Writing formulas and names of compounds practice

Remember: First identify if the compound is molecular or ionic. Then use the appropriate rules to name it.

Name the following compounds:

1. HCl _____
2. $CuNO_2$ _____
3. HgOH _____
4. KCl _____
5. $FeCl_3$ _____
6. HNO_3 _____
7. NH_4OH _____
8. Cu_2O _____
9. $Al_2(SO_4)_3$ _____
10. N_2O_5 _____
11. AgOH _____
12. CO_2 _____

Write the correct formula for the following compounds:

1. dihydrogen monosulfide _____
2. sodium hydroxide _____
3. cobalt(III) bromide _____
4. barium hydroxide _____
5. tin(IV) oxide _____
6. magnesium oxalate _____
7. lithium sulfate _____
8. carbon monoxide _____
9. magnesium oxide _____
10. sulfur dioxide _____
11. iron(III) sulfate _____
12. chromium(I) nitrite _____

AP Topic 4.7: Types of Chemical Reactions (44 questions/3.6%)

What's in this topic:

Enduring Understanding

A substance can change into another substance through different processes, and the change itself can be classified by the sort of processes that produced it.

Learning Objective

Identify a reaction as acid-base, oxidation-reduction, or precipitation.

Essential Knowledge

- Acid-base reactions involve transfer of one or more protons between chemical species.
- Oxidation-reduction reactions involve transfer of one or more electrons between chemical species, as indicated by changes in oxidation numbers of the involved species. Combustion is an important subclass of oxidation-reduction reactions, in which a species reacts with oxygen gas. In the case of hydrocarbons, carbon dioxide and water are products of complete combustion.
- In a redox reaction, electrons are transferred from the species that is oxidized to the species that is reduced.
- Oxidation numbers may be assigned to each of the atoms in the reactants and products; this is often an effective way to identify the oxidized and reduced species in a redox reaction.
- Precipitation reactions frequently involve mixing ions in aqueous solution to produce an insoluble or sparingly soluble ionic compound. All sodium, potassium, ammonium, and nitrate salts are soluble in water.

Review Materials:

- Fuller's Review Video: Types of Chemical Reactions (13:40)
- Fuller's PowerPoint Notes: 1) Chemical Reactions and Equations; 2) Double Replacement Reactions; 3) Redox Reactions 4) Acids and Bases Introduction
- College Board Review Video: 4.7 Daily Video (9:40)
- Bozeman Science Video: 1) Synthesis and Decomposition Reactions (4:15); 2) Neutralization (Acid-Base) Reactions (6:03); 3) Redox Reactions (11:41)
- Khan Academy Review Videos: 1) Redox Reactions (4 videos); 2) Intro to Acid-Base Reactions (2 videos)
- Fiveable Review: Types of Chemical Reactions (6 min read)
- "I Do, We Do, You Do" Practice: Types of Chemical Reactions

"The Basics" Review Questions

Acid and Base Reactions.

1. Define an acid (both definitions).

2. Define a base (both definitions).

3. Define amphoteric.

4. What is an acid-base conjugate pair? How do you identify an acid-base conjugate pair?

5. Identify the acid, base, conjugate acid, and conjugate base in the following reactions:

$HCl\ (aq)$	+	$H_2O(l)$	$\rightarrow$	$H_3O^+(aq)$	+	$Cl^-(aq)$
$NH_3\ (aq)$	+	$H_2O(l)$	$\rightleftharpoons$	$NH_4^+(aq)$	+	$OH^-(aq)$
$CH_3NH^-\ (aq)$	+	$HCl(l)$	$\rightarrow$	$CH_3NH_2(aq)$	+	$Cl^-(aq)$

6. What is a sign that the acid/base is stronger than the conjugate acid/conjugate base in a chemical reaction?

7. If the acid/base is stronger than the conjugate acid/conjugate base, to which direction does the reaction mostly proceed?

8. What is a sign that the acid/base is weaker than the conjugate acid/conjugate base in a chemical reaction?

9. If the conjugate acid/conjugate base is stronger than the acid/base, to which direction does the reaction mostly proceed?

