



Scope Phenomenon

Name: _____ Date: _____

Chemical Reactions

1. The video shows a piece of metal reacting when it is dropped into water. What metal would cause such a reaction to occur?
2. Describe the concept of decomposition.
3. What indicators would identify a combustion reaction?
4. What products would you expect to form during an acid-base reaction?

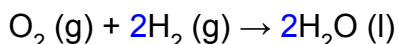
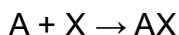


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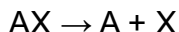
Types of Reactions

There are five types of chemical reactions. The law of conservation of mass dictates that these equations must be balanced; that is, the number of reactant atoms must equal the number of product atoms. Notice the state of matter symbols (**s** = solid; **l** = liquid; and **g** = gas) included in each of these equations. One special symbol is (**aq**). This indicates that the chemical compound is dissolved in water. Note that reference charts are needed to determine which symbols are best to represent products in single-replacement and double-replacement reactions. They are also used to determine whether the reaction will occur.

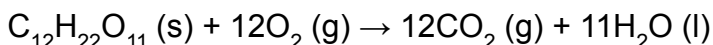
Synthesis reaction (also known as a combination reaction): This involves two reactants and one product; both the reactants and the product can be compounds.



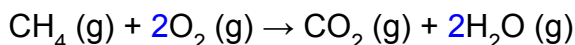
Decomposition reaction: One reactant breaks down into two or more products.



Combustion reaction (also known as a burning reaction): A compound containing carbon, hydrogen, and (sometimes) oxygen reacts with oxygen gas to produce carbon dioxide gas and water.



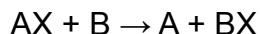
or



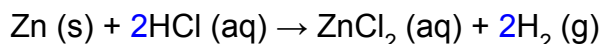


Explore

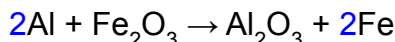
Single-replacement reaction: From two reactants (one element + one compound), one element displaces (replaces) another. For this to occur, the element replacing element **A** must be a more active element than element **A**.



For example, examine your Activity Series of Metals chart. Locate zinc and hydrogen on the chart. Notice how zinc is listed above hydrogen. This means that it is more reactive than hydrogen and will replace it in the HCl below.

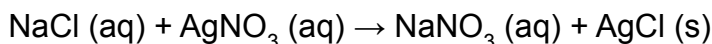
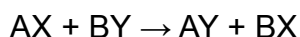


Will this chemical reaction occur? Examine your activity series chart before looking below for the answer.



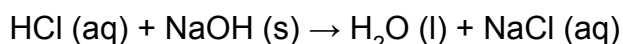
If you answered yes, you are right. Aluminum is more reactive than iron, so this reaction will occur.

Double-replacement reaction: Solutions of two different reacting compounds are mixed, and the positive ions from one compound combine with the negative ions from the other compound. (Metals are written first, and negative ions switch places.) It is important to note that double-replacement reactions happen only if one of the products is either water or an insoluble solid. Determine this by finding the parts of each product on the chart titled Solubility of Common Ionic Compounds.



Look at the two products of the reaction above: sodium nitrate and silver chloride. Nitrate is in the generally soluble column, and sodium is not an exception. Chloride is also generally soluble, but this time silver is listed as an exception. This means silver chloride is insoluble and is solid.

Neutralization reaction (a special type of double-replacement reaction): An amount of acid equal to the base is added to a base so that the acid and the base neutralize each other, forming water and a salt.

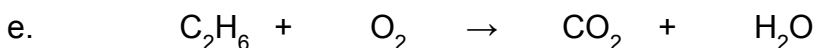
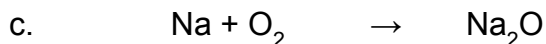
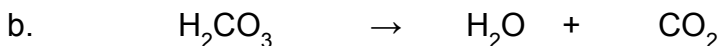




Explore

Part I: Types of Reactions

1. All chemical equations must follow the law of conservation of mass. Using a pencil, apply what you have learned to balance the following equations.



2. State the correct type of chemical reaction for each of the equations that you balanced in question 1.

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____



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3. Complete line 1 of the Data Table below, and then proceed to line 1 of the table in question 4. Repeat with line 2 and so forth. Use your copies of Solubility of Common Ionic Compounds and Summary Chart of Naming Compounds as well as clues to give your best guess on substances being solid, liquid, gas, or aqueous.

