Review Booklet
Atomic Theory

- Understand frequency, wavelength, and energy.
  - Electromagnetic spectrum
  - ROY G BIV
- Write electron configurations.
  - s^2, p^6, d^{10}, f^{14}
- Understand periodic trends including atomic radii, ionic radii, ionization energy (first, second, third), and electronegativity.

1. When an electron in an atom gains energy, the electron
   a) moves to higher energy levels
   b) falls to lower energy levels
   c) is gained by the neutral atom
   d) is shared in covalent bonds

2. Which of the following has the largest atomic radius?

a) Li b) Na c) Mg d) Al e) F

3. How many "d" electrons in total are there in an atom of Rb?

a) 0 b) 1 c) 6 d) 10 e) 37

4. For each configuration of electrons give the neutral element that corresponds with it.

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^7$ Co
$1s^2 2s^2 2p^6 3s^2 3p^3$ P

5. Write full electron configurations for….
   Na $1s^2 2s^2 2p^6 3s^1$
   S $1s^2 2s^2 2p^6 3s^2 3p^4$
   Copper $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^9$
   Fe^{3+} $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$

Review Booklet – Kinetics

- Factors affecting reaction rates.
- Rate stoichiometry.
- Understand the collision theory including activation complex and activation energy.
- Writing rate laws.
  - Calculate rate constants.
  - Determine orders of reactions.
- Read and draw potential energy diagrams.
- Interpret reaction mechanisms and rate determining steps.

Equations to know:

Average Rate = $\Delta[\ ]/\ \Delta t$

General Rate law – Rate = $k[A]^x[B]^y[C]^z$

6. Define each of the following terms (in 2 sentences or less each)

a) activation energy – the energy required for reactant molecules to be converted to products.

b) activated complex – a molecular structure at the top of the P.E. graph

c) catalyst – A substance that speeds up a reaction by lowering the E_A.

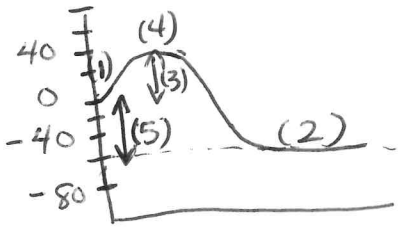
d) effective collision – A collision of molecules that results in a successful bonding.

e) reaction mechanism – A sequence of reactions by which an overall reaction may occur.

7. For a reaction ΔH = - 60 kcal, E_a (forward) = 30 kcal and P.E. (reactants) = 0 kcal.

(a) Draw the potential energy curve for the reaction. Be sure to label the axes.
(b) Calculate E_a (reverse) and P.E. (products)
(c) Label the parts of the curve representing (1) the reactants, (2) the products, (3) the activation energy of the forward reaction, (4) the activated complex and (5) ΔH

b) E_A (reverse) = 90kcal P.E. (products) = 60kcal



8) When a catalyst is added to a reaction

I.	the heat of reaction increases
II.	a new mechanism is provided
III.	the equilibrium constant increases

A.) II and I only
B.) II only
C.) I and II only
D.) I, II and III

9.) Consider this reaction mechanism. The catalyst is

Step 1	$ClO^- + H_2O \rightarrow HClO + OH^-$
Step 2	$I^- + HClO \rightarrow HIO + Cl^-$
Step 3	$HIO + OH^- \rightarrow IO^- + H_2O$

A.) IO^-
B.) ClOH
C.) ClO^-
D.) H_2O

10.) A substance that increases the rate of a chemical reaction and may be recovered unchanged at the end of the reaction is a(n)

A.) product.
B.) catalyst.
C.) activated complex.
D.) reaction intermediate.

11.) Which of the following changes will increase the average kinetic energy of reactant molecules?

A.) increasing the surface area
B.) adding a catalyst
C.) increasing the temperature
D.) increasing the concentration

12.) Which of the following is true for an activated complex?

A.) unstable and has low PE
B.) unstable and has high PE
C.) stable and has high PE

13.) Increasing the temperature of a reaction increases the reaction rate by

I.	increasing frequency of collisions
II.	increasing the kinetic energy of collision
III.	decreasing the potential energy of collision

A.) I only.
B.) I and II only.
C.) II and III only.
D.) I, II and III.

