Let's build a time machine and travel into the future!!

What do we find????

Congratulations!
You have a new job!
Your Employer:

3M

Does anybody know what the 3 M's stand for?

- Minnesota
- Mining and
- Manufacturing

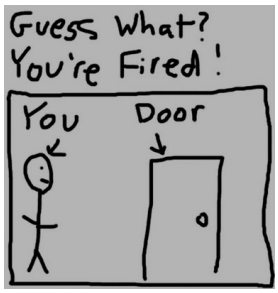
Your Job Title:
Chemical Engineer

Your Job Description:
Production of
Post-It Note Sticky Goop

Post-It Note Reaction:
3 GuNk + 4 MuCk → 2 StIcKyGoOp

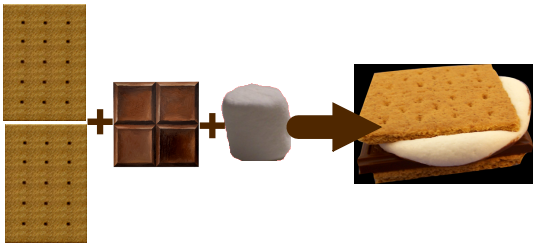
The coefficients tell the mole ratio between two different substances in the reaction.

If we want to make a profit selling Sticky Goop, we had better consider this ratio when producing a batch. If we disregard this ratio, we will waste big bucks for the company and we will be fired!



The study of the quantitative relationships between reactants and products is called:

STOICHIOMETRY



2 Grahams + 4 Chocolates + Marshmallow ⟶ Smore

How many grahams are required to make 26 smores?

How many chocolates are required to use up 15 marshmallows?

How many smores can you make with 16 chocolates?

$2NH_3(g) \text{ ----> } N_2(g) + 3H_2(g)$

What is the mole ratio(chemical equivalence) between NH_3/N_2?

What is the mole ratio (chemical equivalence) between NH_3/H_2?

What number of moles of hydrogen would form if 5 moles of ammonia reacted?

What number of moles of ammonia are required to make 16 moles of nitrogen?

$2H_2 + O_2 \rightarrow 2H_2O$

How many moles of water would be produced if 20 moles of hydrogen react with adequate oxygen?

How many moles of water would be produced if 15.4 moles of oxygen react with adequate hydrogen?

If 14 moles of water are formed, how many moles of hydrogen and moles of oxygen reacted?

Solving Stoichiometry Problems

STEP 1: Check to make sure you have a balanced equation.

STEP 2: Read the problem and identify the known quantity in the problem (what's given) and the unknown quantity (what you are trying to solve for).

STEP 3: If the known from the problem is not given in moles . . . CONVERT TO MOLES (Use the mole map)

DIN Train

STEP 4: Convert moles of known to moles of unknown. Multiply moles of the known by a conversion fraction. The top of the fraction is the coefficient for the unknown and the bottom of the fraction is the coefficient for the known.

STEP 5: Convert the moles found in step 4 to the units the problem is asking you to solve in. (Use the mole map.)

MOUT Train

Using the balanced equation, determine how many grams of nitrogen will form if 4.0 moles of NH_3 react.

$$2NH_3(g) \quad ----> \quad N_2(g) \quad + \quad 3H_2(g)$$

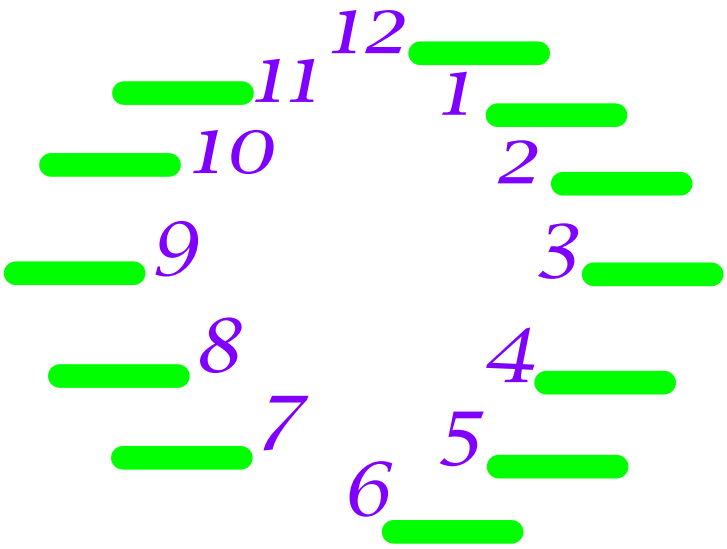
Using the balanced equation, determine how many moles of NH_3 react if 14.5 grams of hydrogen form.

$$2NH_3(g) \quad ----> \quad N_2(g) \quad + \quad 3H_2(g)$$

How many liters of $N_2(g)$ would form if the reaction is taking place at STP?

Using the balanced equation, if 65.0 g of hydrogen are to be produced, how many grams of ammonia are required?

$2NH_3(g)$ ----> $N_2(g)$ + $3H_2(g)$



P3 Appointment Problem

4 1 & 2.

P4 Appointment Problem

P5 Appointment Problem

Baking & Sodium Bicarbonate

What's better than walking inside your house to the nice warm delicious smell of cookies coming out of the oven? Or freshly frosted cupcakes sitting on the counter? We can barely wait to dig our teeth into the moist and fluffy confections. But what makes sweet treats like cakes, cookies, and cupcakes so fluffy and light? Dare we say… chemistry?

The real secret ingredient to light and fluffy, melt-in-your-mouth deserts is baking soda, or to be more chemically specific, sodium bicarbonate. Baking soda has a chemical formula of $NaHCO_3$ and is used in everything from cooking and cleaning to treating heartburn and indigestion.

How does this simple little compound do so much work in our kitchens? When baking soda is used in baking recipes it makes batter rise, which results in a light and fluffy texture. This occurs because baking soda decomposes upon heating to form carbon dioxide (a gas) according to the following equation:

$$2\ NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$$

According to our grandmother's favorite the-berry-best-strawberry cupcake recipe we need 1.5 grams of baking soda for two-dozen cupcakes. If we make five-dozen cupcakes how much CO_2 (in grams) will we produce?

$2H_2 + O_2 \rightarrow 2H_2O$

If 16.00g of oxygen react with adequate hydrogen, how many grams of water will form?

How many grams of each reactant are required to produce 36.04 grams of water?

Using the balanced equation, if 3.55×10^{21} molecules of hydrogen are to be produced, how many grams of ammonia are required?

$$2NH_3(g) \text{ ----> } N_2(g) + 3H_2(g)$$

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$$2NH_3(g) \text{ ----> } N_2(g) + 3H_2(g)$$

$$3O_2 + 4Fe \text{ --> } 2Fe_2O_3$$

How many moles of Fe are required to react with 22.7 moles of oxygen?

How many grams of oxygen are required to produce 75.0 grams of Fe_2O_3 ?

$$3O_2 + 4Fe \rightarrow 2Fe_2O_3$$

How many moles of Fe are required to react with 22.7 moles of oxygen?

$$22.7 \text{ mol } O_2 \times \frac{4 \text{ mol Fe}}{3 \text{ mol } O_2} = 30.3 \text{ mol Fe}$$

How many grams of oxygen are required to produce 75.0 grams of Fe_2O_3?

$$\frac{75.0 \text{ g } Fe_2O_3}{159.70 \text{ g/mol}} = 0.4696 \text{ mol } Fe_2O_3 \times \frac{3 \text{ mol } O_2}{2 \text{ mol } Fe_2O_3}$$

$$= 0.704 \text{ mol } O_2 \times \frac{32.00 \text{ g/mol}}{22.5 \text{ g } O_2}$$

Yield: The amount of product expected or formed in a reaction.

Theoretical Yield: The number of grams of product that should form in a reaction according to your calculations. The theoretical yield is a 100% yield.

Actual Yield: When you carry out a reaction in the lab and measure the actual number of grams of product you get in the reaction.

Percent Yield: A ratio of actual yield divided by theoretical yield multiplied by 100.

$$\% \text{ Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$$

Percent Yield Calculations

1) Balance this equation:

_____ Mg + _____ HNO_3 → _____ $Mg(NO_3)_2$ + _____ H_2

2) If I start this reaction with 40 grams of Mg, how many grams of H_2 will I produce?

Theoretical Yield

3) If 1.7 grams of H_2 is actually produced, what was my percent yield of hydrogen?

Actual Yield

1) Balance this equation:

_____ Mg + __2__ HNO_3 → _____ $Mg(NO_3)_2$ + _____ H_2

2) If I start this reaction with 40 grams of Mg, how many grams of H_2 will I produce?

$$\frac{40.\text{g Mg}}{\frac{24.31\text{g}}{\text{mol}}} = 1.645\text{mol Mg} \times \frac{1\text{mol } H_2}{1\text{mol Mg}} = 1.645\text{mol } H_2 \times \frac{2.02\text{g}}{1\text{mol}} = 3.3\text{g } H_2$$

3) If 1.7 grams of H_2 is actually produced, what was my percent yield of hydrogen?

$$\frac{1.7\text{g}}{3.3} \times 100 = 52\%$$

25.0 g of ethane (C_2H_6) combust to produce carbon dioxide and liquid water. Write the balanced equation and calculate how many mL of water will form in this reaction. The density of water is 0.9982 g/mL.

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

25.0 g ; ? mL

$\frac{25.0\text{ g } C_2H_6}{30.08\text{ g/mol}} = 0.8311\text{ mol } C_2H_6 \times \frac{6\text{ mol } H_2O}{2\text{ mol } C_2H_6} = 2.493\text{ mol } H_2O$

$2.493\text{ mol } H_2O \times 18.02\text{ g/mol} = 44.930\text{ g } H_2O$

$44.930\text{ g } H_2O \times \frac{1\text{ mL}}{0.9982\text{ g}} = \boxed{45.0\text{ mL } H_2O}$