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 interconvertable, when one form of energy disappears, some other form of energy of equal magnitude must appear, and vice versa.

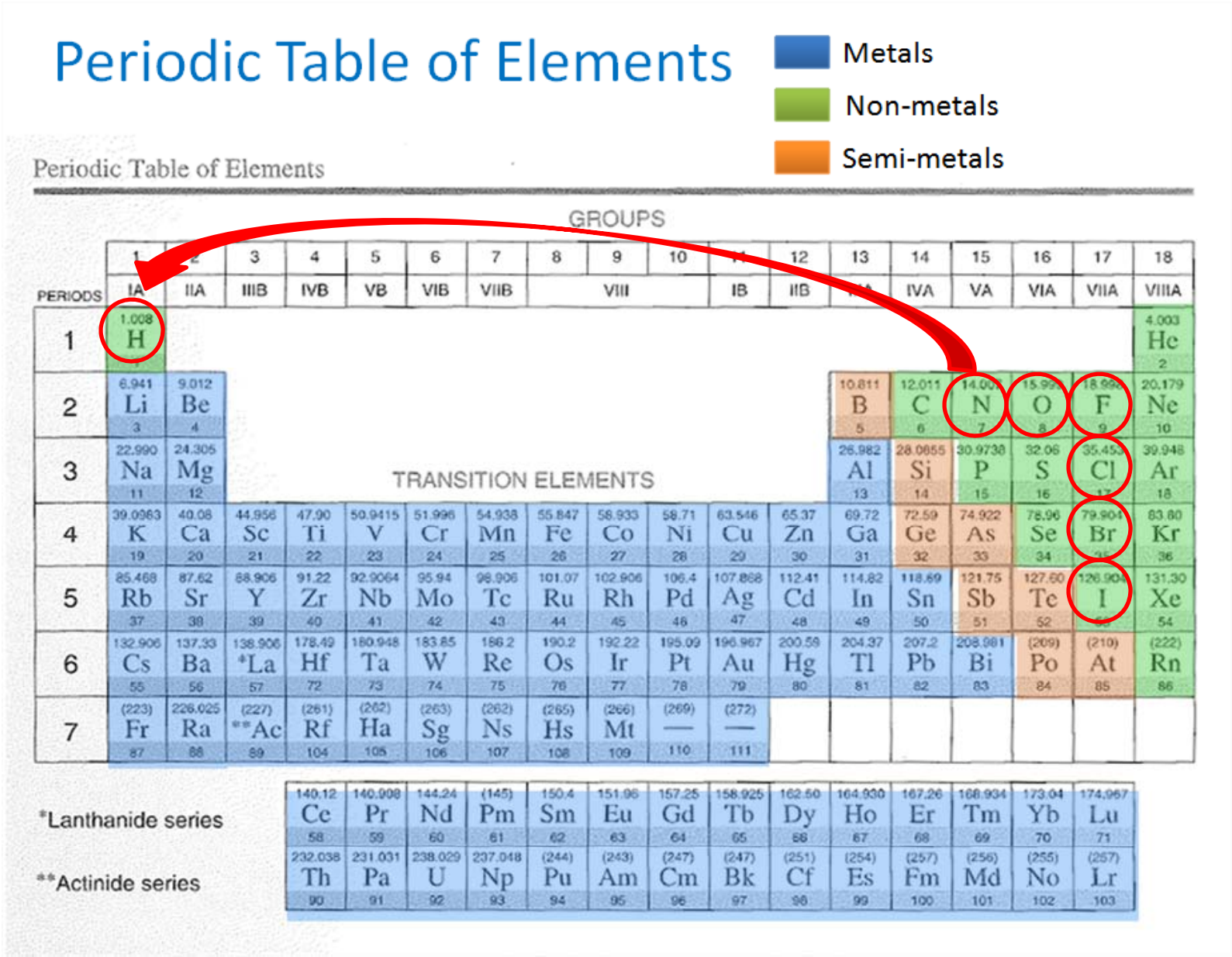
In other words, the total quantity of energy in the universe is constant.

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



F_2

Cl_2

Br_2

I_2

O_2

N_2

H_2

Experiment 6 – Percent Composition

Objectives

1. To observe the techniques involved to carry out the decomposition of a chemical, potassium chlorate, $KClO_3$, quantitatively.
2. To calculate the percentage of oxygen in potassium chlorate, $KClO_3$, theoretically and experimentally.
3. To verify the product of the decomposition reaction is potassium chloride, KCl.

The decomposition of potassium chlorate occurs at temperatures above 400°C.
The reaction is described by the word equation as:

Word Equation

potassium chlorate + heat → potassium chloride + oxygen

Recall, oxygen is a diatomic element.

$$KClO_{3(s)} + \text{heat} \rightarrow KCl_{(s)} + O_{2(g)}$$

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

Example: $KClO_{3(s)} + heat \rightarrow KCl_{(s)} + O_{2(g)}$

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

$\underline{2}\ KClO_{3(s)} + heat \rightarrow \underline{2}\ KCl_{(s)} + \underline{3}\ O_{2(g)}$

LHS			RHS		
K	~~1~~	2	~~1~~	2	✓
Cl	~~1~~	2	~~1~~	2	✓
O	~~3~~	6	~~2~~	6	✓

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

Lab manual: $2KClO_{3(s)} \xrightarrow{\Delta\ (heat)} 2KCl_{(s)} + 3O_{2(g)}$ Endothermic reaction

Read: 2 moles $KClO_3$ decomposes to give 2 moles KCl and 3 moles 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'.

$$\_\,C_3H_{8\,(g)} + \mathbf{5}\,O_{2\,(g)} \rightarrow \mathbf{3}\,CO_{2\,(g)} + \mathbf{4}\,H_2O_{(l)} + \text{heat}$$

	LHS		RHS		
C	3		~~1~~ ✗ 3		✓
H	8		2 ✗ ~~2~~	8	✓
O	~~2~~	10	~~3~~ ✗ ~~7~~	10	✓

Exothermic reaction

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 coefficents should give lowest whole number ratios.

Balance Chemical Reactions

Example: The combustion (burning) of ethanol, $C_2H_5OH_{(l)}$.

Unbalanced reaction

$$\_\_\ C_2H_5OH_{(l)} + \_\_\ O_{2\,(g)} \rightarrow \_\_ CO_{2\,(g)} + \_\ H_2O_{(l)} + \text{heat}$$

	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

$$C_2H_5OH_{(l)} + 3\ O_{2\,(g)} \rightarrow 2\ CO_{2\,(g)} + 3\ H_2O_{(l)} + \text{heat}$$

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

$$\_\_\ C_8H_{18\,(l)} + \_\_ O_{2\,(g)} \rightarrow \_\_ CO_{2\,(g)} + \_\ H_2O_{(l)} + \text{heat}$$

	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

$$2\ C_8H_{18\,(l)} + 25\ O_{2\,(g)} \rightarrow 16\ CO_{2\,(g)} + 18\ H_2O_{\,(l)} + \text{heat}$$

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!!