

UNIT 4 Identifying and Balancing Reactions

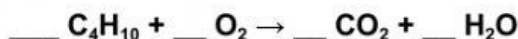
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Guidelines for Predicting the Products of Selected Types of Chemical Reaction

Key: M = Metal
NM = Nonmetal

1. **SYNTHESIS:**
 - a. Formation of binary compound: $A + B \rightarrow AB$
 - b. Metal oxide-water reactions: $MO + H_2O \rightarrow \text{base}$
 - c. Nonmetal oxide-water reactions: $(NM)O + H_2O \rightarrow \text{acid}$
2. **DECOMPOSITION:**
 - a. Binary compounds: $AB \rightarrow A + B$
 - b. Metallic carbonates: $MCO_3 \rightarrow MO + CO_2$
 - c. Metallic hydrogen carbonates: $MHCO_3 \rightarrow MO + H_2O + CO_2$
 - d. Metallic hydroxides: $MOH \rightarrow MO + H_2O$
 - e. Metallic chlorates: $MClO_3 \rightarrow MCl + O_2$
 - f. Oxyacids decompose to nonmetal oxides and water: $\text{acid} \rightarrow (NM)O + H_2O$
3. **SINGLE REPLACEMENT:**
 - a. Metal-metal replacement: $A + BC \rightarrow AC + B$
 - b. Active metal replaces H from water: $M + H_2O \rightarrow MOH + H_2$
 - c. Active metal replaces H from acid: $M + HX \rightarrow MX + H_2$
 - d. Halide-Halide replacement: $D + BC \rightarrow BD + C$
4. **DOUBLE REPLACEMENT:** $AB + CD \rightarrow AD + CB$
 - a. Formation of a precipitate from solution
 - b. Acid-Base neutralization reaction
5. **COMBUSTION REACTION**
Hydrocarbon + oxygen \rightarrow carbon dioxide + water

Select the coefficients that balance the equation and then identify the type of reaction.



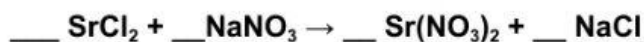
Type of reaction: _____



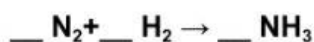
Type of reaction: _____



Type of reaction: _____



Type of reaction: _____



Type of reaction: _____

UNIT 4 Solubility Rules

Reference this section of your reference packet

SOLUBILITY RULES

Soluble:

- All Nitrates, Acetates, Ammonium, and Group 1 (IA) salts
- All Chlorides, Bromides, and Iodides, except Silver, Lead, and Mercury(I)
- All Fluorides except Group 2 (IIA), Lead(II), and Iron(III)
- All Sulfates except Calcium, Strontium, Barium, Mercury, Lead(II), and Silver

Insoluble (0.10 M or greater):

- All Carbonates and Phosphates except Group 1 (IA) and Ammonium
- All Hydroxides except Group 1 (IA), Strontium, Barium, and Ammonium
- All Sulfides except Group 1 (IA), 2 (IIA), and Ammonium
- All Oxides except Group 1 (IA)

If the compound is soluble, that means that it _____ (will, will not) dissolve in water and that the state of matter of the compound will _____ (remain solid, dissociate into aqueous ions).

If the compound is insoluble, that means that it _____ (will, will not) dissolve in water and that the state of matter of the compound will _____ (remain solid, dissociate into aqueous ions).

In some cases, aqueous ions will recombine to form a new solid product. We say these products precipitate out of solution meaning that they form an _____ (insoluble solid precipitate, soluble spectator ion).

The soluble ions that don't take part in the reaction to form an insoluble product are called our _____ (insoluble solid precipitate, soluble spectator ions). We see these as the _____ (soluble, insoluble) compound on the product side of our reaction.

For the following compounds, use your solubility rules and state whether each compound would be soluble or insoluble. If the compound is soluble, write (aq) for the state of matter. If the compound is insoluble, write (s) for the state of matter.

Calcium Sulfate _____ Ammonium Nitrate _____

Barium Hydroxide _____ Sodium Carbonate _____

Aluminum Carbonate _____ Lead (II) Chloride _____

For the double replacement reactions below, two soluble compounds will dissociate in solution to make two new products.

Use your solubility rules to determine if each product is either soluble or insoluble. If the compound is soluble, write **aqueous (aq)** for the state of matter. If the compound is insoluble, write **solid (s)** for the state of matter to indicate that the product is a solid precipitate.