	Equation Description	Reactants	Products
1	Copper reacts with silver nitrate to produce copper(II) nitrate and silver.		
2	Sulfuric acid reacts with aluminum hydroxide to produce water and aluminum sulfate.		
3	Sulfur trioxide gas reacts with water to produce sulfuric acid.		
4	Ammonium chloride reacts with silver nitrate to produce ammonium nitrate and silver chloride.		
5	Potassium chlorate breaks down into potassium chloride and oxygen gas.		
6	Methane—CH ₄ (g)—reacts with oxygen gas to produce carbon dioxide and water vapor.		



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4. Write the balanced chemical equation for each equation on the previous page. Use your copy of Summary Chart of Naming Compounds. Include the state of matter symbols, and identify the type of reaction.

	Balanced Chemical Equation	Type of Reaction
1		
2		
3		
4		
5		
6		



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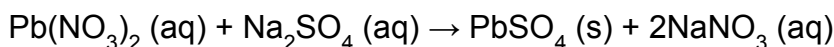
Part II: Producing Precipitates

Not all single-replacement and double-replacement reactions occur. Some combinations of elements and compounds will result in no reaction for various reasons.

Remember that if a single-replacement reaction involves two metals, we have to look up those metals on the Activity Series of Metals chart. The metal that is alone on the reactants side must be more active, or higher on the activity series list, than the metal it is trying to replace in the compound on the reactant side. If the lone metal is lower, then it is not active enough to remove the bonded metal from the compound, and no reaction will occur. View the introduction section on single-replacement reactions for an example.

Double-replacement reactions must have a driving force for a reaction to occur. They need to produce either a precipitate (insoluble solid), water, or a gas. We will be focusing on the formation of a precipitate. If these reactions do not form a precipitate on the product side, there is no reaction. We can refer to a solubility chart (such as your Solubility of Common Ionic Compounds sheet) to determine whether compounds dissolve or are solid in solution.

Many reactions that occur in aqueous solutions produce these precipitates. For example, when aqueous lead(II) nitrate is combined with aqueous sodium sulfate, solid lead(II) sulfate precipitates out of the solution. This is seen by the chemical equation below.



A set of rules, known as the solubility rules, helps us know what ions combine to form insoluble precipitates in water. When classifying ionic solutes with regard to solubility, we usually refer to the anion in the compound. These rules show what anion and cation combinations will form soluble or insoluble compounds.



Explore

1. Using the solubility rules on your copy of Solubility of Common Ionic Compounds, develop your own chart of general rules for both soluble and insoluble anions. Be sure to include any and all exceptions.

Anion	Soluble or Insoluble?	Common Exceptions: Compounds Containing . . .
Cl^-		
SO_4^{2-}		
CO_3^{2-}		
OH^-		
NO_3^-		



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2. Predict the probable products for the following reactions. Remember that the charges for ionic compounds must cancel out in the products.

Reaction	Solutions Combined	Probable Products
1	$\text{CaCl}_2 (\text{aq}) + \text{MgSO}_4 (\text{aq})$	
2	$\text{CaCl}_2 (\text{aq}) + \text{Na}_2\text{CO}_3 (\text{aq})$	
3	$\text{CaCl}_2 (\text{aq}) + \text{NaOH} (\text{aq})$	
4	$\text{CaCl}_2 (\text{aq}) + \text{AgNO}_3 (\text{aq})$	
5	$\text{MgSO}_4 (\text{aq}) + \text{Na}_2\text{CO}_3 (\text{aq})$	
6	$\text{MgSO}_4 (\text{aq}) + \text{NaOH} (\text{aq})$	
7	$\text{MgSO}_4 (\text{aq}) + \text{AgNO}_3 (\text{aq})$	
8	$\text{Na}_2\text{CO}_3 (\text{aq}) + \text{KOH} (\text{aq})$	
9	$\text{Na}_2\text{CO}_3 (\text{aq}) + \text{AgNO}_3 (\text{aq})$	
10	$\text{NaOH} (\text{aq}) + \text{AgNO}_3 (\text{aq})$	



Explore

3. Write the balanced chemical equations for all of the combinations of ionic compounds in question 2. Indicate which, if any, product was the solid precipitate and which was aqueous using the appropriate symbols.

