

## Balancing Equations

### Chemical Equations

Reactants → Products

Color change

Solid forms (Cloudiness ... precipitation)

Bubbles (gas) form

Heat and/or flame is produced

Heat is absorbed (cooling)

#### Reactants

Substances present at the beginning

Starting materials

Initial materials that enter into the reaction; things consumed

#### Products

Substances present at the end of the reaction

New materials formed

Ending materials; things produced

### Chemical Equations

**For:**            **Reactants (A + B) → Products (C + D)**

+ is read as

“plus”

“and”

→ is read as

“yields”

“produces”

“forms”

**May use “state symbols” (often as subscript):**

(aq) = aqueous, dissolved in water

(s) = solid, precipitate; also

(l) = liquid

(g) = gas

## Chemical Equations Must

be “balanced”

follow the Law of Conservation of Mass

Total mass reactants = Total mass products

No mass is lost during chemical reaction

No atoms destroyed during ordinary reactions

Atoms recombined into new materials (products)

**Total # atoms reactants = Total # atoms products**

**Total # atoms reactants = Total # atoms products**

**To balance: need same # atoms on both sides of the →**

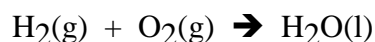
**Start with correct chemical formulas**

### WORK WITH COEFFICIENTS

(Trial and error until atoms on both sides are equal)

**For Hydrogen + Oxygen yields water**

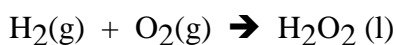
**Write Starting Materials and Products**



**Count atoms → must be same on both sides**



**There is a tendency (wrong) to balance with subscripts:**



But,  $\text{H}_2\text{O}$  is not the same as  $\text{H}_2\text{O}_2$

### Chemical Equations

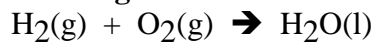
**Balance With Coefficients, not subscripts**

‘cause balancing with subscripts changes the reaction

Remember,  $\text{H}_2\text{O}$  is chemically not the same as  $\text{H}_2\text{O}_2$

**For Hydrogen + Oxygen yields water**

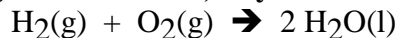
**Write Starting Materials and Products**



**Count atoms → must be same on both sides**



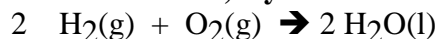
**Oxygen unbalanced; Try**



**Count atoms → must be same on both sides**



**Oxygen now balanced, try**



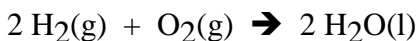
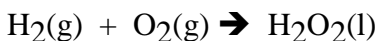
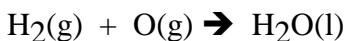
**Count atoms → must be same on both sides**



Success!

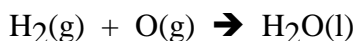
### Chemical Equations

**Which is correct?**

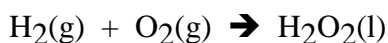


**Which is correct?**

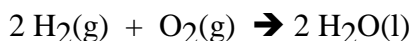
**Oxygen should be diatomic, so these are wrong**



**Equation balanced, but not for water:**



**Equation balanced for water formation:**



## Hints for Balancing

### I tend to work with whole numbers ...

fractional coefficients tend to confuse

### Bottom line:

No fixed rule ... every reaction is different

Requires practice to develop balancing skills

### My two guidelines:

Start with a metal or most complex reaction material

Save water (or diatomic gasses) last step

### Genius is 10% inspiration and 90 % perspiration.

Thomas Alva Edison

## Balance This Chemical Equation



Safety Tip: HCl is a corrosive acid; lab precautions needed

### Start with Chlorine:

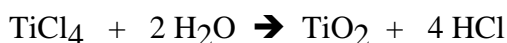


Atom Count: 1 Ti; 4 Cl; 2 H; 1 O  $\rightarrow$  1 Ti; 4 Cl; 4 H; 2 O

Ti & Cl balanced; H & O are not

### Hint: Leave H & O for last, especially if water is involved

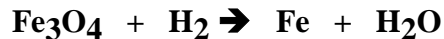
4 H suggests 2 waters, so try 2 H<sub>2</sub>O



Atom Count: 1 Ti; 4 Cl; 4 H; 2 O  $\rightarrow$  1 Ti; 4 Cl; 4 H; 2 O

Success!

