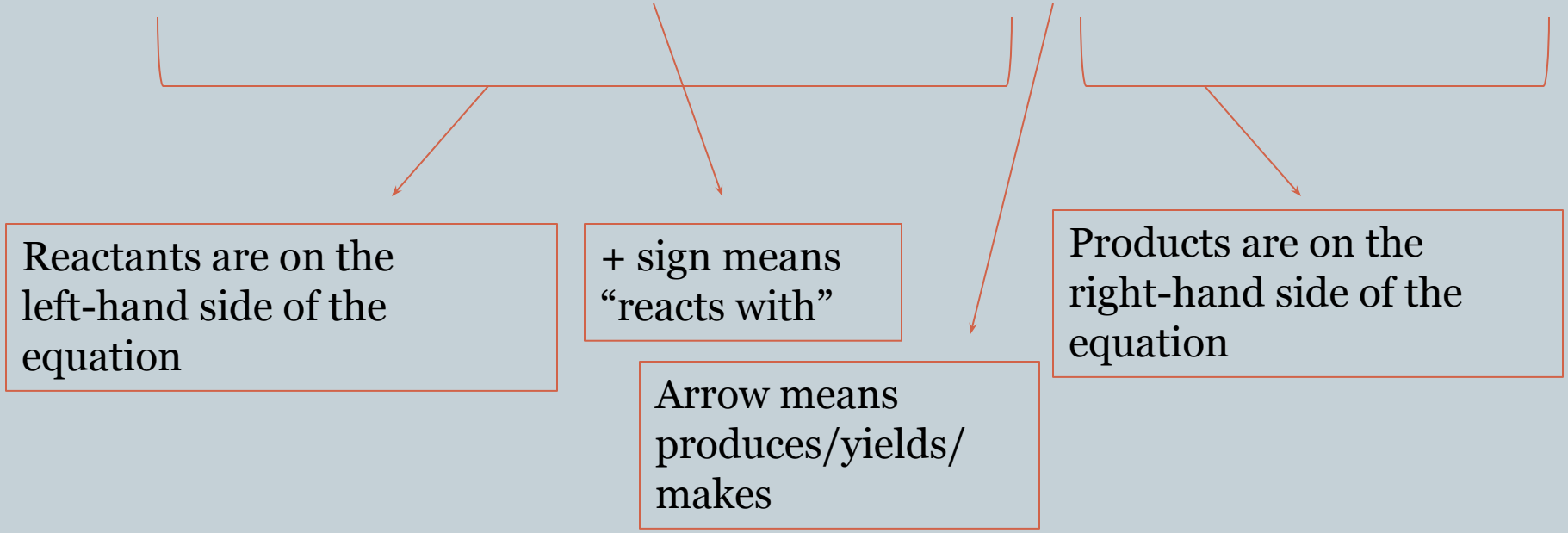
Writing and Balancing Equations

WHAT DO WE KNOW ALREADY??

WORD EQUATION

- Not much information other than the elements/compounds involved
  - **Potassium metal + oxygen gas → potassium oxide**



SKELETON (Unbalanced) EQUATION

- **A skeleton equation shows the formulas of the elements/compounds – it is unbalanced**
  - **Shows atoms, but not quantities of atoms**
    - $K_{(s)} + O_{2\ (g)} \rightarrow K_2O_{(s)}$

Law of Conservation of Mass!

- **Because of the Law of Conservation of Mass, we know that the reactants have to equal the products. So to balance an equation – there must be the same amount of atoms (for each element) on the reactant side and the product side**
  - **Word equation:**
  - **Methane + oxygen → water + carbon dioxide**
  - **Skeleton equation:**
    - $CH_{4(g)} + O_{2\,(g)} \rightarrow H_2O_{(\,)} + CO_{2(g)}$
    - **So we have to get the same number of C, H and O, on each side of the equation. (we can only add coefficients to do this!)**

BALANCED EQUATION

- **A balanced chemical equation shows all atoms and their quantities**
  - **Balancing ensures that the number of each atom is the same on both sides of the reaction arrow**
  - **Always use the smallest whole number ratio**
  - **You can only ever add Coefficients (in front)– not subscripts behind!**
  - **Hint, balance H's 2nd last and O's Last!!!**
    - $4K_{(s)} + O_{2\,(g)} \rightarrow 2K_2O_{(s)}$

