

Balancing Chemical Equations

A Chemical Equation:

- is a representation of a chemical reaction in terms of chemical formulas

Example:

1. Word Description of a Chemical Reaction

When methane gas (CH₄) burns in the presence of oxygen gas, it produces carbon dioxide gas and water vapor.

2. Word Equation

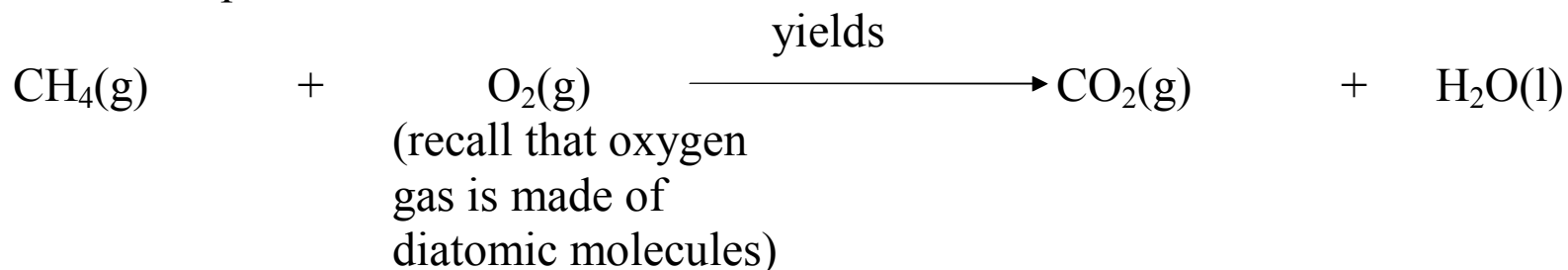
- distinguishes between the starting substances (**REACTANTS**) and the substances that result from the chemical reaction (**PRODUCTS**)

- indicates the chemical change with an arrow, referred to as the “**YIELD**” sign ()

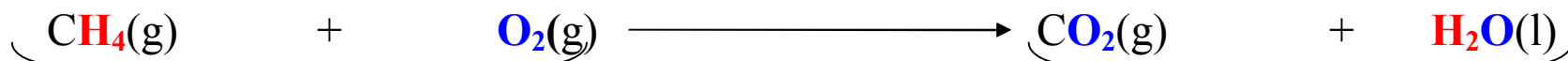


3. Unbalanced Chemical Equation

- represents Reactants and Products with correct chemical formulas
- indicates the physical state (phase designation) of all substances involved:
 - “s” for solid
 - “l” for liquid
 - “g” for gas
 - “aq” for “dissolved in water (aqueous solution)”
- does not attempt to account for the number of atoms involved in the reaction.



NOTE:



4 H atoms

≠

2 H atoms

2 O atoms

≠

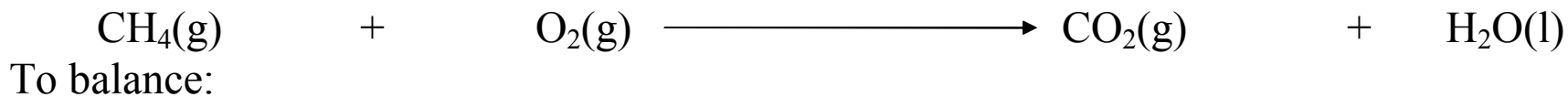
3 O atoms

This equation is not in agreement with one of the postulates of Dalton’s Atomic Theory: A Chemical Reaction consists of the **REARRANGEMENT OF ATOMS** present in the reacting substances.

ATOMS ARE NEITHER CREATED, NOR DESTROYED IN A CHEMICAL REACTION.

