Name: ____________________

# AP Chemistry Big Idea Review

## Background

The AP Chemistry curriculum is based on 6 Big Ideas and many Learning Objectives associated with each Big Idea. This review will cover all of the Big Ideas and Learning Objectives (LO).

## Directions

Working as directed by your teacher, complete all of the questions in the packet. Be sure to write out your thinking and justifications for all of your answers to the questions in the packet. For all multiple choice questions, describe why the correct answer is correct and why the other answers are not correct. For the calculations, show all work and label all units.

When you are finished with the packet, identify which Big Ideas and Learning Objectives are your strengths and which are your weaknesses. This will help you focus your studies for the remainder of your review time before the exam. Good Luck.

## Big Idea 3: Chemical Reactions

Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.

*When all else fails*, remember that boys dance with girls in chemical reactions. Many chemical reactions (not all) come down to the exchange of cations and anions. If you cannot figure out a reaction, try determine who the boys and girls are in the reaction and try to remember who likes to hook up. Think about forming water, precipitates, or production of a gas.

**LO 3.1** Students can translate among macroscopic observations of change, chemical equations, and particle views.

Example:

A strong acid, HCl, is titrated with a strong base, NaOH. Write the net ionic equation for the reaction. Do not include spectator ions in the equation.

**LO 3.2** The student can translate an observed chemical change into a balanced chemical equation and justify the choice of equation type (molecular, ionic, or net ionic) in terms of utility for the given circumstances.

Example:

A solution contains silver ions ($Ag^+$). You have to get them out.

a) Identify a chemical that would work to add to the solution to remove the silver ions. _________
b) Write the appropriate equation for the reaction to remove the silver ions.
c) Describe why it does not matter what the counter ions are for the reactions you listed above.

**LO 3.3** The student is able to use stoichiometric calculations to predict the results of performing a reaction in the laboratory and/or to analyze deviations from the expected results.

Example:

When a 2.50 g sample of an unknown hydrate of copper sulfate, $CuSO_4 \cdot x\,H_2O$ (s) , is heated, water (molar mass 18) is driven off. The mass of the anhydrous $CuSO_4$(s) (molar mass 160 g) that remains is 1.60 g. The value of x in the hydrate is

a) 0.90 b) 1.8 c) 5.0 d) 6.0

**LO 3.4** The student is able to relate quantities (measured mass of substances, volumes of solutions, or volumes and pressures of gases) to identify stoichiometric relationships for a reaction, including situations involving limiting reactants and situations in which the reaction has not gone to completion.
Example:

$$2\ MnO_4^-\ (aq)\ +\ 5\ C_2O_4^{2-}\ (aq)\ +\ 16\ H^+\ (aq) \rightarrow 2\ Mn^{2+}\ (aq)\ +\ 10\ CO_2\ (g)\ +\ 8\ H_2O(l)$$

Permanganate and oxalate ions react in an acidified solution according to the balanced equation above. How many moles $Mn^{2+}$(g) are produced when 40. mL of acidified 0.20 M $KMnO_4$ solution are added to 100. mL of 0.10 M $Na_2C_2O_4$?

a) 0.0020 mol b) 0.0040 mol c) 0.010 mol d) 0.020 mol

**LO 3.5** The student is able to design a plan in order to collect data on the synthesis or decomposition of a compound to confirm the conservation of matter and the law of definite proportions.
Example:

A sample of iron is heated in oxygen to produce a product. Design an experiment to quantitatively determine whether the product is iron(II) oxide or iron(III) oxide.

**LO 3.6** The student is able to use data from synthesis or decomposition of a compound to confirm the conservation of matter and the law of definite proportions.
Example:

A compound consists of the following elements by weight percent:

carbon - 40.0% oxygen - 53.3% hydrogen - 6.7%

The ratio of carbon : oxygen : hydrogen in the empirical formula is

a) 1:2:1 c) 1:1:2
b) 1:1:1 d) 2:1:2

Water is added to 4.267 grams of $UF_6$. The only products are 3.730 grams of a solid containing only uranium, oxygen and fluorine and 0.970 gram of a gas. The gas is 95.0% fluorine, and the remainder is hydrogen.

(a) From these data, determine the empirical formula of the gas.