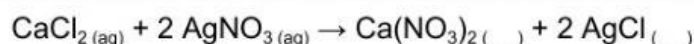
SOLUBILITY RULES

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- All Fluorides except Group 2 (IIA), Lead(II), and Iron(III)
- All Sulfates except Calcium, Strontium, Barium, Mercury, Lead(II), and Silver

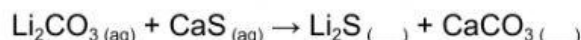
Insoluble (0.10 M or greater):

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- All Hydroxides except Group 1 (IA), Strontium, Barium, and Ammonium
- All Sulfides except Group 1 (IA), 2 (IIA), and Ammonium
- All Oxides except Group 1 (IA)



- The product $\text{Ca}(\text{NO}_3)_2$ is _____ (insoluble, soluble) meaning that they would contain our _____ (spectator ions, precipitate)
- The product AgCl is _____ (insoluble, soluble) meaning that it would be our _____ (spectator ions, precipitate)

The Net ionic equation for the reaction above would be



- The product Li_2S is _____ (insoluble, soluble) meaning that it would contain our _____ (spectator ions, precipitate)
- The product CaCO_3 is _____ (insoluble, soluble) meaning that this product would be our _____ (spectator ions, precipitate)

The Net ionic equation for the reaction above would be



Unit 4 Activity Series

Reference this section of your reference packet

ACTIVITY SERIES of Halogens:

F₂
Cl₂
Br₂
I₂

ACTIVITY SERIES of Metals

Li
Rb
K
Ba
Sr
Ca
Na
Mg
Al
Mn
Zn
Cr
Fe
Cd
Co
Ni
Sn
Pb
[H₂]
Sb
Bi
Cu
Hg
Ag
Pt
Au

Replace hydrogen from cold water

Replace hydrogen from steam

Replace hydrogen from acids

React with oxygen to form oxides

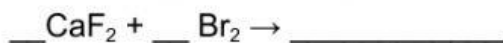
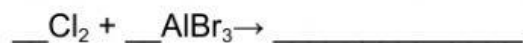
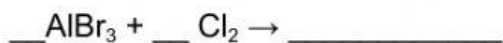
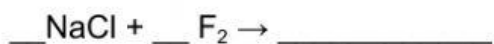
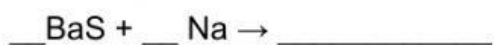
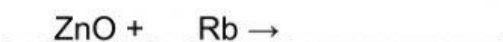
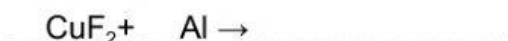
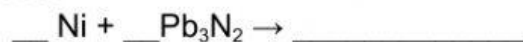
The most reactive Halogen would be _____.

If a more reactive halogen is by itself in a single replacement reaction, it _____ (will, will not) swap with the _____ (less reactive metal, less reactive halogen) that is bonded.

The most reactive metal would be _____.

If a more reactive metal is by itself in a single replacement reaction, it _____ (will, will not) swap with the _____ (less reactive metal, less reactive halogen) that is bonded.

Determine if the following reactions occur. If the reaction occurs, write the correct products for the reaction. No need to balance the equation. If the reaction does not occur, write does not occur



Reference this section of your reference packet

Chemistry Reference Tables

Name	Value
Avogadro's number	6.022×10^{23} particles/mole
Gas constant (R)	$0.0821 \frac{\text{L atm}}{\text{mole K}}$
	$62.4 \frac{\text{L mmHg}}{\text{mole K}}$
	$8.314 \frac{\text{L kPa}}{\text{mole K}}$
Standard pressure	1.00 atm = 101.3 kPa = 760. mmHg = 760. torr
Standard temperature	0°C or 273K
Volume of 1 mole of any gas at STP	22.4 L

OF THE ELEMENTS

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Consider the reaction Below



The Necessary mole equations for the reaction above would be:

- **Particle Equation:** 1 Mole Particles = _____ Particles
- **Molar Mass Equation:**
 - 1 Mole Substance = _____ found from Periodic table
- **Volume Equation:** 1 Mole of gas = 22.4 Liters @ STP
- **Mole \longleftrightarrow mole equation** from _____:

$\text{mole Na} = \quad \text{mole Cl}_2 = \quad \text{mol NaCl}$

What is the molar mass for NaCl?

How many molecules would be contained in 50 grams of NaCl?

How many liters would be contained in 5.0×10^{24} molecules of Cl_2 ?

