Teacher

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 SYNTHESIS

$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

$MgO(s) + H_2O(l) \rightarrow Mg(OH)_2(aq)$

$P_2O_5(g) + 3H_2O(l) \rightarrow 2H_3PO_4(aq)$

$SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$

Set B DECOMPOSITION

$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$

$8Li_2S(s) \rightarrow 16Li(s) + S_8(s)$

$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

$2Na_2O_2(s) \rightarrow 2Na_2O(s) + O_2(g)$

$(NH_4)_2CO_3(s) \rightarrow 2NH_3(g) + H_2O(l) + CO_2(g)$

Set C SINGLE REPLACEMENT

$2FeCl_3(aq) + 3Zn(s) \rightarrow 2Fe(s) + 3ZnCl_2(aq)$

$2Al(NO_3)_3(aq) + 3Ca(s) \rightarrow 3Ca(NO_3)_2(aq) + 2Al(s)$

$Mg(s) + CuSO_4(aq) \rightarrow MgSO_4(aq) + Cu(s)$

$2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2(g)$

$Cl_2(g) + 2NaBr(aq) \rightarrow 2NaCl(aq) + Br_2(l)$

$ZnBr_2(aq) + F_2(g) \rightarrow ZnF_2(aq) + Br_2(l)$

Set D DOUBLE REPLACEMENT

$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

$2HNO_3(aq) + Mg(OH)_2(aq) \rightarrow Mg(NO_3)_2(aq) + 2H_2O(l)$

$Na_2CO_3(aq) + CaCl_2(aq) \rightarrow CaCO_3(s) + 2NaCl(aq)$

$FeS(s) + 2HCl(aq) \rightarrow H_2S(g) + FeCl_2(aq)$

$HCl(aq) + NaOH(aq) \rightarrow H_2O(l) + NaCl(aq)$

$FeBr_3(aq) + K_3PO_4(aq) \rightarrow FePO_4(s) + 3KBr(aq)$

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 — aq liquid — l solid — s gas — g

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

   ? What state of matter normally has ions in it ? aqueous set C ? D ? A

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

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

D	Ionic compounds dissolved in water switch partners.
B	One compound breaks into elements or smaller compounds.
A	Two or more elements or compounds combine to form one product.
C	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— combining into one

Decomposition— breaking into smaller parts

Replacement— replacing one with another

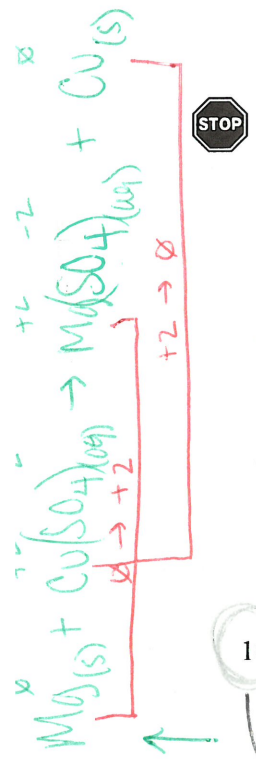
6. The four sets of chemical reactions shown in Model 1 have the following general names. Discuss within your group which name belongs to which set of chemical reactions. Write the name in the appropriate place in Model 1.

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.

Yes. $4Fe_{(s)} + 3O_{2(g)} \rightarrow 2Fe_2O_{3(s)}$

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.

Yes. $MgO_{(s)} + H_2O_{(l)} \rightarrow Mg(OH)_{2(aq)}$

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.

elements & compounds
& breakdown of the reactants.

10. In single 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.

Alone element is neutral. Element in compound is charged to make compound neutral.

In single replacement reactions elements that are being replaced change their charge.

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.

No. All elements retain their charges to make the compounds neutral.

$\overset{+1}{Ag}\overset{-1}{NO_3}_{(aq)} + \overset{+1}{Na}\overset{-1}{Cl}_{(aq)} \rightarrow \overset{+1}{Ag}\overset{-1}{Cl}_{(s)} + \overset{+1}{Na}\overset{-1}{NO_3}_{(aq)}$

In double replacement reactions, both partners switch places, so there is no need to change charges.

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

a. Write the chemical reaction in reverse.

$2Fe_2O_3(s) \rightarrow 4Fe(s) + 3O_2(g)$

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

decomposition.

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

S $K_2O(s) + H_2O(l) \rightarrow 2KOH(aq)$

DR $2MgCl_2(aq) + Na_2CO_3(aq) \rightarrow 2NaCl(aq) + MgCO_3(s)$

D $2Al_2O_3(s) \rightarrow 4Al(s) + 3O_2(g)$

SR $Cu(NO_3)_2(aq) + Zn(s) \rightarrow Cu(s) + Zn(NO_3)_2(aq)$

DR $H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$

SR $2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$

S $2O_2(g) + N_2(g) \rightarrow N_2O_4(g)$

D $2NaF(s) \rightarrow 2Na(s) + F_2(g)$

STOP

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

$Mg + O_2 \rightarrow MgO_2$

Another student writes the following incorrect synthesis reaction.

$Mg + O \rightarrow MgO$

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

MgO

formula is the compound asked for

b. What is the correct formula for elemental oxygen?

O_2

c. Describe the error made by the first student.

did not check oxidation states for MgO_2 → it is not neutral.

chemical reaction is Reactants → products

$Mg + O_2 \rightarrow MgO$

d. Describe the error made by the second student.

coefficient = ↑ # in front of a compound or element that gets distributed.

↳ oxygen is diatomic when it is by itself. must have a 2 as a subscript.

ex $4H_2O$

H: (4·2) = 8

O: (4·1) = 4

$2Mg + O_2 \rightarrow 2MgO$

Mg: 1/2	Mg: 1/2
O: 2	O: 1/2

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

$2LiBr(aq) + F_2(g) \rightarrow 2Li(s) + 2FBr(g)$

a. In a single replacement reaction, part of an ionic compound is removed and replaced by a new element. What element will fluorine replace in lithium bromide? *Hint:* What is the most common ionic form of fluorine?

Bromine

In a SR rxn
- metals replace metals
- nonmetals replace nonmetals

b. What is wrong with the student's prediction of the products in the above reaction?

they replaced a cation

metal replaces metal
nonmetal replaces nonmetal.

c. Predict the products and write the correct balanced equation for the single replacement reaction between lithium bromide and fluorine.

$2LiBr + F_2 \rightarrow 2LiF + Br_2$

Li x2 F 2 | Li x2 F x2
Br x2 | Br 2

once you predict, we will balance together

16. A student writes the following incorrect chemical equation for a double replacement reaction between iron(III) bromide and sodium hydroxide solutions.

$FeBr_3(aq) + NaOH(aq) \rightarrow FeOH(s) + NaBr_3(aq)$

If you have a transition metal (metal w/ charge) is a reactant, the charge stays the same on the product side.

a. What is wrong with the chemical formula(s) of the product(s) predicted by this student?

- Iron keeps the charge of +3 from reactants.
- Na is +1 Br is -1

FeOH is not formed correctly & neutral.

b. Write the correct equation for the double replacement reaction between iron(III) bromide and sodium hydroxide.

$FeBr_{3(aq)} + 3NaOH_{(aq)} \rightarrow Fe(OH)_{3(s)} + 3NaBr_{(aq)}$

17. Consider the following chemical reaction written as a **word equation**.

diphosphorus pentoxide + water → phosphoric acid

a. Identify the type of chemical reaction from Model 1 that would describe this reaction.

Synthesis

b. Write chemical formulas under the names of the substances in the word equation. & Balance.

$P_2O_5 + 3H_2O \rightarrow 2H_3PO_{4(aq)}$

P: 2 | P: x 2
O: 1 6 8 | O: 4 x 8
H: 2 6 | H: 3 6