# Unit 6 Study Guide
## Balancing Equations & Reaction Types

**Targets:**

**E4.** *Describe an application of the Law of Conservation of Matter.*

**Activity #1 –Chemical Equations & the Law of Conservation of Matter**

*Open Chemical Equations and read the page.*

1) Define
   a) chemical reaction
   b) diatomic molecules
   c) reactants
   d) products
2) What is wrong with each of the following?
   a) $H + O \rightarrow H_2O$
   b) $H_2 + O_2 \rightarrow H_2O$
3) Watch the simulation, "The formation of water".
   a) In what ratio do hydrogen gas and oxygen gas react to form water?
   b) Click "magnify the reaction". Describe what happens.
   c) Click "Help". Fill in the blanks: _____ hydrogen molecules react with _____ oxygen molecules to form _____ water molecules. Write the balanced equation below:
4) To write a correct equation, what must you do?
5) What is a "coefficient" in an equation?

6) Consider the reaction methane in oxygen gas.

   a) Write a balanced equation for this reaction.

   b) Fill in the blanks: ____ molecules of water are produced for every _____ molecule of methane consumed.

7) State the **law of conservation of matter**.

8) Fill in the chart. Explain how this illustrates the conservation of matter.

| | | | | | |
|---|---|---|---|---|---|
| balanced equation | ___ $H_2$ | + | ___$O_2$ | → | ___ $H_2O$ |
| draw molecules | | + | | → | |
| find molecular masses | __ * ____g | + | ____g | = | __ * ____g |

**<u>Activity #2 – Balancing Equations</u>**

**Directions:**

1) Go to Classic Chembalancer.
2) Click 'Directions'. Read and understand the directions.
3) Click 'OK'.
4) Click on 'Start Game'
5) Try entering some numbers in the text boxes in front of each molecule. What happens?
6) If you forget the directions, click on the 'How to Play the Game' link. Click 'OK' when you finish reading them to return to the game.
7) When you think you have typed the right numbers in all the boxes, click the 'Balanced' button.
8) If you didn't get it right, try again.
9) If you did get it right, then fill in the correct answers on this worksheet for #1.
10) Repeat steps 7-9 for the other 10 questions.