Reaction 1: _____

Reaction 2: _____

Reaction 3: _____

Reaction 4: _____

Reaction 5: _____

Reaction 6: _____

Reaction 7: _____

Reaction 8: _____

Reaction 9: _____

Reaction 10: _____

4. Compare your results for question 3 above with other groups. Did you correctly identify the combination of reactants that would produce precipitates? Explain how you used your solubility rules to do this.
5. Look at the solubility rules chart that you created. If you were to design a reaction that would produce two solid products, describe how you would accomplish this. Refer to your copy of Solubility of Common Ionic Compounds, and write the complete balanced equations for this process.



Explore

Part III: Predicting Products

Now that you have been exposed to all the types of reactions and what types of products they make, you can predict products of reactions from only the reactants.

Predict the products, and balance the reactions below. Remember to use the Activity Series of Metals chart for single-replacement reactions and the Solubility of Common Ionic Compounds chart for double-replacement reactions.





Explore

Reflections and Conclusions

1. A chemical equation represents the compounds involved in a chemical reaction, but it does more than this. What else does a chemical equation represent? (Hint: It has to do with the law of conservation of mass.)
2. During a particular chemical reaction, two aqueous compounds are mixed. What type of chemical reaction is this?
3. During a particular chemical reaction, a metal is placed in a colored solution, resulting in the solution turning clear as another metal is formed. What type of reaction is this?
4. During a particular chemical reaction, a carbon-based compound reacts with oxygen gas, producing carbon dioxide and steam. What type of reaction is this?
5. Using all of the following terms, develop a graphic organizer based on what you've learned in this Explore. Use another sheet of paper, if needed.

Terms: *chemical formula, reactant, product, coefficient, reaction, chemical equation, law of conservation of mass, combination reaction, decomposition reaction, combustion reaction, double-replacement reaction, and single-replacement reaction*



Explore

Periodic Table of the Elements

1 H 1.008																	2 He 4.0026
3 Li 6.94	4 Be 9.0122											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.085	15 P 30.974	16 S 32.06	17 Cl 35.45	18 Ar 39.948
19 K 39.098	20 Ca 40.078(4)	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845(2)	27 Co 58.933	28 Ni 58.693	29 Cu 63.546(3)	30 Zn 65.38(2)	31 Ga 69.723	32 Ge 72.630(8)	33 As 74.922	34 Se 78.971(8)	35 Br 79.904	36 Kr 83.798(2)
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224(2)	41 Nb 92.906	42 Mo 95.95	43 Tc	44 Ru 101.07(2)	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60(3)	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 - 71	72 Hf 178.49(2)	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23(3)	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 - 103	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
Lanthanide Series			57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm	62 Sm 150.36(2)	63 Eu 151.96	64 Gd 157.25(3)	65 Tb 158.93	66 Dy 162.93	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
			89 Ac	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr



Explore

Solubility of Common Ionic Compounds

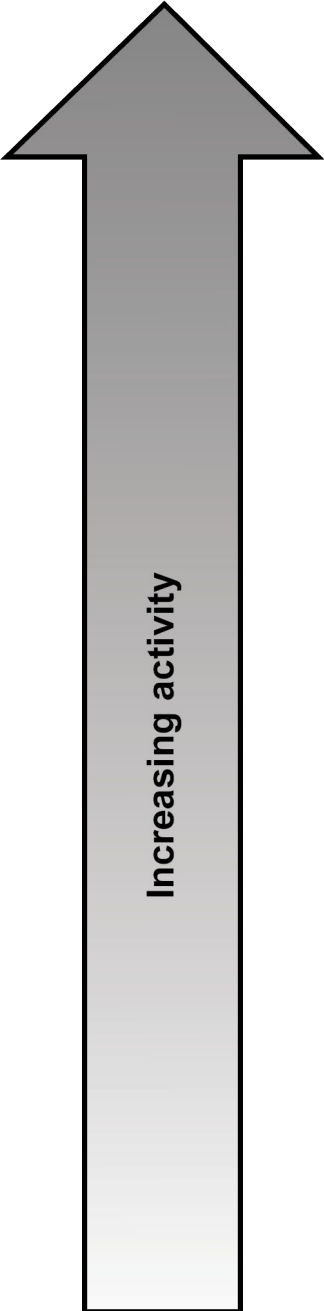
Generally Soluble Ions	Exceptions
Group 1A salts	None
$\text{C}_2\text{H}_3\text{O}_2^-$ or CH_3COO^-	None
NH_4^+	None
NO_3^-	None
CN^-	None
ClO^-	None
ClO_2^-	None
ClO_3^-	None
ClO_4^-	None
Br^-	Compounds with Ag^+ , Pb^{2+} , Hg_2^{2+}
Cl^-	Compounds with Ag^+ , Pb^{2+} , Hg_2^{2+}
I^-	Compounds with Sr^{2+} , Ba^{2+} , Pb^{2+} , Hg_2^{2+}
SO_4^{2-}	Compounds with Sr^{2+} , Ba^{2+} , Pb^{2+} , Hg_2^{2+}

