

Types of Chemical Reactions

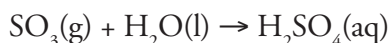
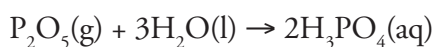
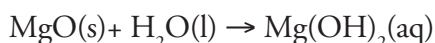
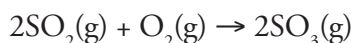
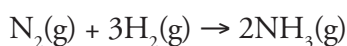
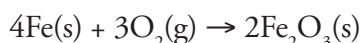
Do atoms rearrange in predictable patterns during chemical reactions?

Why?

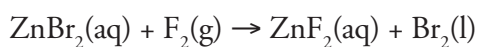
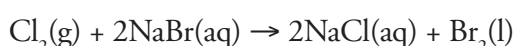
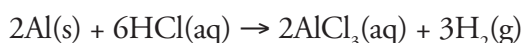
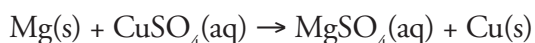
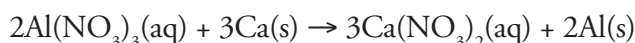
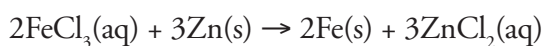
Recognizing patterns allows us to predict future behavior. Weather experts use patterns to predict dangerous storms so people can get their families to safety. Political analysts use patterns to predict election outcomes. Similarly, chemists classify chemical equations according to their patterns to help predict products of unknown but similar chemical reactions.

Model 1 – Types of Reactions

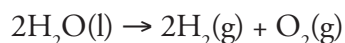
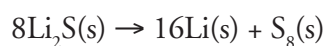
Set A _____



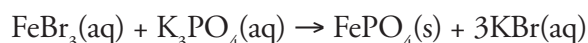
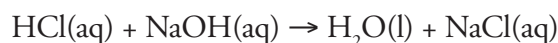
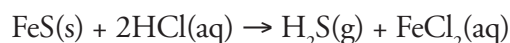
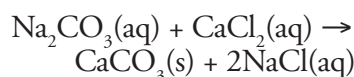
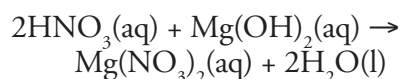
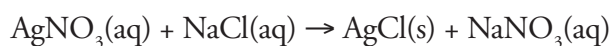
Set C _____



Set B _____



Set D _____



1. The chemical equations in Model 1 contain the phase notations (s), (l), (g), and (aq). Match each symbol with its meaning.

dissolved in water

liquid

solid

gas

2. Based on the examples provided, which set(s) of reactions in Model 1 typically involve ions in solution (A, B, C or D)?
3. Based on the examples provided, which set(s) of reactions in Model 1 typically involve gases and/or solids?

4. Match each description below to one of the reactions sets (A, B, C or D) from Model 1.

- _____ Ionic compounds dissolved in water switch partners.
_____ One compound breaks into elements or smaller compounds.
_____ Two or more elements or compounds combine to form one product.
_____ Part of an ionic compound is removed and replaced by a new element.

5. Define the following terms as they are commonly used in the English language.

Synthesis—

Decomposition—

Replacement—



6. The four sets of chemical reactions shown in Model 1 have the following general names. Discuss within your group which name belongs to which set of chemical reactions. Write the name in the appropriate place in Model 1.

Single Replacement Reaction

Synthesis Reaction

Double Replacement Reaction

Decomposition Reaction



7. Can two elements be used as reactants for a synthesis reactions? If yes, give at least one example from Model 1 to support your answer.
8. Can two compounds be used as reactants for a synthesis reaction? If yes, give at least one example from Model 1 to support your answer.
9. What types of substances (elements or compounds) are seen in the products of decomposition reactions? Use examples from Model 1 to support your answer.
10. In single replacement reactions, do any of the atoms change their charge as they change from a reactant to a product? If yes, use an example from Model 1 to describe the changes that take place.
11. In double replacement reactions, do any of the atoms change their charge? If yes, use an example from Model 1 to describe the changes that take place.

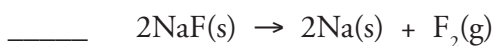
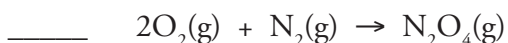
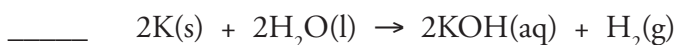
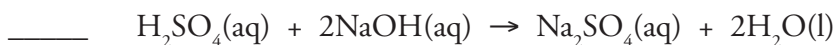
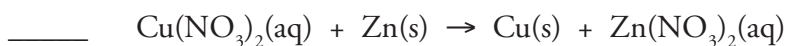
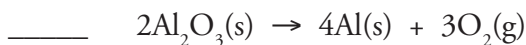
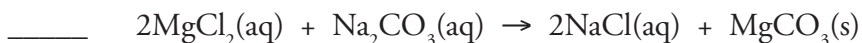
12. Choose one example from the set of synthesis reactions in Model 1.

a. Write the chemical reaction in reverse.