**Fill in the blanks below as you go though the game.**

1. _____ Fe + _____ S → _____ FeS

2. _____ $H_2$ + _____ $Cl_2$ → _____ HCl

3. _____ Mg + _____ $O_2$ → _____ MgO

4. _____ $O_2$ + _____ $H_2$ → _____ $H_2O$

5. _____ HgO → _____ Hg + _____ $O_2$

6. _____ Ca + _____ $H_2O$ → _____ $Ca(OH)_2$ + _____ $H_2$

7. _____ $CH_4$ + _____ $O_2$ → _____ $CO_2$ + _____ $H_20$

8. _____ $Na_2O_2$ + _____ $H_2SO_4$ → _____ Na2SO4 + _____ H2O2

9. _____ $N_2$ + _____ $H_2$ → _____ $NH_3$

10. _____ Al + _____ $O_2$ → _____ $Al_2O_3$

11. _____ $KMnO_4$ → _____ $K_2O$ + _____ MnO + _____ $O_2$

*Now open Review Chembalancer.*

1. _____ S + _____ $O_2$ → _____ $SO_2$

2. _____ Na + _____ $O_2$ → _____ $Na_2O_2$

3. _____ Hg + _____ $O_2$ → _____ HgO

4. _____ $Ag_2O$ → _____ Ag + _____ $O_2$

5. _____ $Ba(OH)_2$ + _____ $H_3PO_4$ → _____ $BaHPO_4$ + _____ $H_2O$

6. _____ NaOH + _____ $H_3PO_4$ → _____ $Na_2HPO_4$ + _____ $H_2O$

7. _____ $C_4H_8$ + _____ $O_2$ → _____ $CO_2$ + $H_2O$

8. _____ $C_3H_8$ + _____ $O_2$ → _____ $CO_2$ + $H_2O$

9. _____ Fe + _____ $Cl_2$ → _____ $FeCl_3$

10. _____ Al + _____ HCl → _____ $AlCl_3$ + _____ $H_2$

*Think you've got it? You have if you can do Brain Boggle Chembalancer!*

1. _____ $F_2$ + _____ $Al_2O_3$ → _____ $AlF_3$ + _____ $O_2$

2. _____ $C_2H_6$ + _____ $O_2$ → _____ CO + _____ $H_2O$

3. _____ $NH_3$ + _____ $O_2$ → _____ NO + _____ $H_2O$

4. _____ $C_5H_{12}$ + _____ $O_2$ → _____ CO + _____ $H_2O$

5. _____ $C_8H_{18}$ + _____ $O_2$ → _____ CO + _____ $H_2O$

**Activity #3 – Reaction Types**

*Open The Six Types of Chemical Reactions. Describe each t ype of reaction IN WORDS and write a chemical equation showing that kind of reaction.*

1) Combustion:

2) Synthesis

3) Decomposition

4) Single displacement

5) Double displacement

6) Acid-base:

**Mr. Guch's Handy Checklist for figuring out what type of reaction is taking place:**

*Follow this series of questions. When you can answer "yes" to a question, then stop!*

1) Does your reaction have oxygen as one of it's reactants and carbon dioxide and water as products? If yes, then it's a **combustion reaction**.

2) Does your reaction have two (or more) chemicals combining to form one chemical? If yes, then it's a **synthesis reaction**.

3) Does your reaction have one large molecule falling apart to make several small ones? If yes, then it's a **decomposition reaction.**

4) Does your reaction have any molecules that contain only one element? If yes, then it's a **single displacement reaction.**

5) Does your reaction have water as one of the products? If yes, then it's an **acid-base reaction.**

6) If you haven't answered "yes" to any of the questions above, then you've got a **double displacement reaction.**

*Using the checklist above, determine the type of reaction in each of the following:*

1) $NaOH + KNO_3 \rightarrow NaNO_3 + KOH$

2) $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$

3) $2\ Fe + 6\ NaBr \rightarrow 2\ FeBr_3 + 6\ Na$

4) $CaSO_4 + Mg(OH)_2 \rightarrow Ca(OH)_2 + MgSO_4$

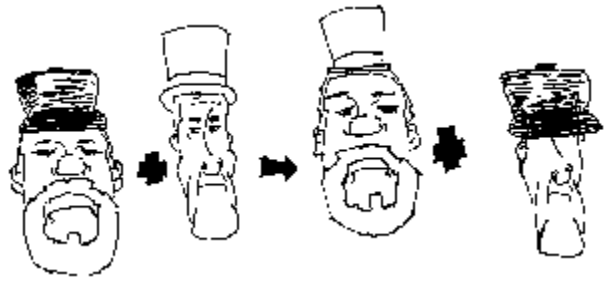
5) $NH_4OH + HBr \rightarrow H_2O + NH_4Br$

