

## Unit 6

On completion of the unit you should be able to:

1. balance chemical equations.
2. interpret balanced equations in terms of moles, mass units and number of particles.
3. given the number of moles (or mass or number of particles) of one substance calculate the number of moles ( or mass or number of particles) of another substance in the balanced equation.
4. define limiting and excess reactants.
5. identify the following types of reactions:
  - synthesis
  - decomposition
  - combustion
  - single-replacement
  - double-replacement
  - neutralization
6. define endothermic and exothermic reactions.
7. define acids and bases.

Today's focus.

### CHEMICAL REACTIONS

6.1 **Law of conservation of energy**

6.2 **Chemical reactions: Law of conservation of mass**

Reading: Hebden – page 105-106

6.3 **Balancing chemical equations**

Reading: Hebden – page 107-112

## Scientific Law:

# Law of Conservation of Energy

***In any physical and chemical changes, energy is neither created nor destroyed.***

Scientists have reached the conclusion that although energy has many different forms that are interconvertible, when one form of energy disappears, some other form of energy of equal magnitude must appear, and vice versa.

In other words, the total quantity of energy in the universe is constant.

Scientific Law:

Law of Conservation of Mass

*In any physical and chemical changes,  
mass is neither created nor destroyed.*

We will make sure that this scientific law is obeyed by ***balancing*** all the chemical reactions.

# 7 Diatomic Elements

## Periodic Table of Elements

- Metals
- Non-metals
- Semi-metals

Periodic Table of Elements

PERIODS	GROUPS																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	IA	IIA	IIIB	IVB	VB	VIB	VII B	VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1.008 H																	4.003 He
2	6.941 Li	9.012 Be											10.811 B	12.011 C	14.007 N	15.999 O	18.998 F	20.179 Ne
3	22.990 Na	24.305 Mg											26.982 Al	28.086 Si	30.974 P	32.06 S	35.45 Cl	39.948 Ar
4	39.098 K	40.08 Ca	44.956 Sc	47.90 Ti	50.9415 V	51.996 Cr	54.938 Mn	55.847 Fe	58.933 Co	58.71 Ni	63.546 Cu	65.37 Zn	69.72 Ga	72.59 Ge	74.922 As	78.96 Se	79.904 Br	83.80 Kr
5	85.468 Rb	87.62 Sr	88.906 Y	91.22 Zr	92.9064 Nb	95.94 Mo	98.906 Tc	101.07 Ru	102.906 Rh	106.4 Pd	107.868 Ag	112.41 Cd	114.82 In	118.69 Sn	121.75 Sb	127.60 Te	126.905 I	131.30 Xe
6	132.905 Cs	137.33 Ba	138.906 *La	178.49 Hf	180.948 Ta	183.85 W	186.2 Re	190.2 Os	192.22 Ir	195.09 Pt	196.967 Au	200.59 Hg	204.37 Tl	207.2 Pb	208.981 Bi	(209) Po	(210) At	(222) Rn
7	(223) Fr	226.025 Ra	(227) **Ac	(261) Rf	(262) Ha	(263) Sg	(262) Ns	(265) Hs	(266) Mt	(269) —	(272) —							

\*Lanthanide series

\*\* Actinide series

140.12 Ce	140.908 Pr	144.24 Nd	(145) Pm	150.4 Sm	151.96 Eu	157.25 Gd	158.925 Tb	162.50 Dy	164.930 Ho	167.26 Er	168.934 Tm	173.04 Yb	174.967 Lu
232.038 Th	231.031 Pa	238.029 U	237.048 Np	(244) Pu	(243) Am	(247) Cm	(247) Bk	(251) Cf	(254) Es	(257) Fm	(256) Md	(255) No	(257) Lr
90	91	92	93	94	95	96	97	98	99	100	101	102	103

F<sub>2</sub>  
Cl<sub>2</sub>  
Br<sub>2</sub>  
I<sub>2</sub>  
O<sub>2</sub>  
N<sub>2</sub>  
H<sub>2</sub>

## Experiment 6 – Percent Composition

### Objectives

1. To observe the techniques involved to carry out the decomposition of a chemical, potassium chlorate,  $\text{KClO}_3$ , quantitatively.
2. To calculate the percentage of oxygen in potassium chlorate,  $\text{KClO}_3$ , theoretically and experimentally.
3. To verify the product of the decomposition reaction is potassium chloride,  $\text{KCl}$ .