Generally Insoluble Ions	Exceptions
CO_3^{2-}	Compounds with NH_4^+ , alkali metal cations
PO_4^{3-}	Compounds with NH_4^+ , alkali metal cations
CrO_4^{2-}	Compounds with NH_4^+ , alkali metal cations
$\text{Cr}_2\text{O}_7^{2-}$	Compounds with NH_4^+ , alkali metal cations
OH^-	Compounds with NH_4^+ , alkali metal cations Ca^{2+} , Sr^{2+} , Ba^{2+}
S^{2-}	Compounds with NH_4^+ , alkali metal cations Ca^{2+} , Sr^{2+} , Ba^{2+}



Explore

Activity Series of Metals

Metal	
Lithium	 Increasing activity
Potassium	
Barium	
Calcium	
Sodium	
Magnesium	
Aluminum	
Manganese	
Zinc	
Chromium	
Iron	
Cobalt	
Nickel	
Tin	
Lead	
(Hydrogen)	
Copper	
Mercury	
Silver	
Platinum	
Gold	



Explore

Summary Chart of Naming Compounds

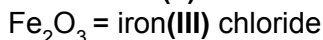
Ionic Compounds

Two Elements: Metal + Nonmetal

Name the metal first, and then change the nonmetal ending to *-ide*.

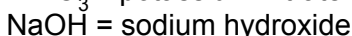


For elements with multiple charges (transition metals), use Roman numerals.



More than Two Elements: Cation + Anion

Name the metal first (cation), and then name the nonmetal (anion).

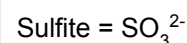
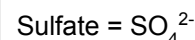
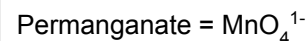
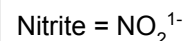
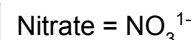
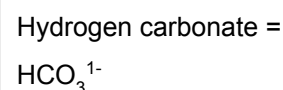
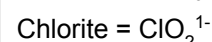
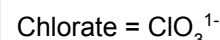
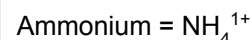
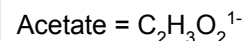


See the polyatomic ion chart. Most are anions except NH_4^+ .

If ammonium is used, then the anion ends in *-ide*.



Polyatomic Ions



Acids

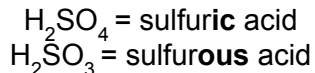
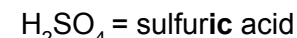
H + Non-oxyacid (anion)

Use the prefix *hydro-*, and change the anion's ending to *-ic*.



H + Oxyacid (anion)

Change the ending of the oxyacid (anion). If it is *-ate*, the ending becomes *-ic*. If it is *-ite*, the ending becomes *-ous*.



Covalent Compounds

Two Elements: Nonmetal + Nonmetal

Use a prefix for each element in the compound (count the atoms in the formula). Name the first element, and change the second element's ending to *-ide*.



Prefixes

1 = *mono-*

2 = *di-*

3 = *tri-*

4 = *tetra-*

5 = *penta-*

6 = *hexa-*

7 = *hepta-*

8 = *octa-*

9 = *nona-*

10 = *deca-*

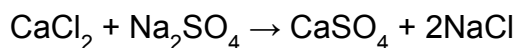


Name: _____

Date: _____

What's Going on Here?