PERIODIC TABLE

1 H Hydrogen 1.008																	18 Ar Argon 39.95
2 He Helium 4.003																	
3 Li Lithium 6.941	4 Be Beryllium 9.012																
11 Na Sodium 22.99	12 Mg Magnesium 24.31	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95										
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 51.99	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29
55 Cs Cesium 132.91	56 Ba Barium 137.33	57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97	
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.04	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium 259	103 Lr Lawrencium (262)	

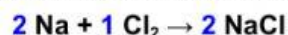
OF THE ELEMENTS

10 VIB	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
28 Ni Nickel (58.69)	29 Cu Copper (63.55)	30 Zn Zinc (65.39)	31 Ga Gallium (69.72)	32 Ge Germanium (72.61)	33 As Arsenic (74.92)	34 Se Selenium (78.96)	35 Br Bromine (79.90)	36 Kr Krypton (83.80)
46 Pd Palladium (106.42)	47 Ag Silver (107.87)	48 Cd Cadmium (112.41)	49 In Indium (114.82)	50 Sn Tin (118.71)	51 Sb Antimony (121.76)	52 Te Tellurium (127.60)	53 I Iodine (126.90)	54 Xe Xenon (131.29)
78 Pt Platinum (195.08)	79 Au Gold (196.97)	80 Hg Mercury (200.59)	81 Tl Thallium (204.38)	82 Pb Lead (207.2)	83 Bi Bismuth (208.98)	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
110 Ds Darmstadtium (271)	111 Rg Roentgenium (272)	112 Uub Ununbium (277)						
65 Tb Terbium (158.93)	66 Dy Dysprosium (162.50)	67 Ho Holmium (164.93)	68 Er Erbium (167.26)	69 Tm Thulium (168.93)	70 Yb Ytterbium (173.04)	71 Lu Lutetium (174.97)		
97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)		

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Page 4

Consider the reaction Below



The Necessary mole equations for the reaction above would be:

- 1 Mole Particles = 6.02×10^{23} Particles
- 1 Mole Substance = _____ found from the element symbol
- 1 Mole of gas = 22.4 Liters @ STP
- Mole \longleftrightarrow mole equation: 2 mole Na = 1 mole Cl_2 = 2 mol NaCl

Question 1: How many moles of NaCl could be produced from the addition of 8 moles of Chlorine gas?

Question 2: How many moles of NaCl could be produced from the addition of 100 Liters of Chlorine gas?

Question 3: How many grams of NaCl could be produced from the addition of 100 Liters of Chlorine gas?

Question 4: How many Liters of chlorine gas would be required to react with 5.0×10^{24} Sodium atoms?

% Composition, Empirical Formula, Molecular Formula

% Composition worked out example	Determine the % composition of Iron and Chlorine in the compound FeCl₃
<p>1. Calculate the percentage of both hydrogen and oxygen in water.</p> <div style="margin-left: 40px;"> $\begin{array}{rcl} \text{H (2)} 1.0 \text{ g} & = & 2.0 \text{ g} \quad \text{Part} \\ \text{O (1)} 16.0 \text{ g} & = & 16.0 \text{ g} \quad \text{Part} \\ & & 18.0 \text{ g} \quad \text{Whole} \end{array}$ $\% \text{ H} = \frac{2.0 \text{ g}}{18.0 \text{ g}} \times 100 = 11.1\%$ $\% \text{ O} = \frac{16.0 \text{ g}}{18.0 \text{ g}} \times 100 = 88.9\%$ </div>	<p>Compound FeCl₃</p> <p>%Fe = _____</p> <p>% Cl = _____</p>
Empirical formula Problem with worked out solution for NO₂	You try empirical formula example
<p>Find the empirical formula for a substance consisting of 30.4 % nitrogen and 69.6 % oxygen.</p> <div style="margin-left: 40px;"> $\frac{30.4 \text{ g N}}{1} \times \frac{1 \text{ mol N}}{14.01 \text{ g N}} = 2.17 \text{ mol N} \quad \textcircled{1}$ $\frac{69.6 \text{ g O}}{1} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = 4.35 \text{ mol O} \quad \textcircled{2}$ $\frac{4.35 \text{ mol O}}{2.17 \text{ mol N}} = 2 \text{ mol O} \quad \textcircled{3}$ <p style="text-align: center;">empirical formula $\boxed{\text{NO}_2}$</p> </div>	<p>Find the empirical formula for a compound consisting of 15.8 % Carbon and 84.2 % Sulfur.</p>
What is the molecular formula for a substance with this empirical formula that has a mass of 92.02 grams?	What is the molecular formula for a substance with the empirical formula that has a mass of 228.45 grams?
<p>Solution</p> <p>Molecular Formula mass _____ = 2</p> <p>Empirical Formula mass</p> <p>NO₂ → times 2 → N₂O₄</p>	<p>Solution</p> <p>Molecular Formula mass _____ = _____</p> <p>Empirical Formula mass</p> <p>Answer = _____</p>