The decomposition of potassium chlorate occurs at temperatures above  $400^\circ\text{C}$ . The reaction is described by the word equation as:

potassium chlorate + heat  $\rightarrow$  potassium chloride + oxygen

Word  
Equation

Recall, oxygen is a diatomic element.



Unbalanced reaction

	LHS		RHS	
K	1		1	✓
Cl	1		1	✓
O	3		2	✗

As written,  
we lost an oxygen!  
Let's fix it.

# Balance Chemical Reactions



	LHS		RHS	
K	1		1	✓
Cl	1		1	✓
O	3		2	✗

As written, we lost an oxygen!  
Let's fix it by balancing the above chemical reaction.

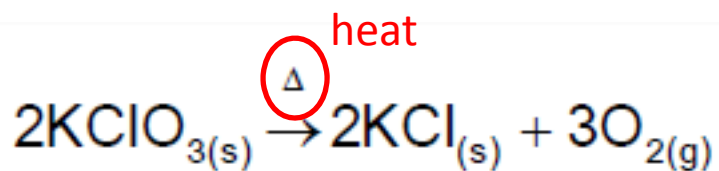


coefficients

	LHS		RHS	
K	<del>1</del> 2		<del>1</del> 2	✓
Cl	<del>1</del> 2		<del>1</del> 2	✓
O	<del>3</del> 6		<del>2</del> 6	✓

When balancing chemical reactions, we are only allowed to add numbers in front of the compounds. These are called *coefficients*.

Lab manual:



Endothermic reaction

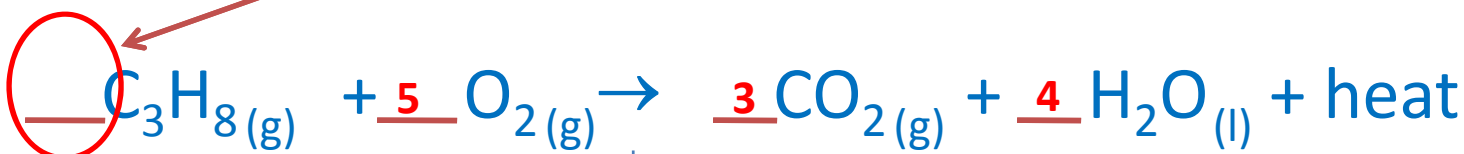
**Read:** 2 moles  $\text{KClO}_3$  decomposes to give 2 moles  $\text{KCl}$  and 3 moles  $\text{O}_2$ .

# Balance Chemical Reactions

Example: The burning of propane,  $C_3H_8(g)$ .

Unbalanced  
reaction

When nothing is written, the default value is '1'.



	LHS		RHS				
C	3		<del>1</del>	<del>3</del>	3	✓	Exothermic reaction
H	8		2	<del>2</del>	8	✓	
O	<del>2</del>	10	<del>3</del>	<del>7</del>	10	✓	

When balancing chemical reactions, we are only allowed to add numbers in front of the compounds. These are called *coefficients*.

**Read:** 1 mole of propane gas burns with 5 moles oxygen to give 3 moles carbon dioxide and 4 moles water.

**NOTE:** A balanced equation's coefficients should give lowest whole number ratios.

# Balance Chemical Reactions

Example: The combustion (burning) of ethanol,  $\text{C}_2\text{H}_5\text{OH}_{(l)}$ .

Unbalanced reaction



	LHS	RHS
C	2	1
H	6	2
O	3	3

Exothermic  
reaction

When balancing chemical reactions, we are only allowed to add numbers in front of the compounds. These are called *coefficients*.

Balanced reaction



**Read:** 1 mole of ethanol burns with 3 moles oxygen to give 2 moles carbon dioxide and 3 moles water.



# Balance Chemical Reactions

Example: The combustion (burning) of octane,  $C_8H_{18(l)}$ .

Unbalanced reaction



	LHS	RHS
C	8	1
H	18	2
O	2	3

Exothermic  
reaction

When balancing chemical reactions, we are only allowed to add numbers in front of the compounds. These are called *coefficients*.

Balanced reaction



**Read:** 2 moles of octane burn with 25 moles oxygen to give 16 moles carbon dioxide and 18 moles water.

Try some practice problems in Maple TA.

Use Dimensional Analysis in ALL your  
calculations!!