14.) Which of the changes occur when the temperature of a reaction is increased?

I.	ΔH of the reaction increases
II.	Frequency of the collisions increases
III.	Kinetic energy of the reactants increases

A.) I, II, and III.
B.) II and III only.
C.) I and III only.
D.) I and II only.

15.) Consider the following mechanism for a reaction:
Which of the following statements is correct?

Step 1	$HBr + O_2 \rightarrow HOOBr$
Step 2	$HBr + HOOBr \rightarrow 2HOBr$
Step 3	$2HBr + 2HOBr \rightarrow 2H_2O + 2Br_2$

A.) HOBr is a catalyst.
B.) Br_2 is a reactant.
C.) HOOBr is a reaction intermediate.
D.) HBr is a product.

16.) A catalyst changes the rate of a reaction by

A.) decreasing the energy of the products.

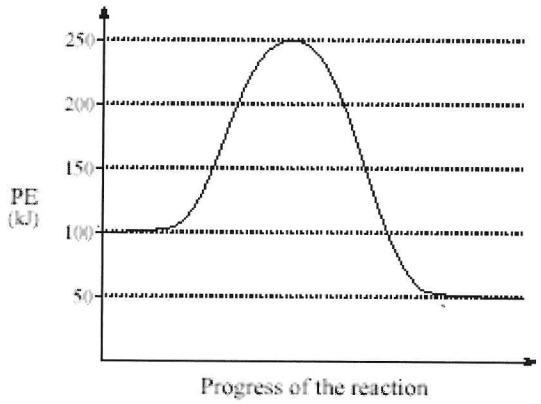
B.) increasing the temperature.

C.) changing the

D.) providing an alternate reaction mechanism.

(you just need to know that it decreases the E_A on the exam)

17.) Consider this PE diagram. Which of the following describes the forward reaction? {delta H (kJ); Activation Energy (kJ)}



A.) -50; 150

B.) -50; 200

C.) +50; 150

D.) +50; 250

One more Kinetics Question.....

Consider the all gas-phase reaction at 800 °C: $CO + H_2 \Longrightarrow 2\,H_2CO$

The following kinetic data was collected:

Exp't #	[CO] mol/L	$[H_2]$ mol/L	Initial Rate of Rxn (mol/L)/s
1	0.001	0.004	0.002 ×4
2	0.002	0.004	0.008
3	0.003	0.004	0.018
4	0.004	0.001	0.008 ×2
5	0.004	0.002	0.016
6	0.004	0.003	0.024

a) What is the rate law expression for this reaction? Also calculate k.

$$\text{Rate} = k[CO]^2[H_2]$$

$$\text{Rate} = k[CO]^2[H_2]$$

$$(0.002) = k(0.001)^2(0.004)$$

$$\frac{0.002\,M}{(0.001\,M)^2(0.004\,M)} = k$$

$$k = 5.0\times10^5\ M.$$

Review Booklet – Equilibrium

- Conditions of equilibrium.
- Writing equilibrium expressions.
- Calculating concentrations using ICE boxes.
- Calculating Keq using ICE boxes.
- Applying Le Chatelier's Principle and predicting the effects of a stress.

Equations to know:

Keq = [products]/[reactants] – raised to the power of their exponents

Given:

Solubility Table

1. Write the K_{eq} expression for each of the following equilibrium systems:

a) $SrCO_3$ (s) <=> SrO (s) + CO_2 (g) $K_{eq} = [CO_2]$

b) 2 Cu^+ (aq) + CO_3^{2-} (aq) <=> Cu_2CO_3 (s) $K_{eq} = \frac{1}{[Cu^+]^2[CO_3^{2-}]}$

c) H_2O (g) + F_2 (s) <=> 2 HF (g) + O (g) $K_{eq} = \frac{[O][HF]^2}{[H_2O]}$

2. At 900 kelvin, consider the all gas-phase reaction

2 A + B <=> 3 C + D

Initially, 0.60 M A and 0.60 M B are mixed together. (No C or D is present). When equilibrium is eventually reached, the equilibrium concentration of D is found to be 0.10 M. Calculate K_{eq} .