Method #1: Counting Atoms by splitting the sides of the Equation

$$Ba + 2H_2O \rightarrow Ba(OH)_2 + H_2$$

Ba	1	✓	Ba	1 ✓
H	2 x 2=4		H	4
O	1 x 2=2		O	2

So to balance everything, we need 2 more H's on the reactant side, so place a 2 in front of the H

We need 2 more O's on the reactant side, so place a 2 in front of the O

WAIT!!!! There is already a 2 in front of the O from when we placed it to balance the H's…great… it works out more easily than we thought.

Try another

$Fe_2O_3 + 3C \rightarrow 2\ Fe + 3\ CO$

Fe	2		Fe	1 x 2 = 2
C	1	✓	C	1 ✓
O	3		O	1 x 3 = 3

WAIT!!!! Now the C's aren't balanced anymore! We need 3 more C's on the reactant side to balance it.

Try a harder one!

$Pb(NO_3)_2 + 2\,KI \rightarrow PbI_2 + 2\,K(NO_3)$

Pb	1	✓
NO_3	2	
K	1	✓
I	1 x 2=2	

Pb	1	✓
NO_3	1 x 2=2	
K	1	✓
I	2	

WAIT!!!! That changed the K's… but we were lucky… It balanced them both out to 2 each.

Try the hardest one!

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

C	2	C	1 x 2 = 2
H	6	H	2 x 3 = 6
O	2 x 3·5 = 7	O	3 7

WAIT!!!! We can't have a decimal in an equation. So multiply everything by 2 to get the next whole number

$$2C_2H6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

Balanced Equation

Method #2: Counting Atoms to Balance an Equation

- **Because of the Law of Conservation of Mass, we can count atoms and use math to balance the number of atoms in chemical equations.**
  - **Word equation:**
  - **Methane + oxygen → water + carbon dioxide**
  - **Skeleton equation:**
    - $CH_{4(g)} + O_{2\,(g)} \rightarrow H_2O_{(\,)} + CO_{2(g)}$
    - **To balance the compounds, take note of how many atoms of each element are on each side of the reaction arrow. Try to make the same number of each element on each side!**

$$CH_{4(g)} + O_{2\,(g)} \rightarrow H_2O_{(aq\,)} + CO_{2(g)}$$

- 1 Carbon, 4 Hydrogen, 2 Oxygen → 1 Carbon, 2 Hydrogen, 3 Oxygen
- **Remember – do O last and H 2nd last.**
- **To balance, attempt to find values that equate atoms on both sides**

Balanced equation:

- $CH_{4(g)} + 2O_{2\,(g)} \rightarrow 2H_2O_{(aq)} + CO_{2(g)}$

- 1 Carbon, 4 Hydrogen, (2x2) Oxygen → 1 Carbon, (2x2) Hydrogen, (2)+2 Oxygen
- ***Remember***, *you can only add numbers as Coefficients (#'s in front), never as subscripts behind!!!*
- Hint, balance H's 2nd last and O's Last!!!

TIPS for Balancing Equations

- Balance chemical equations by following these steps:
  - **Trial and error will work, but can be very inefficient**
  - **Use the table method**
  - **Polyatomic ions (such as SO_4^{2-}) can often be balanced as a whole group**
  - **Only add coefficients (the #'s in front of the elements); NEVER change or add subscripts (behind the elements)!**
  - **Balance the H's 2nd last**
  - **Balance O's Last**
  - **Always double-check after you think you are finished!**

Balance the following:

1. $Fe + Br_2 \rightarrow FeBr_3$
2. $Sn(NO_2)_4 + K_3PO_4 \rightarrow KNO_2 + Sn_3(PO_4)_4$
3. $C_2H4 + O_2 \rightarrow CO_2 + H_2O$
4. $2Fe + 3Br_2 \rightarrow 2FeBr_3$
5. $3Sn(NO_2)_4 + 4K_3PO_4 \rightarrow 12KNO_2 + Sn_3 (PO_4)_4$
6. $C_2H4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$