10. What is a neutralization reaction? What are the products of a neutralization reaction?

11. What is the net-ionic reaction for any strong acid/strong base reaction?

12. What are the signs that a chemical reaction is an acid-base reaction?

13. Write neutralization reactions for the following reactions. Then give the net-ionic equation. Finally, identify the acid, base, salt, and water. Note: NH_3 is a weak base and $HC_2H_3O_2$ is a weak acid. Since they are weak they do not break up completely and some molecules are left in solution (use an equilibrium arrow!)
    a. $HCl + NaOH \rightarrow$
    b. $H_2SO_4 + NaOH \rightarrow$
    c. $NH_3 + HCl \rightarrow$
    d. $HC_2H_3O_2 + NaOH \rightarrow$

Reduction and Oxidation (Redox) Reactions.

1. Define oxidation.

2. Define reduction.

3. How can you identify that a substance has been oxidized?

4. How can you identify that a substance has been reduced?

5. How can you identify a reduction-oxidation reaction?

6. Where are the electrons located in a balanced oxidation half-reaction? A reduction half-reaction?

7. What are the rules for applying oxidation numbers?

8. Determine the oxidation number of the atom listed below.
    a. C in CO_2
    b. S in S^{2-}
    c. S in $S_{(s)}$
    d. S in SO_4^{2-}
    e. S in SO_3^{2-}
    f. Mn in MnO_4^-

9. For the following reactions,
    1. Balance the equation.
    2. Write a net-ionic equation.
    3. Determine the oxidation states of all species in the net-ionic equation.
    4. Determine if the reaction is a redox reaction.
        (A) If the reaction is not a redox reaction then write **NONE**.
        (B) If the reaction is a redox reaction determine what is being oxidized and what is being reduced

    a. _____$Zn_{(s)}$ + _____$HCl_{(aq)} \rightarrow$ _____$ZnCl_{2(aq)}$ + _____$H_{2(g)}$
    b. _____$Co(NO_3)_{2(aq)}$ + _____$Na_2HPO_{4(aq)} \rightarrow$ _____$CoHPO_{4(s)}$ + _____$NaNO_{3(aq)}$
    c. _____$CH_{4(g)}$ + _____$O_{2(g)} \rightarrow$ _____$H_2O_{(l)}$ + _____$CO_{2(g)}$
    d. _____$H_2SO_{4(aq)}$ + _____$Ca(OH)_{2(aq)} \rightarrow$ _____$CaSO_{4(s)}$ + _____$H_2O_{(l)}$

Precipitation Reactions

1. For the reactions below:
    1. Complete the reaction.
    2. Determine if a precipitate or gas forms. Include phase symbols.
    3. If a precipitate or gas forms write a net-ionic reaction.
    a. $NaCl_{(aq)} + NH_4NO_{3(aq)} \rightarrow$
    b. $Na_3PO_{4(aq)} + Ba(NO_3)_{2(aq)} \rightarrow$
    c. $K_2S_{(aq)} + (NH_4)_2CO_{3(aq)} \rightarrow$
    d. $HCl_{(aq)} + NaHCO_{3(aq)} \rightarrow$

AP Topic 1.1: Moles and Molar Mass (39 questions/2.7%)

What's in this topic:

Enduring Understanding

The mole allows different units to be compared.

Learning Objective

Calculate quantities of a substance or its relative number of particles using dimensional analysis and the mole concept.

Essential Knowledge

- One cannot count particles directly while performing laboratory work. Thus, there must be a connection between the masses of substances reacting and the actual number of particles undergoing chemical changes.
- Avogadro's number ($N_A = 6.022 \times 10^{23}$ mol^{-1}) provides the connection between the number of moles in a pure sample of a substance and the number of constituent particles (or formula units) of that substance.
- Expressing the mass of an individual atom or molecule in atomic mass units (amu) is useful because the average mass in amu of one particle (atom or molecule) or formula unit of a substance will always be numerically equal to the molar mass of that substance in grams. Thus, there is a quantitative connection between the mass of a substance and the number of particles that the substance contains
- EQN: n = m/M

Review Materials:

- Fuller's Review Video: Moles and Molar Mass (12:25)
- Fuller's PowerPoint Notes: 1) Moles; 2) Molar Mass and Molar Conversions
- College Board Review Videos: 1.1 Daily Video 1 (7:23) and 1.1 Daily Video 2 (4:46)
- Bozeman Science Video: The Mole (7:02)
- Khan Academy Review Videos: Moles and Molar Mass (3 videos)
- Fiveable Review Video: Moles and Molar Mass (54:24)
- "I Do, We Do, You Do" Practice: None

"The Basics" Review Questions

1. Convert the following from either grams to moles or from moles to grams.
   a. How many grams are in 1.200 moles of hydrogen cyanide, HCN?
   b. Determine the number of moles in 3.55 grams of selenium hexafluoride, SeF_6.
   c. How many grams would be in 0.75 moles of ammonium sulfate, $(NH_4)_2SO_4$?
   d. Determine the number of grams in 2.04 moles of antimony pentafluoride, SbF_5.
   e. How many moles are in 175 grams of $NH_4[Cr(SCN)_4(NH_3)_2]$?
   f. Determine the number of moles in 1.45×10^{-3} grams of potassium dichromate, $K_2Cr_2O_7$.

2. Calculate the number of atoms in 5.00 g of …
   a. Ca b. N_2 c. Ne

3. Perform the following calculations.
   a. How many grams of Cu are in 0.010 moles of $CuSO_4$
   b. How many moles are in 1.80 grams of $C_6H_{12}O_6$ (MM = 180 g/mol)
   c. What is the percent composition of Ca in CaF_2?

4. The minimum energy needed to break an oxygen-oxygen bond in ozone is 387 kJ mol^{-1}. Determine the amount of energy needed to break 1 oxygen-oxygen bond in ozone.

5. Hydrogen peroxide (H_2O_2) decomposes to water and oxygen, as shown below.

$$2\ H_2O_2(aq) \rightarrow 2\ H_2O(g) + O_2(g)$$

A small sample of MnO_2 is placed into a beaker of H_2O_2 while it is placed on a balance. The mass is measured over a period of 10 seconds and the data shown to the right

Time (sec)	Mass (g)
0	134.45
1	134.20
2	133.95
3	133.70
4	133.45
5	133.20
6	132.95
7	132.70
8	132.45
9	132.20
10	131.95

   a. Explain why the beaker lost mass.
   b. Determine the moles of oxygen created in the reaction.

6. Perform the following calculations.
   a. How many molecules are in 1.8 g of H_2O?
   b. How many molecules are in 3.8 g of C_6H_6?
   c. Determine the number of oxygen atoms in 1.00 g of $CaCO_3$

7. You have a 2.00 g sample of compounds X, Y, and Z. The molar mass (in g mol^{-1}) of X is 50, Y is 35, and Z is 90. Arrange the compounds from smallest number of moles present to largest number of moles present.

8. Four different metal oxides each have one oxygen. The number of metal atoms in each compound may vary.
   a. Does the percent of oxygen in the compound increase, decrease, or remain the same as the molar mass of the compound increases?
   b. Would a compound with a high percent of oxygen produce more or less oxygen than a compound with a low percent of oxygen?

AP Topic 4.5: Stoichiometry (84 questions/6.8%)

What's in this topic:

Enduring Understanding

When a substance changes into a new substance, or when its properties change, no mass is lost or gained.

Learning Objective

Explain changes in the amounts of reactants and products based on the balanced reaction equation for a chemical process.

Essential Knowledge

- Because atoms must be conserved during a chemical process, it is possible to calculate product amounts by using known reactant amounts, or to calculate reactant amounts given known product amounts.
- Coefficients of balanced chemical equations contain information regarding the proportionality of the amounts of substances involved in the reaction. These values can be used in chemical calculations involving the mole concept.
- Stoichiometric calculations can be combined with the ideal gas law and calculations involving molarity to quantitatively study gases and solutions.