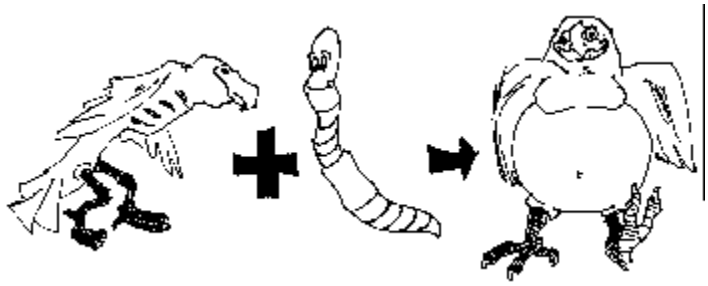
6) $Pb + O_2 \rightarrow PbO_2$

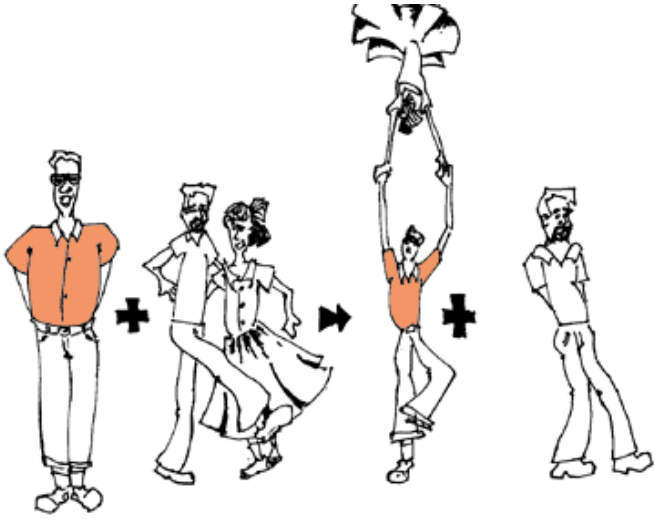
7) $Na_2CO_3 \rightarrow Na_2O + CO_2$

*Open To react or not to react? THAT is the question!.*

*These pictures might look a little silly, but they are another way to help you understand reactions types. Label each picture with* **SYNTHESIS REACTION, DECOMPOSITION REACTION, SINGLE REPLACEMENT REACTION, or DOUBLE REPLACEMENT REACTION.**







**Activity #4 – Review**

WRITE THE FORMULA FOR EACH MATERIAL CORRECTLY AND THEN BALANCE THE EQUATION. THERE ARE SOME REACTIONS THAT REQUIRE COMPLETION. FOR EACH REACTION TELL WHAT TYPE OF REACTION IT IS. CHECK YOUR ANSWERS HERE. You may need the charts at the end of this packet and a periodic table to help with this.

1. sulfur trioxide and water combine to make sulfuric acid.

2. lead II nitrate and sodium iodide react to make lead iodide and sodium nitrate.

3. calcium fluoride and sulfuric acid make calcium sulfate and hydrogen fluoride (Hydrofluoric acid)

4. calcium carbonate will come apart when you heat it to leave calcium oxide and carbon dioxide.

5. ammonia gas when it is pressed into water will make ammonium hydroxide.

6. sodium hydroxide neutralizes carbonic acid

7. zinc sulfide and oxygen become zinc oxide and sulfur.

8. lithium oxide and water make lithium hydroxide

9. aluminum hydroxide and sulfuric acid neutralize to make water and aluminum sulfate.

10. sulfur burns in oxygen to make sulfur dioxide.

11. barium hydroxide and sulfuric acid make water and barium sulfate.

12. aluminum sulfate and calcium hydroxide become aluminum hydroxide and calcium sulfate.

13. copper metal and silver nitrate react to form silver metal and copper II nitrate.

14. sodium metal and chlorine react to make sodium chloride.

15. calcium phosphate and sulfuric acid make calcium sulfate and phosphoric acid.

16. phosphoric acid plus sodium hydroxide.

17. propane burns (with oxygen)

18. zinc and copper II sulfate yield zinc sulfate and copper metal

19. sulfuric acid reacts with zinc

20. acetic acid ionizes.

21. steam methane to get hydrogen and carbon dioxide

22. calcium oxide and aluminum make aluminum oxide and calcium

23. chlorine gas and sodium bromide yield sodium chloride and bromine

**Activity #5 – Review Quizzes & a Puzzle**

*Show your teacher your score and have her initial when you finish a quiz.*

Types of Chemical Reactions Quiz (choose 6 questions) _____
Balancing Chemical Equations (choose 10 questions or play thrillionaire) _____
Balancing chemical equations _____

