75 mol/L. Once equilibrium is reached, the equilibrium concentration of C is [C] = 0.65 mol/L. Determine the K_{eq} for this reaction.

4. Consider the following reaction:

$N_2\ (g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3\ (g)$ $\Delta H = -92.2$ kJ

What are the ideal conditions that would favour the greatest yield of ammonia?

5. 0.550 mol of nitrogen are combined with 0.350 mol of oxygen in a 4.00 L flask and allowed to reach equilibrium. Determine the equilibrium concentration of each substance.

$N_2\ (g) + O_2(g) \rightleftharpoons 2\ NO\ (g)$ $K_c = 2.51 \times 10^{-7}$

SOLUBILITY EQUILIBRIUM

1. a) Write the balanced equation for the reaction between potassium phosphate $\{K_3PO_4\}$and magnesium nitrate $\{Mg(NO_3)_2\}$.
   b) Write the ionic equation for the above reaction.
   c) Write the net ionic equation for the above reaction.
   d) Write the dissociation reaction for the dissolving of the possible precipitate.
   e) Write the Ksp for the above precipitate.

2. When $CaSO_4$ dissolved in 100.0 mL of water, a saturated solution contains how many moles of Ca^{2+} ions?

3. The solubility product constant (Ksp) of $Ag_2CrO_4\ (s)$in water is 5.02×10^{-13} at 25 °C. What is the solubility of silver chromate (in g/L) at 298 K?

4. A 50.0 mL volume of 0.0420 mol/L $Ca(NO_3)_2$ is added to 150.0 mL of 0.00810 mo/L $(NH_4)_2SO_4$ solution. Will a precipitate form if the Ksp for the possible precipitate is 2.61×10^{-4} ?

5. Calculate the maximum fluoride ion concentration possible in an aqueous solution that is already 0.750 mol/L barium nitrate $\{Ba(NO_3)_3\}$. The Ksp for barium fluoride $\{BaF_2\}$ is 1.71×10^{-6} .

IONIC EQUILIBRIUM

1. Which of the following is the strongest acid ?
   a) H_2PO_2 b)H_2PO_3 c) H_2PO_4

2. Briefly distinguish between an Arrhenius base, a Bronsted base, and a Lewis base. Give a suitable, yet different example of each.

3. a) Use the salt sodium acetate $NaC_2H_3O_2$ to explain hydrolysis. Include chemical equations and written explanations.

   b) Would a solution of sodium acetate be acidic, basic or neutral ?

4. A 0.0020 mol/L solution of acetic acid (CH_3CO_2H) is 5.60% ionized at 40°C. Calculate its K_a at this temperature.

5. Find the hydrogen and hydroxide ion concentrations, pH and pOH in a solution made by mixing 10.5 mL of 0.12 mol/L KOH with 17.5 mL of 0.20 mol/L HCl.

6. Hydrofluoric acid is a weak acid. Suppose you dissolve 39.98 g of the acid in enough water to make 5.00 L of solution. K_a for HF is 2.56×10^{-4}. Calculate the concentration of the $[H^+]$ ion in solution and the pH of the weak acid HF.

7. Nicotine, is a weak base, calculate the K_b and the pK_b, for a 0.221 M solution of a solution of nicotine that has a pH of 9.75.

OXIDATION & REDUCTION

8. a) Balance the following equation using oxidation numbers.

$$Mn^{7+}(aq) + Cu\ (s) \rightarrow Mn^{2+}(aq) + Cu^{2+}\ (aq)$$

b) (i) Balance the following equation using half-reactions.

$$H_2\ (g) + Zn^{2+}(aq) \rightarrow H^+(aq) + Zn\ (s)$$

(ii) Determine the reduction potential (E^o) for the above reaction.

c) $Sn_{(s)} + HNO_{3\ (aq)} \longrightarrow Sn(NO_3)_{2\ (aq)} + NO_{(g)} + H_2O_{(l)}$

2. Consider a voltaic cell composed of a Cu- Cu^+ half-cell containing 1.0 mol/LK $Cu(NO_3)_2$ and a Zn- Zn^{2+} half - cell containing 1.0 mol/L $ZnSO_4$. The salt bridge contains $(NH_4)_2SO_4$.

a) Draw this cell and label completely (electron flow, ion flow, anode, cathode, oxidation half-cell, reduction half-cell, Cu electrode, Zn electrode, salt bridge, voltmeter, solutions)

b) i Write the half-reaction at the anode
ii Write the half-reaction at the cathode
iii Write the overall reaction.

c) i What is the reducing agent.
ii What is the substance oxidized.

d) What should the reading on the voltmeter be?

e) Write the cell notation.

BONDING & SHAPES

1. a) What is the 'Pauli Exclusion Principle'? Be sure to include an example.
b) What is the VSEPR theory?

c) Use the VSEPR theory to discuss the bond angle in a molecule of water.
d) Give the electronic configuration of: V, Fe^{+2}, Cu^{+1} Ni^{+3} Br^{-1}

2. Complete the table below:

Formula	Lewis Structure	Shape	Polar or Non-polar
$CHCl_3$			
BrO_3^-			
SiS_2			
ICl_5			
CO_3^{2-}			
CrI_6			
PBr_4^+			

3. a) What is the electron configuration of the sulphide ion, S^{2-}?
   b) What is the outermost electron orbital & number of electrons in the electron configuration that represents a halogen?
4. (a) what is the number of orbitals available at n = 4 ?
   (b) what is the ground state electron configurations most likely to represent an alkali metal?
5. State an ion or neutral atom that has the same electron configuration as Mg^{+2}.
6. (a) The CCl_4 molecule is non-polar. Why? (b) what does a polar molecule result from?
7. State and explain the order of boiling points for the following compounds:
   C_3H_7COOH C_4H_{10} C_3H_7OH C_4H_7Cl
8. Explain the abnormal boiling point of H_2O, compared to the hydrides of Group VI.

ORGANIC

1. List **three** characteristics of an homologous series, and explain the term functional group.
2. State and explain two tests you could carry out to determine if an unknown hydrocarbon is saturated or unsaturated.
3. When propene reacts with hydrogen bromide, there are two possible products. Give the structural formulas and the names of the two products, state which of the two products formed is the major.
4. (a) Ethanol and ethanoic acid can be distinguished by their melting points. State and explain which of the two compounds will have a higher melting points.
   (b) (i) Ethanoic acid reacts with ethanol in the presence of concentrated sulphuric acid and heat. Identify the type of reaction that takes place. Write an equation for the reaction, name the organic product formed and draw its structure.
   (ii) State and explain the role of sulphuric acid in this reaction.
   (iii) State one major commercial use of the organic product from this type of reaction.
5. (a) (i) The plastic PVC, poly(chloroethene), is made from the monomer, chloroethene, C_2H_3Cl, by a polymerization reaction. Draw the structural formula of chloroethene. State the type of polymerization reaction that occurs to make poly(chloroethene) and identify the structural feature needed in the monomer.
   (ii) Draw the structure of the repeating unit of poly(chloroethene).
   (b) (i) Hexandioic acid and 1,6-diaminohexane react together to form a synthetic polymer. Give the structural formula of each monomer in the synthetic polymer. State the type of polymerization reaction that occurs between these two monomers and identify the structural feature needed in the polymer.
   (iii) Draw the structure of and state the type of linkage formed in this polymer, and identify the other product of this polymerization reaction.
6. Polyesters are formed in a similar reaction to proteins. Their monomers are esters. State one use of esters and identify the two compounds that can react together to form the ester ethylmethanoate.