**LO 3.7** The student is able to identify compounds as Bronsted-Lowry acids, bases, and/or conjugate acid-base pairs, using proton-transfer reactions to justify the identification.
Example:
Designate the Bronsted-Lowry acid and base on the left side of each equation and the conjugate acid and base on the right side:

a) $NH_4^+\ (aq) + CN^-\ (aq) \Leftrightarrow HCN\ (aq) + NH_3\ (aq)$

b) $(CH_3)_3N\ (aq) + H_2O\ (l) \Leftrightarrow (CH_3)_3NH^+\ (aq) + OH^-\ (aq)$

c) $HCOOH\ (aq) + PO_4^{3-}\ (aq) \Leftrightarrow HCOO^-\ (aq) + HPO_4^{2-}\ (aq)$

**LO 3.8** The student is able to identify redox reactions and justify the identification in terms of electron transfer.
Example:

Given the following reactions, circle the reactions that are redox reactions:

a) $H^+(aq) + OH^-(aq)$ ➔ $H_2O(l)$
b) $Zn(s) + 2\ H^+(aq)$ ➔ $Zn^{2+}(aq) + H_2(g)$
c) $Ba^{2+}(aq) + S^-(aq)$ ➔ $BaS(s)$
d) $2\ H_2O_2(aq)$ ➔ $2\ H_2O(l) + O_2(g)$

**LO 3.9** The student is able to design and/or interpret the results of an experiment involving a redox titration.
Example:

$2\ MnO_4^{1-} + 16\ H^+ + 5\ C_2O_4^{2-} \rightarrow 10\ CO_2(g) + 2\ Mn^{2+}(aq) + 8\ H_2O(l)$

In a titration experiment, $C_2O_4^{2-}$ reacts $MnO_4^-$ with as represented by the equation above. The dark purple $KMnO_4$ solution is added from a buret to an acidified colorless solution in an Erlenmeyer flask.
At some point in the experiment, the rate of appearance of $Mn^{2+}$ ions was $1.0 \times 10^{-4}$M/s. What was the rate of disappearance of $C_2O_4^{2-}$?

a) $4.0 \times 10^{-4}$M/s b) $4.0 \times 10^{-5}$M/s c) $2.5 \times 10^{-4}$M/s d) $2.5 \times 10^{-5}$M/s

**LO 3.10** The student is able to evaluate the classification of a process as a physical change, chemical change, or ambiguous change based on both macroscopic observations and the distinction between rearrangement of covalent interactions and noncovalent interactions.
Example:

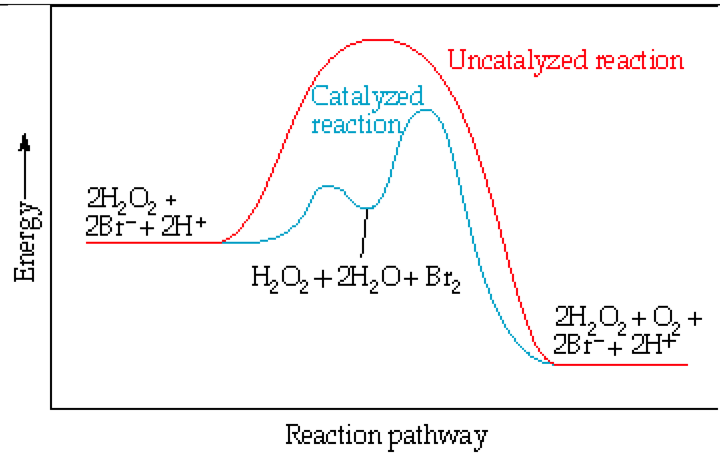
Which of the following is a chemical change?

a) Boiling water
b) Hydrogen peroxide decomposing into oxygen and water
c) Tearing paper
d) Melting wax

**LO 3.11** The student is able to interpret observations regarding macroscopic energy changes associated with a reaction or process to generate a relevant symbolic and/or graphical representation of the energy changes. Example:

The reaction profile on the right is for the decomposition of hydrogen peroxide. What is the reason that the catalyzed reaction (the blue line that follows the lower path) is faster than the uncatalyzed reaction (the red line that follows the upper path)?

a) The catalyzed reaction has more components to it, which makes it faster
b) The catalyzed reaction has two peaks, which makes it faster
c) The catalyzed reaction has a lower activation energy, which makes it faster
d) The catalyzed reaction has a higher activation energy, which makes it faster




**LO 3.12** The student can make qualitative or quantitative predictions about galvanic or electrolytic reactions based on half-cell reactions and potentials and/or Faraday's laws.

A student hypothesizes that placing a gold ring in a 1.0 M solution of $Rh(NO_3)_3$(aq) will result in a reaction in which Rh metal is deposited on the white gold ring. Based on the information in the table below, calculate the $E^0$ for the reactions that may occur between ions in solution and atoms in the ring, and indicate whether or not the student's hypothesis is correct.

| Half-Reaction | $E°$ (V) |
|---|---|
| $Au^{3+}(aq) + 3e^- \rightarrow Au(s)$ | 1.50 |
| $Pd^{2+}(aq) + 2e^- \rightarrow Pd(s)$ | 0.92 |
| $Rh^{3+}(aq) + 3e^- \rightarrow Rh(s)$ | 0.76 |

**LO 3.13** The student can analyze data regarding galvanic or electrolytic cells to identify properties of the underlying redox reactions.

Based off the $E^0_{red}$ table from the previous question, which of those elements, Au, Pd, or Rh is most easily oxidized? Describe how you know.