CHEMICAL REACTIONS

Chapter 17

Atomic vs. Molecular Weight

- Atomic weight on periodic table is average of natural abundance of isotopes
- Atomic mass is the number of nucleons in a particular atom—specified by isotope
- Molecular mass is the mass of one mole of molecules
  - One atomic mass number of grams
  - 6.0221367×10^{23} molecules

Calculate Molecular Mass

- O atomic weight 15.9996 (round to 16 for this class)
- O-16 atomic mass 16 u
- Molecular oxygen O_2 atomic mass 32 u
- Molecular O_2 molecular mass 32 g/mole

CO_2 molecular mass

- C=12 g/mole, O_2=32 g/mole
- CO_2=12+32=44 g/mole

Na_2CO_3 molecular mass

- Na = 23 g/mole
- C = 12 g/mole
- O = 16 g/mole
- 2 Na, 3 O, so multiply
- 2(23) + 12 + 3(16) = 106 g/mole

Write these down

- C = 12
- H = 1
- O = 16
- N = 14
- K = 39
- Cl = 35.5
- Use for some questions

How many grams of oxygen can be produced from 122.45 g of $KClO_3$?

$2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$

1. First find molecular masses of substances
2. Convert 122.45 g of $KClO_3$ to moles
3. Find molar ratios from balanced equation
4. Calculate moles of O_2
5. Convert that to grams of O_2

How many grams of oxygen can be produced from 122.45 g of $KClO_3$?

$2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$

1. 32.00 g
2. 48.00 g
3. 61.22 g
4. 122.45 g

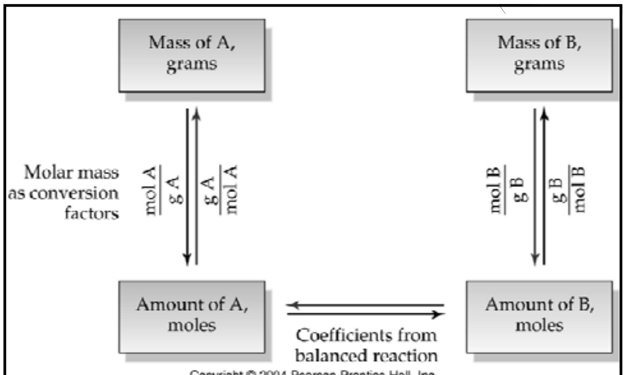
How many grams of water are produced from 1.25 moles of methane?

$1\ CH_4 + 2\ O_2 \rightarrow 2\ H_2O + 1\ CO_2$

1. 11.25 grams
2. 22.5 grams
3. 45 grams
4. 90 grams

Moles calculated from Grams

- 176 g of CO_2 = Number of moles?
- Molar mass of $CO_2 = 44\ \frac{g}{mole}$
- If you multiply,
  - $176\ g \times 44\ \frac{g}{mole}$ results in units of $\frac{g^2}{mole}$
  - you get a unit mess
- **UNITS** alert you that you made an error
- **KEEP UNITS WITH NUMBERS!!**



To convert between grams and moles

- Find molar mass
- Divide grams by molar mass

Proportions

- Correctly organized
- Label the numbers
- Try to put unknown on the top—easier to solve
- The second ratio needs to have substances in same position as the first

Proportions

- Mathematical device to compare ratios
- Cross-multiply to solve
- Correctly organized
- Be sure you keep molar ratio on one side of the equal sign
- Put the ratio of unknown to known on the other side
- Be sure same substance is on top on both sides…so the other substance is on bottom on both sides…

Problem

$NO + O_2 \rightarrow NO_2$

- 64 grams O_2
- How many grams NO_2 produced?

First: Balance Equation

$$2NO + O_2 \rightarrow 2NO_2$$

Problem

$2NO + O_2 \rightarrow 2NO_2$

- 64 grams O_2
- How many grams NO_2 produced?