**Balance This Chemical Equation**



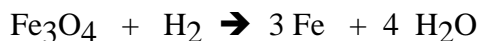
**Start with Iron**



Atom Count: 3 Fe; 2 H; 4 O → 3 Fe; 2 H; 1 O

**Fe & H balanced; O is not ... suggests water is key**

**Four O on the start side suggests 4 waters on product side; try 4 H<sub>2</sub>O**



Atom Count: 3 Fe; 2 H; 4 O → 3 Fe; 8 H; 4 O

**Fe & O balanced; H is not ... finish by balancing H**



Success!

**Balance This Chemical Equation**



Safety Tip: Cl<sub>2</sub> is toxic; lab precautions needed

**Mn Balanced: Start with 4 Chlorine on product side**



Atom Count: 1 Mn; 4 Cl; 4 H; 2 O → 1 Mn; 4 Cl; 2 H; 1 O

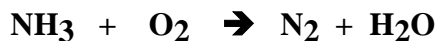
**O is odd on product side, try making it even**



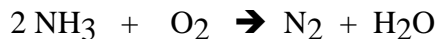
Atom Count: 1 Mn; 4 Cl; 4 H; 2 O → 1 Mn; 4 Cl; 4 H; 2 O

Success!

**Balance This Chemical Equation**

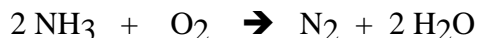


**Reaction has odd/even combination of diatomic molecules  
Start with Nitrogen ... try**



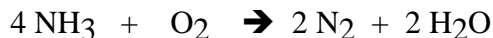
Atom Count: 2 N; 6 H; 2 O → 2 N; 2 H; 1 O

**Oxygen unbalanced ... try**



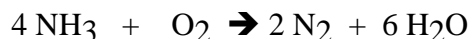
Atom Count: 2 N; 6 H; 2 O → 2 N; 4 H; 2 O

**Hydrogen unbalanced ... try changing N in product**



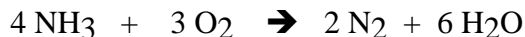
Atom Count: 4 N; 12 H; 2 O → 4 N; 4 H; 2 O

**H & O unbalanced ... try balancing H with water**



Atom Count: 4 N; 12 H; 2 O → 4 N; 12 H; 6 O

**Only O unbalanced ... finish with O on starting side**



Atom Count: 4 N; 12 H; 6 O → 4 N; 12 H; 6 O

Success!

**Balance This Chemical Equation**



Safety Tip: SO<sub>2</sub> is a corrosive acid; lab precautions needed

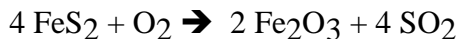
Atom Count: 1 Fe; 2 S; 2 O → 2 Fe; 1 S; 5 O

**Everything unbalanced ... start with iron ... try**



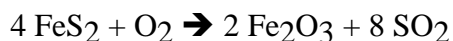
Atom Count: 2 Fe; 4 S; 2 O → 2 Fe; 4 S; 11 O

**Oxygen odd & unbalanced ... try another Fe on product side**



Atom Count: 4 Fe; 8 S; 2 O → 4 Fe; 4 S; 14 O

### **Sulfur unbalanced ... try to balance Sulfur**



Atom Count: 4 Fe; 8 S; 2 O → 4 Fe; 8 S; 22 O

### **Only Oxygen unbalanced ... finish by balancing Oxygen**



Atom Count: 4 Fe; 8 S; 22 O → 4 Fe; 8 S; 22 O

Success!

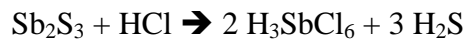
### **Balance This Chemical Equation**



Safety Tip: H<sub>2</sub>S is toxic; lab precautions needed

Atom Count: 2 Sb; 3 S; 1 H; 1 Cl → 1 Sb; 1 S; 5 H; 6 Cl

### **Start with Antimony & Sulfur**



Atom Count: 2 Sb; 3 S; 1 H; 1 Cl → 2 Sb; 3 S; 12 H; 12 Cl

### **Hydrogen & Chlorine Balanced Together**



Atom Count: 2 Sb; 3 S; 12 H; 12 Cl → 2 Sb; 3 S; 12 H; 12 Cl

Success!

### **Practice Improves Performance**

#### **Assignment**

Start Taking Unit 6 Practice Test

Blackboard only records highest score

Take until multiple 100's have been scored (questions are variable)

(Gives sense of test exam format and content)

**The Practice Quiz is very similar to the Unit Exam**

**Success on Unit exam is directly related to practice exam experiences**

At this point:

Elements & polyatomic ions should be memorized