Explain what is happening in this chemical reaction:



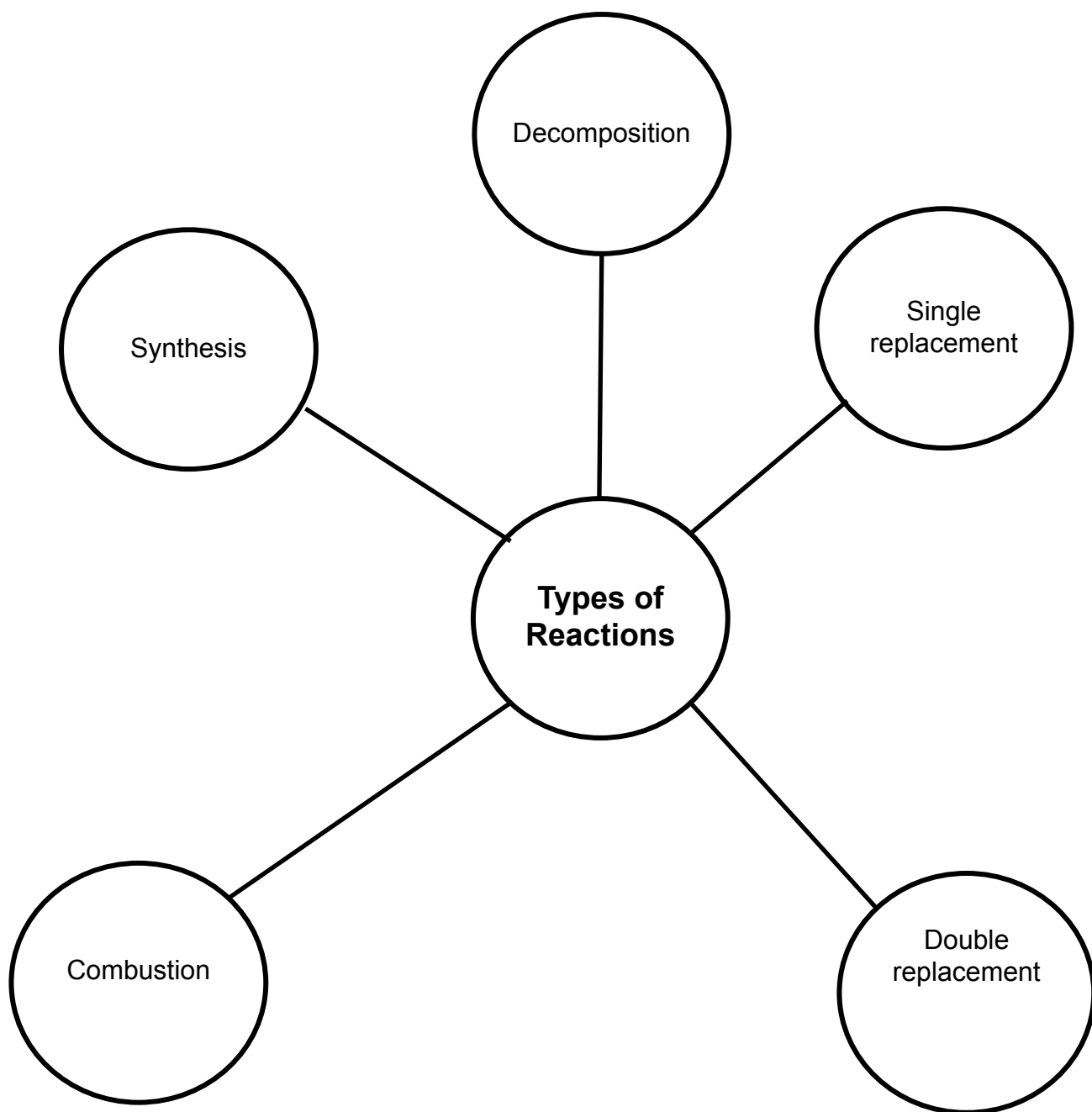


Name: _____

Date: _____

Reaction Mind Map

Create a mind map using the template below. As you read and discover something new or interesting, draw a line from that reaction type and write the fact or thought you had about it.





Name: _____ Date: _____

3-2-1 Review

3 – Things You Learned

- 1.
- 2.
- 3.

2 – Questions You Still Have

- 1.
- 2.

1 – Summary Paragraph About the Types of Chemical Reactions