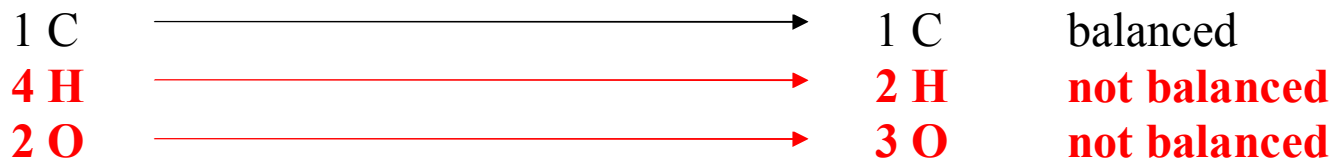
4. Balanced Chemical Equation

- the number of atoms of each element are equal on both sides of the arrow
- uses “**coefficients**” to ensure that the “equation is balanced”
 - coefficients – are the **smallest set of whole numbers** placed in front of the formulas in order to balance the equation.



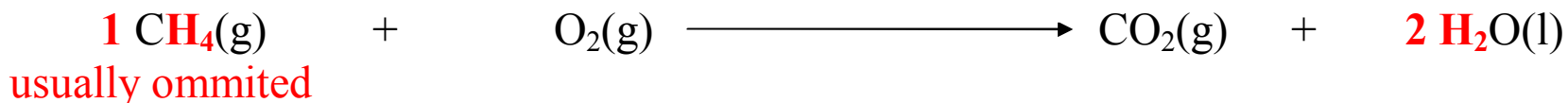
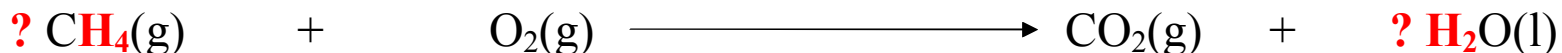
First:

- check number of atoms of each element on both sides of the arrow



Second:

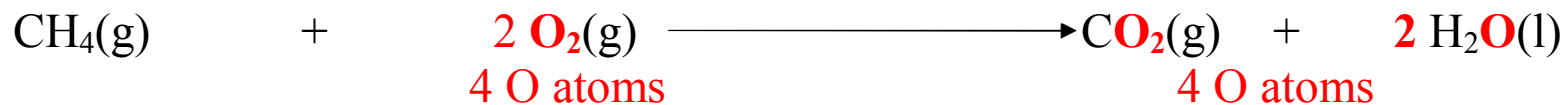
- balance first the atoms for elements that occur in only one substance on each side of equation.



H is now balanced (4 H atoms on both side of the equation)

Third:

Balance all other atoms:



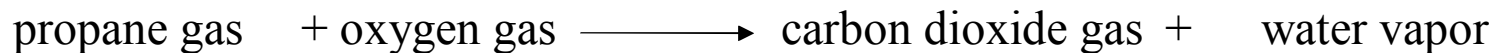
The equation is now balanced:



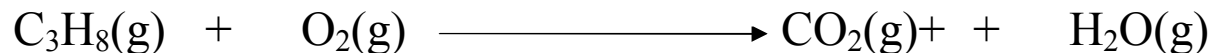
Examples:

1. Propane gas (C₃H₈) burns in the presence of oxygen and produces carbon dioxide gas and water vapor.

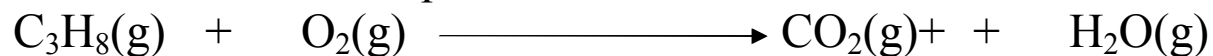
(A) Word Equation



(B) Unbalanced Chemical Equation (include State Designations)



(C) Balanced Chemical Equation



3 C

1 C

8 H

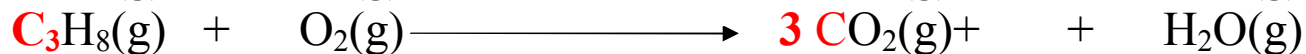
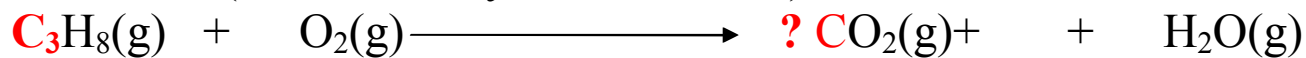
2 H