	2A	+ B	<=> 3C	+ D
I	0.6	0.6	0	0
C	-0.2	-0.1	0.3	0.1
E	0.4	0.5	0.30	0.10

$K_{eq} = \frac{[C]^3[D]}{[A]^2[B]}$

$= \frac{(.3)^3(0.1)}{(.4)^2(.5)}$

$= 0.028$

3. At 1200 °C, consider the all gas-phase exothermic reaction sitting at equilibrium in a **five litre** flask:

$CH_4 + 2\ H_2O \iff CO_2 + 4\ H_2$

Now. let us disturb the equilbrium. Answer each question with either "increase", "decrease" or "not change".

DISTURBANCE	The concentration of H_2 will ...
e.g add a catalyst	not change
(i) add some CH_4	increase ↑
(ii) remove some CO_2	↓
(iii) remove some H_2O	↓
(iv) raise the temperature to 1600 °C	↓
(v) transfer the mixture to a **22 L** flask	↑

4. A student places 6 moles of hydrogen gas and 6 moles of iodine gas into a 1 L flask and the system is allowed to go to equilibrium at 100°C. If K_{eq} is 52, what is the equilibrium concentration of the gaseous product?

Solubility Review Booklet

- Write Ksp equations.
- Calculate Ksp
- Calculate solubility in mol/L
- Calculate solubility in g/L
- Precipitates

1. At 20 °C, the solubility of potassium chlorate in water is 7.4 g $KClO_3$ / 100 g of H_2O. How many grams of $KClO_3$ must be dissolved in 0.5 kg of H_2O to make a saturated solution at 20 °C ?

A. 3.7 B. 0.3 C. 14.8 D. 37.0 E. 1.5

2. At 27 °C, Ksp(AgCl) = 1.9×10^{-10}. What is the molar concentration of Ag+ (aq) in a one litre saturated water solution of silver chloride at this temperature?

A. 0.44×10^{-5} B. 0.95×10^{-5} C. 1.38×10^{-5} D. 0.95×10^{-10} E. 3.81×10^{-10}

3. The K_{sp} for CdS is 3.6×10^{-29} at 18 °C. The concentration of cadmium ion in a saturated solution of CdS at this temperature, in moles per liter, is

A. 3.6×10^{-29} B. 1.4×10^{-5} C. 1.4×10^{-6}

D. 6.0×10^{-15} E. 6.0×10^{-14}

$K_{sp} = x^2$

$\sqrt{3.6 \times 10^{-29}} = \sqrt{x^2}$

$6.0 \times 10^{-15} = x$

5. The solubility of PbF_2 is 0.49 g / L of H_2O at 18 °C. What is the K_{sp} for lead fluoride at this temperature? 0.002 Mol/L 1:1:2 ratio $K_{sp} = 4x^3$

A. 0.002 B. 4.0×10^{-6} C. 8.0×10^{-6} D. 7.4×10^{-7} E. 3.2×10^{-8}

$= 4(0.002)^3$

$= 3.2 \times 10^{-8}$

6. A saturated solution of barium sulfate at 28 °C contains 3.9×10^{-5} M Ba^{2+} ions. What is K_{sp} of this salt at this temperature? $Ba^{2+} + SO_4^{2-} \rightleftharpoons BaSO_4$ 1:1:1 ratio

A. 3.9×10^{-5} B. 3.9×10^{-6} C. 2.1×10^{-7} D. 1.5×10^{-8} E. 1.5×10^{-9}

$K_{sp} = [Ba^{2+}][SO_4^{2-}]$

$= x \cdot x$

$= (3.9 \times 10^{-5})^2$

$= 1.52 \times 10^{-9}$

7. Given the reaction below:
   a. Complete and balance the following reactions.
   b. Indicate which products are soluble and which will form a precipitate.
   c. Write the Ksp equation for the **precipitate**.
   d. Calculate solubility given the literature value of Ksp at 25°C.

$2AgNO_{3\,(aq)} + FeCl_{2\,(aq)} \rightarrow 2AgCl_{(s)} + Fe(NO_3)_{2\,(aq)}$

$K_{sp} = [Ag^+][Cl^-]$

$\sqrt{1.8 \times 10^{-10}} = x^2$

$1.34 \times 10^{-5} = x$

Redox Review Booklet

- Know how to calculate and manipulate oxidation numbers
- OIL RIG
- Oxidizing and reducing agents
- Balancing half and full reactions
    - In acidic conditions only
- Calculate Reduction Potential
- Know how to understand a Galvanic cell and understand which is the cathode and anode.