Review Materials:

- Fuller's Review Video: Stoichiometry (8:57)
- Fuller's PowerPoint Notes: 1) Intro to Stoichiometry; 2) Limiting Reactant
- College Board AP Daily Review Videos: 4.5 Daily Video 1 (7:39), 4.5 Daily Video 2 (6:11), and 4.5 Daily Video 3 (8:25)
- Bozeman Science Video: Stoichiometry (9:46)
- Khan Academy Review Videos: Stoichiometry (3 videos)
- Fiveable Review: Stoichiometry (5 min read)
- "I Do, We Do, You Do" Practice: Stoichiometry

"The Basics" Review Questions

1. According to the balanced equation below, how many moles of HI would be necessary to produce 2.5 mol of I_2, starting with 4.0 mol of $KMnO_4$ and 3.0 mol of H_2SO_4?

$$10\ HI + 2\ KMnO_4 + 3\ H_2SO_4 \longrightarrow 5\ I_2 + 2\ MnSO_4 + K_2SO_4 + 8\ H_2O$$

2. According to the reaction represented below, how many grams of aluminum (atomic mass 27 g) are necessary to produce 0.50 mol of hydrogen gas at 25 °C and 1.00 atm?

$$2\ Al_{(s)} + 6\ HCl_{(aq)} \longrightarrow 2\ AlCl_{3(aq)} + 3\ H_{2(g)}$$

3. According to the balanced equation below, how many moles of $ClO_2^-{}_{(aq)}$ are needed to react completely with 20. mL of 0.20 M $KMnO_4$ solution?

$$2\ H_2O(l) + 4\ MnO_4^-(aq) + 3\ ClO_2^-{}_{(aq)} \longrightarrow 4\ MnO_{2(s)} + 3\ ClO_4^-{}_{(aq)} + 4\ OH^-{}_{(aq)}$$

$$2\ KClO_{3(s)} \xrightarrow{\Delta,\ MnO_2} 2\ KCl_{(s)} + 3\ O_{2(g)}$$ (note: the Δ means heat is added and MnO_2 is a catalyst)

4. According to the equation above, how many moles of potassium chlorate, $KClO_3$, must be decomposed to generate 1.0 L of O_2 gas at standard temperature and pressure? (This multiple choice gives you an idea of the types of answers that show up from time to time on the AP exam.)

A $\frac{1}{3}\left(\frac{1}{22.4}\right)$ mol

B $\frac{1}{2}\left(\frac{1}{22.4}\right)$ mol

C $\frac{2}{3}\left(\frac{1}{22.4}\right)$ mol

D $\frac{3}{2}\left(\frac{1}{22.4}\right)$ mol

E $2\left(\frac{1}{22.4}\right)$ mol

5. Acetic acid and sodium bicarbonate are reacted and the gas collected.

$$HC_2H_3O_{2(aq)} + NaHCO_{3(s)} \longrightarrow NaC_2H_3O_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$$

   a. Determine the volume of CO_2 produced when 2.50 g of $NaHCO_3$ reacts with 55.0 mL of 0.875 M acetic acid at STP.
   b. What mass of sodium bicarbonate is required to produce 19.0 L of carbon dioxide gas at 20 °C and 1.2 atm of pressure?

6. A 5.000 g sample of an organic hydrocarbon is combusted and the products measured. In the reaction, 15.37 g of carbon dioxide and 7.186 g of water are produced. Assuming the oxygen used for the combustion was in excess, determine the empirical formula of the hydrocarbon.

7. An organic compound, containing only C, H, and O, is analyzed via combustion analysis. A 1.875 g sample of the compound is combusted and 3.834 g of CO_2(g) and 1.177 g of H_2O(l) is collected. Determine the empirical formula of the compound.

8. A hydrocarbon undergoes combustion analysis to determine the empirical formula of the compound. After complete combustion it is determined that there are 66 g of CO_2 and 36 g of H_2O. Determine the empirical formula of the hydrocarbon.

9. A 3.00 g sample of $MgSO_4 \bullet xH_2O$ hydrate is thoroughly heated. The data below is collected.

Mass of test tube	24.310 g
Mass of test tube + hydrate	27.330
Mass of test tube + hydrate after 1st heating	26.320
Mass of test tube + hydrate after 2nd heating	25.852
Mass of test tube + hydrate after 3rd heating	25.850

a. Explain why the test tube was heated three times.
b. Determine the mass of water in the hydrate.
c. Determine the ratio of moles of water to moles of anhydrate.
d. Determine the formula of the hydrate.
e. The hydrate is $MgSO_4 \bullet 7H_2O$.
   i. Determine the percent yield of water driven off.
   ii. Determine the percent error of the molar mass of the hydrate.