2 O

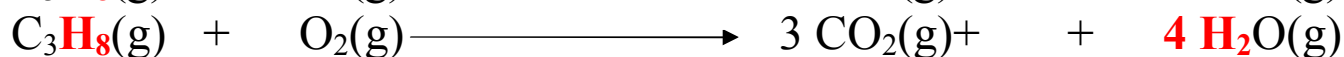
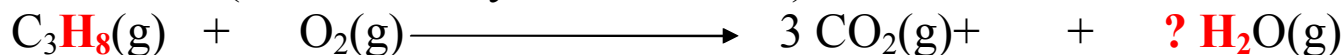
2 O

1 O

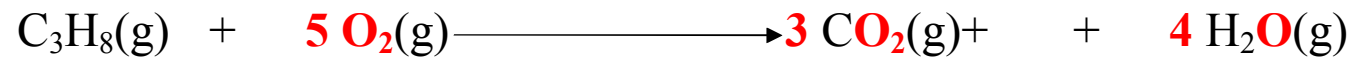
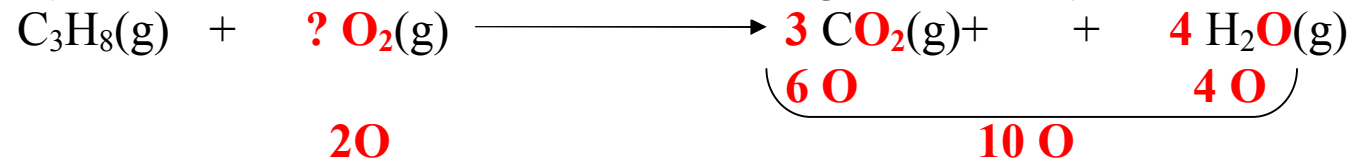
First: Balance C (occurs in only one substance):



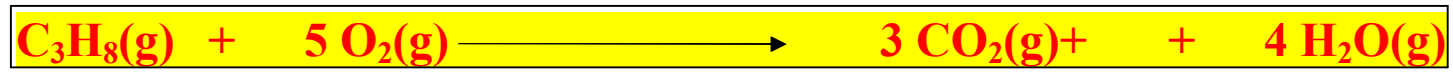
Second: Balance H (occurs in only one substance):



Third: Balance O (occurs in more than one substance on right hand side):

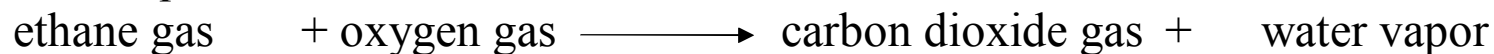


The Equation is now balanced:

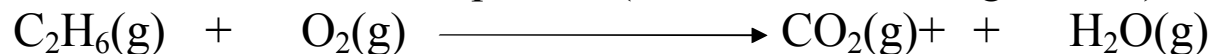


2. Ethane gas (C₂H₆) burns in the presence of oxygen and produces carbon dioxide gas and water vapor.

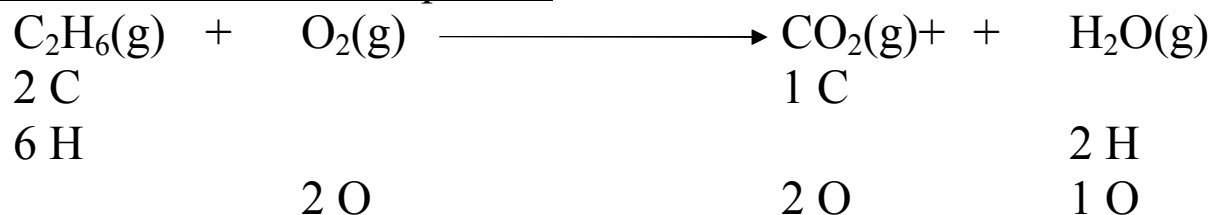
(A) Word Equation



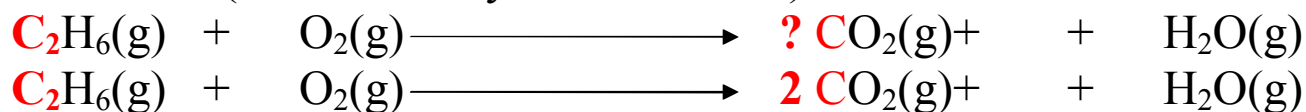
(B) Unbalanced Chemical Equation (include State Designations)