1.) Manganese has an oxidation number of +4 in

A.) Mn_2O_7

B.) MnO_2

C.) MnO

D.) Mn_2O_3

2.) Chlorine has an oxidation number of +5 in

A.) $NaClO_2$

B.) $NaClO_4$

C.) NaClO

D.) $NaClO_3$

3.) Which of the following represents a redox reaction?

A.) $CaCO_3 \rightarrow CaO + CO_2$

B.) $SiCl_4 + 2Mg \rightarrow Si + 2MgCl_2$

C.) $2NaOH + H_2SO_4 \rightarrow 2H_2O + Na_2SO_4$

D.) $AgBr + 2S_2O_3^{2-} \rightarrow Ag(S_2O_3)_2^{3-} + Br^-$

4.) Which of the following will reduce Fe^{2+} ?

A.) $Zn_{(s)}$

B.) $Br_{2(s)}$

C.) $I_{2(s)}$

D.) $Ni_{(s)}$

I

5.) In a reaction, the oxidation number of Cr decreases by 3. This indicates that Cr is

A.) neutralized.

B.) oxidized.

C.) reduced.

D.) a reducing agent.

6.) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

The substance undergoing reduction is

A.) O_2

B.) CO_2

C.) H_2O

D.) $C_6H_{12}O_6$

7.) A substance that is reduced during a redox reaction

A.) is the reducing agent.

B.) is the oxidizing agent.

C.) is the anode.

D.) loses mass.

8.) Which of the following is **not** a redox reaction?

A.) $CuS + 2O_2 + C \rightarrow Cu + SO_2 + CO_2$

B.) $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$

C.) $2Mg + O_2 \rightarrow 2MgO$

D.) $4Ag + 2H_2S + O_2 \rightarrow 2Ag_2S + 2H_2O$

9. Which of the following statements is INCORRECT ?

A. oxidation is the loss of electrons

B. reduction is the gain of electrons

C. when an element is reduced, its oxidation number decreases

D. when an element acts as a reducing agent, it loses electrons

Acids & Bases

- Definitions of acids and bases.
- Bronsted-Lowry and conjugate acid base pairs.
- Dissociation of acids and bases.
- Kw
- Using Ka & Kb to determine acid and base strength.
- Writing Ka & Kb expressions.
- Calculate Ka and Kb given ICE box.
- Calculate equilibrium concentrations from ICE box..
- Calculate [[H+], [H3O+], pH, pOH, [OH-} and % dissociation.
- Neutralization and titration.

Equations to know:

$pH = -\log[H_3O^+]$
$pOH = -\log[OH^-]$
$[H3O+] = 10^{-pH}$
$[OH-] = 10^{-pOH}$
$pH + pOH = 14$
$Kw = [H_3O^+][OH^-]$
% dissociation = $\Delta HA/[HA]_I$
M = moles/L
~~$[\ ]_A V_A = [\ ]_B V_B$~~

Given:

$K_w = 1.0 \times 10^{-14}$
A list of common acids and bases and their relative Ka's.

1. If the pH of a grapefruit is 3.3, what is the $[H_3O^+]$, [OH-], and pOH?

$[H_3O^+] = 5.01 \times 10^{-4}$ $[OH^-] = 1.996 \times 10^{-11}$ pOH = 10.7

2. What is the pH and [H+] of a 0.0020 M NaOH solution?

$[OH^-] = 0.002$
$[H^+] = 5.0 \times 10^{-12}$ pH = 11.3

3. Calculate the pH of a 0.1 M HCl solution given Ka=1.6×10^{-5}

omit

4. The pH of a solution of HCl is 2.1. Calculate the Ka.

$K_a = 6.24 \times 10^{-5}$

5. How many moles of NaOH are needed to neutralize 2 mol HCl?

2mol

6. If 45 ml of 0.64M HCl is needed to neutralize 60.0 ml of KOH. Calculate the concentration of KOH.

0.48M

7. A volume of 145 ml of 0.6M HCl neutralizes a 100ml sample of $Ca(OH)_2$ solution. What is the concentration of $Ca(OH)_2$?

0.435M