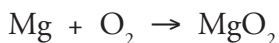
b. Label the reaction written in part *a* with one of the reaction types in Model 1.



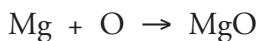
13. Identify each of the reactions below as synthesis (S), decomposition (D), single replacement (SR) or double replacement (DR).



14. A student writes the following incorrect chemical equation for the synthesis of magnesium oxide.



Another student writes the following incorrect synthesis reaction.



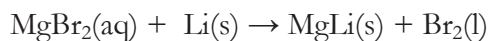
a. What is the correct formula for magnesium oxide? *Hint:* Magnesium oxide is an ionic compound.

b. Describe the error made by the first student.

c. Describe the error made by the second student. *Hint:* Oxygen exists as O_2 when alone

d. Write the correct balanced chemical equation for the synthesis of magnesium oxide.

15. A student writes the following *incorrect* chemical equation for a single replacement reaction between magnesium bromide and lithium.



- In a single replacement reaction, part of an ionic compound is removed and replaced by a new element. What element will lithium replace in magnesium bromide? *Hint:* What is the most common charge for lithium?
 - What is wrong with the student's prediction of the products in the above reaction? Note: Bromine does exist as Br_2 when alone.
 - Predict the products and write the correct balanced equation for the single replacement reaction between magnesium bromide and lithium.
16. A student writes the following incorrect chemical equation for a double replacement reaction between iron(III) bromide and sodium hydroxide solutions.
- $$\text{FeBr}_3(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{FeOH}(\text{s}) + \text{NaBr}_3(\text{aq})$$
- What is wrong with the chemical formula(s) of the product(s) predicted by this student? (Hint: look at the charges)
 - Write the correct equation for the double replacement reaction between iron(III) bromide and sodium hydroxide.
17. Consider the following chemical reaction written as a **word equation**.
- diphosphorus pentoxide + water \rightarrow phosphoric acid

- Identify the type of chemical reaction from Model 1 that would describe this reaction.
- Balance the following chemical equation written as a **formula equation**.
$$\text{P}_2\text{O}_5 + \text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_4$$

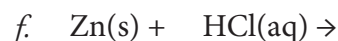
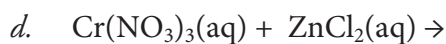
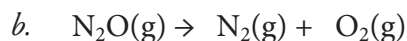
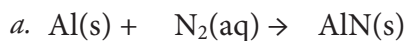


Read This!

Chemists use their knowledge of synthesis, decomposition, single replacement, and double replacement to predict what will happen in chemical reactions. When predicting the products for a reaction it is important to remember that atoms or ions will only combine in ways that make them stable, otherwise the reaction will not happen under normal conditions. This means that it is important to pay attention to ion charges, the natural state of elements, and the formulas of common molecular substances like carbon dioxide and water. It is only *after* predicting the products and writing the correct formulas that a chemist would then apply the law of conservation of mass and balance the chemical equation using coefficients as needed.

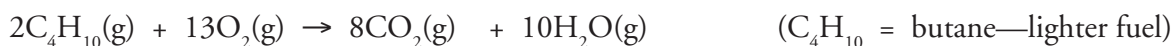
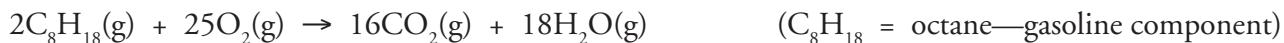


18. Use your understanding of common chemical reactions to predict the products for the following reactions. Label the type of reaction. Balance the chemical equations *after* you have written the correct chemical formulas for all of the reactants and products for those that do not have products provided. You do not need to include states on products



Extension Questions

Model 2 – Combustion Reactions



19. What are the products in all of the combustion reactions in Model 2?
20. What reactant is common in all of the combustion reactions in Model 2?
21. The “fuel” in most combustion reactions is a **hydrocarbon**. Using the examples in Model 2, write a description for the classification of substances known as hydrocarbons.
22. Predict the products of the following combustion reactions, and balance each reaction equation.
 - a. $\text{C}_5\text{H}_{12} + 8\text{O}_2 \rightarrow$
 - b. $2\text{C}_2\text{H}_2 + 5\text{O}_2 \rightarrow$
23. Compounds such as isopropyl alcohol ($\text{C}_3\text{H}_7\text{OH}$) and glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) can also undergo combustion in a similar way. Predict the products of the following combustion reactions, and balance each reaction equation.
 - a. $\text{C}_3\text{H}_7\text{OH} + \text{O}_2 \rightarrow$
 - b. $\text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \rightarrow$
24. For each of the reaction types in Model 1, explain why a combustion reaction CANNOT be classified as that type from Model 1.