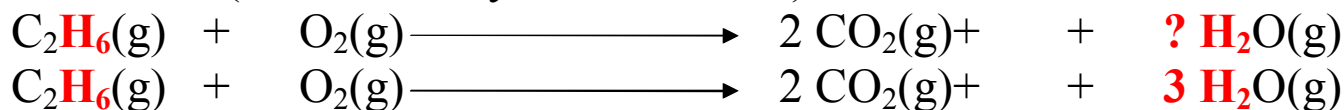
(C) Balanced Chemical Equation



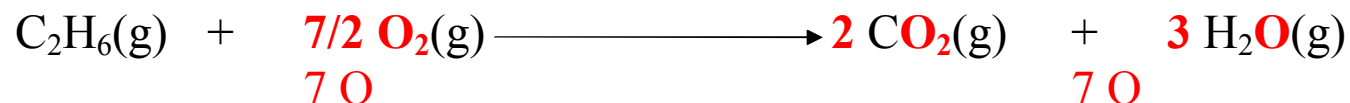
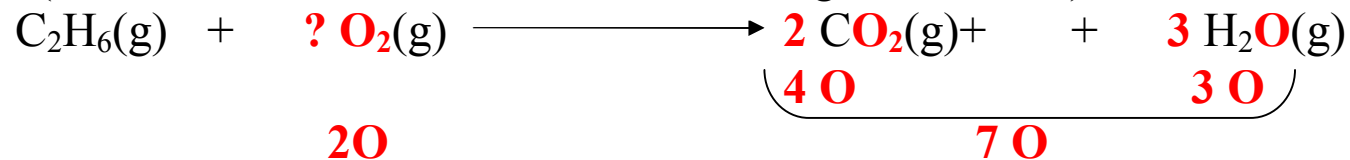
First: Balance C (occurs in only one substance):



Second: Balance H (occurs in only one substance):

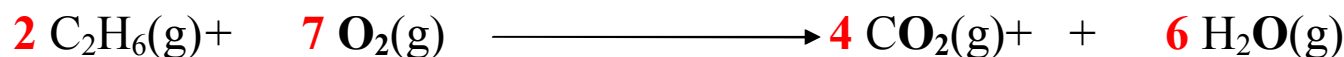
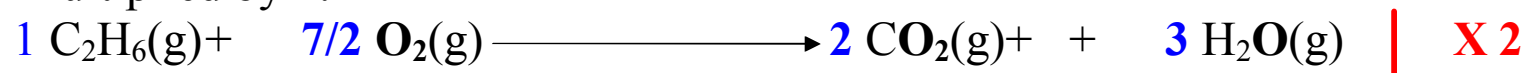


Third: Balance O (occurs in more than one substance on right hand side):



NOTE: The equation is balanced, but it uses a fractional coefficient (3/2)
 - while this is mathematically correct, the fractional coefficient is not consistent with the chemical reality (half molecules do not exist)

Fourth: To remove the fractional coefficient, the whole equation (all the coefficients) are multiplied by 2:



4 C	=	4C	
12 H	=		12 H
14 O	=	8 O	+ 6 O

Balanced Chemical Equation:



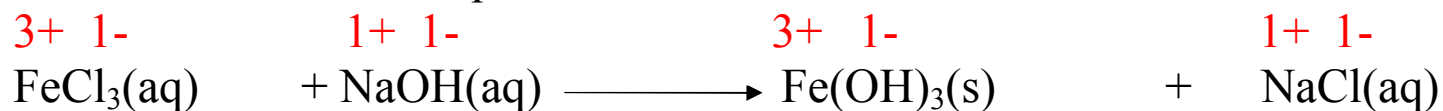
3. An aqueous solution of iron (III) chloride reacts with an aqueous solution of sodium hydroxide and forms solid iron (III) hydroxide and an aqueous solution of sodium chloride.

Write a balanced chemical equation that illustrates this chemical reaction.