**Word Search**

S Z E T I N A E J P F O Q I W W P
F Y C R U L C O M P O U N D T T R
Z G N E X Y M M U G V K Q E C E E
U Z A T E C C X Y A B P W D Y L C
X S T E H Y X N O I T A U Q E W I
R M S Q X E Y G X V T H I M P B P
E P B W A J S W V D Y W E V A X I
A L U K H E D I C Y A N G K Q U T
C Y S B K G M I S X T B K G U T A
T J M Q X J C X B S A M N N E J T
I F G M I X T U R E K U C U O N E
O R M Q A H H T D A C R D W U G T
N O I T I S O P M O C E D B S V Q

Words about the concepts in this module can be obtained from the clues given. Find these words in the block of letters:

1. Solid formed in a chemical reaction involving solutions.
2. Substance that cannot be decomposed into a simpler substance.
3. Reaction type in which two or more substances form a single substance in a reaction.
4. Reaction type in which two or more substances are formed from a single substance.
5. Process by which one or more substances change into new substances.
6. Two or more substances that are not chemically combined and do not have a fixed set of properties.
7. Substance composed of two or more elements.
8. Sample of matter that has a uniform set of properties and a definite composition.
9. Symbolism used to represent reactions that occur.
10. Adjective for a water solution.

**Solids, Liquids, Gases: Pictures in the Mind**

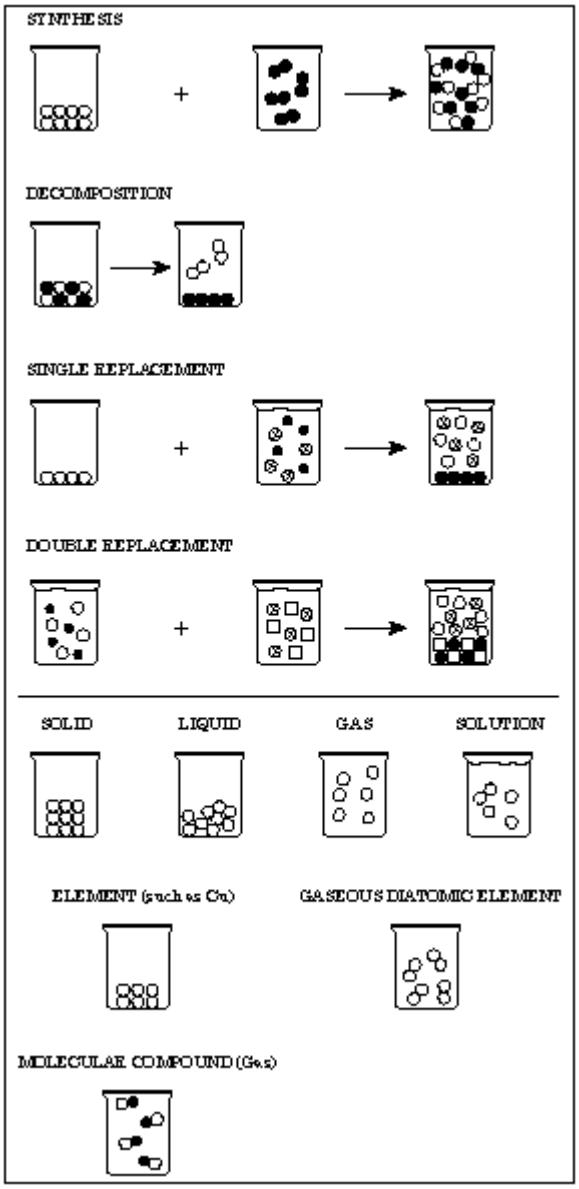


**Table 1: Metal cations** with more than one common charged form (**Note:** silver, cadmium and zinc most always form these ions: $Ag^{+1}$, $Cd^{2+}$ and $Zn^{2+)}$

| | |
|---|---|
| $Fe^{2+}$ | iron(II) ion |
| $Fe^{3+}$ | iron(III) ion |
| $Cu^{+}$ | copper(I) ion |
| $Cu^{2+}$ | copper(II) ion |
| $Hg_2^{2+}$ | mercury(I) ion |
| $Hg^{2+}$ | mercury(II) ion |
| $Pb^{2+}$ | lead(II) ion |
| $Pb^{4+}$ | lead(IV) ion |
| $Sn^{2+}$ | tin(II) ion |
| $Sn^{4+}$ | tin(IV) ion |
| $Cr^{2+}$ | chromium (II) ion |
| $Cr^{3+}$ | chromium (III) ion |
| $Mn^{2+}$ | manganese (II) ion |
| $Mn^{3+}$ | manganese (III) ion |
| $Co^{2+}$ | cobalt (II) ion |
| $Co^{3+}$ | cobalt (III) ion |

**Table 2: Common polyatomic cations, arranged by family.** (alternate names in italics)

| carbon | | nitrogen | | sulfur | | chlorine | |
|---|---|---|---|---|---|---|---|
| $CO_3^{2-}$ | carbonate | $NO_3^-$ | nitrate | $SO_4^{2-}$ | sulfate | $ClO_4^-$ | perchlorate |
| $HCO_3^-$ | hydrogen carbonate *(bicarbonate)* | $NO_2^-$ | nitrite | $SO_3^{2-}$ | sulfite | $ClO_3^-$ | chlorate |
| | | | | $S_2O_3^{2-}$ | thiosulfate | $ClO_2^-$ | chlorite |
| | | | | $HSO_4^-$ | hydrogen sulfate *(bisulfate)* | $ClO^-$ | hypochlorite |
| | | | | $HSO_3^-$ | hydrogen sulfite *(bisulfite)* | | |

| phosphorus | | cyanide | | cations | | metal oxyanions | |
|---|---|---|---|---|---|---|---|
| $PO_4^{3-}$ | phosphate | $CN^-$ | cyanide | $NH_4^+$ | ammonium | $CrO_4^{2-}$ | chromate |
| $HPO_4^{2-}$ | hydrogen phosphate | $OCN^-$ | cyanate | $H_3O^+$ | hydronium | $Cr_2O_7^{2-}$ | dichromate |
| $H_2PO_4^-$ | dihydrogen phosphate | $SCN^-$ | thiocyanate | $Hg_2^{2+}$ | mercury(I) | $MnO_4^-$ | permanganate |

| oxygen | | organics | |
|---|---|---|---|
| $OH^-$ | hydroxide | $C_2H_3O_2^-$ | acetate |
| $O_2^{2-}$ | peroxide | | |

**Table 2. Prefixes for molecular compounds**

1 – mono
2 – di
3 – tri
4 – tetra
5 – penta
6 – hexa
7 – hepta
8 – octa
9 – nona
10 - deca

**Table 3. Common Acids**

| | |
|---|---|
| Hydrochloric Acid | $HCl$ |
| Nitric Acid | $HNO_3$ |
| Acetic Acid | $HC_2H_3O_2$ |
| Sulfuric Acid | $H_2SO_4$ |
| Citric Acid | $H_3C_6H_5O_7$ |
| Carbonic Acid | $H_2CO_3$ |
| Phosphoric Acid | $H_3PO_4$ |
| Oxalic Acid | $H_2C_2O_4$ |

**Table 4. The Saturated Hydrocarbons, or Alkanes**

| *Name* | *Molecular Formula* |
|---|---|
| methane | $CH_4$ |
| ethane | $C_2H_6$ |
| propane | $C_3H_8$ |
| butane | $C_4H_{10}$ |
| pentane | $C_5H_{12}$ |
| hexane | $C_6H_{14}$ |
| heptane | $C_7H_{16}$ |
| octane | $C_8H_{18}$ |
| nonane | $C_9H_{20}$ |
| decane | $C_{10}H_{22}$ |

**Worksheets/Labs for Unit 6:**
Activity 8.1: Balancing Chemical Equations
Worksheet 8.2, 8.3: Predicting the Products of Replacement Reactions
FOUR TYPES OF REACTIONS LABS
Heat a Hydrate
Burning a Hydrocarbon I