Balance Equation
Determine molar ratios of them 1:2
Find molar mass of each component
NO_2=46 g, O_2=32 g, (NO=30 g)

Problem

$2NO + O_2 \rightarrow 2NO_2$

- 64 grams O_2
- How many grams NO_2 produced?

Molar mass of each: O_2=32 g, NO_2=46 g

How many moles is 64 grams O_2?
One mole

Problem

$2NO + O_2 \rightarrow 2NO_2$

- 64 grams O_2
- How many grams NO_2 produced?
- Molar mass of each O_2=32 g, NO_2=46 g

Molar ratios O_2:NO_2 is 1:2
Two mole of O_2
So four moles of NO_2 is produced
How many grams is that?
4 mol x 46 g/mol = 184 grams

Problem

$$H_2S + O_2 \rightarrow SO_2 + H_2O$$

- 32 grams SO_2
- How many grams O_2 used?

Problem

- 32 grams SO_2
- How many grams O_2 used?

$$H_2S + O_2 \rightarrow SO_2 + H_2O$$

- Balance first

$$2H_2S + 3O_2 \rightarrow 2SO_2 + 2H_2O$$

- Then determine molar ratios
- 2 SO_2 to 3 O_2

Problem

- 32 grams SO_2
- How many grams O_2 used?

$$2H_2S + 3O_2 \rightarrow 2SO_2 + 2H_2O$$

- Find molar masses
  - SO_2 = 32 + 32 = 64 g/mol SO_2
  - O_2 = (2x1) +16 = 32 g/mol O_2
  - H_2O= (2x1) +16 = 18 g/mol H_2O
  - H_2S = (2x1) +32 = 34 g/mol H_2S

Problem

- 32 grams SO_2
- How many grams O_2 used?

$$2H_2S + 3O_2 \rightarrow 2SO_2 + 2H_2O$$

- 32 g SO_2 needs how many grams O_2?
- How many moles is 32 g SO_2?

$$32\,\text{g}\,SO_2 \cdot \frac{1\,mole}{64\,\text{g}} = 0.5\,moles\,SO_2$$

Problem

- 32 grams SO_2
- How many grams O_2 used?

$$2H_2S + 3O_2 \rightarrow 2SO_2 + 2H_2O$$

- How many moles O_2 is needed?
- 0.5 moles SO_2 in 2:3 ratio with O_2
- 0.75 moles O_2

$$32\,\text{g}\,SO_2 \cdot \frac{1\,mole}{64\,\text{g}} = 0.5\,moles\,SO_2$$

Set up proportion

- 32 grams SO_2
- How many grams O_2 used?

with the unknown on top (the O_2)

$$\frac{?\,\text{g}\,O_2}{[\quad]} = \frac{[\quad]}{[\quad]}$$

O2 on top SO2 on bottom

molar amount known SO2 on bottom

molar ratio from balanced equation

Problem 6

$$C + O_2 \rightarrow CO_2$$

Is it balanced?
Molar ratio 1:1:1
4 grams oxygen

- Grams carbon consumed?
- Grams carbon dioxide produced?

Problem 6

$$C + O_2 \rightarrow CO_2$$

Molar ratio 1:1:1
4 grams oxygen

- 1 mole O_2 = 32 g

$$4g\ O_2 \cdot \frac{1\,mole}{32g} = 0.125\ moles\ O_2$$

Problem 6

$$C + O_2 \rightarrow CO_2$$

Molar ratio 1:1:1

0.125 moles O_2 in 1:1 ratio

0.125 moles C
0.125 moles CO_2

Problem 6

$$C + O_2 \rightarrow CO_2$$

0.125 moles C

Grams carbon consumed?

$$0.125 moles\ C \cdot \frac{12g}{1\,mole} = 1.5g\ C$$

$$0.125\ \text{mole}\ CO_2 \cdot \frac{44g}{1\,mole} = 5.5g\ CO_2$$

Reaction Speed

Collision of molecules required for it to occur

- Increase concentration
- Increase temperature
- Catalyst can facilitate reaction

Chlorine catalyst