(A) Word Equation

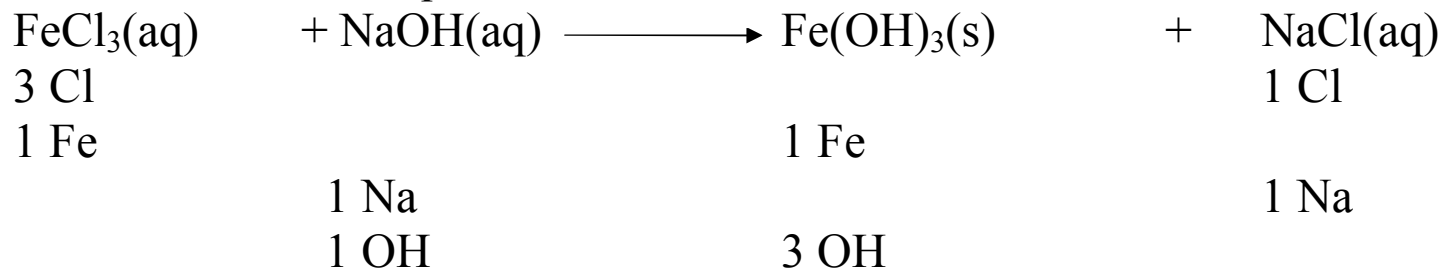
iron(III)chloride (aq) + sodium hydroxide (aq) → iron(III)hydroxide + sodium chloride(aq)

(B) Unbalanced Chemical Equation



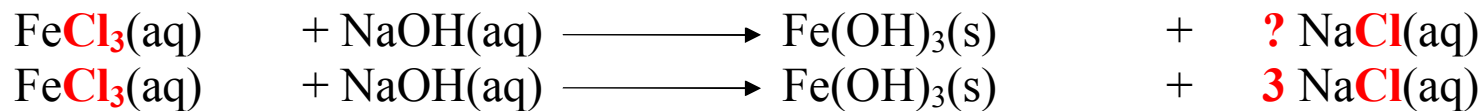
NOTE: Make absolutely sure that all formulas are correctly written before you go to the next step (consider the names given and the charges of ions)

(C) Balanced Chemical Equation

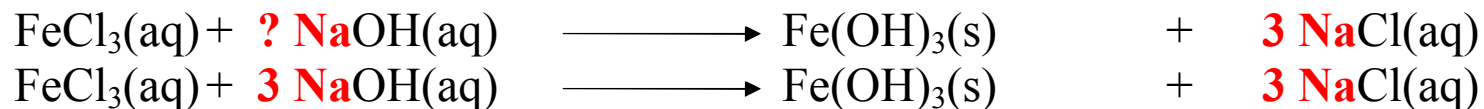


(since the OH⁻ ion does not change, it may be balanced as a group)

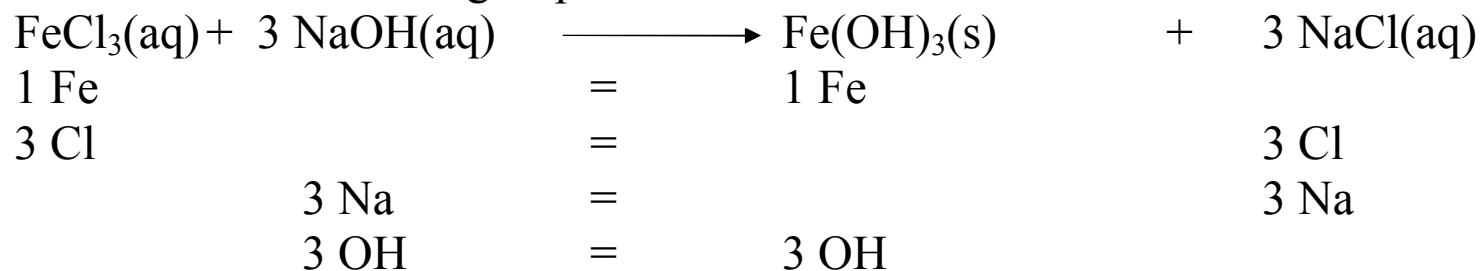
First: Balance Cl:



Second: Balance Na:



Third: Check all other atoms and groups:



The equation is correctly balanced:



