Stoichiometry

1 marshmallow + 4 chocolate chips + 2 crackers → 1 s'more

1 : 4 : 2 → 1

actual amount: 6 : 24 : 12 → 6

If I have 6 marshmallows and I want to use them all up:

- How many s'mores can I make? 6
- How many chocolate chips will I need? 24
- How many crackers will I need? 12

Show the math to determine number of crackers needed:

$$\#\text{crackers} = 6\ \text{marshmallows} \times \frac{2\ \text{crackers}}{1\ \text{marshmallow}}$$

$$= 12\ \text{crackers}$$

Stoichiometry: determing the quantities of reactants/products in a chemical equation

- Coefficients in balanced chemical equations tell you the quantities needed for a reaction, and how much product is produced.

$1\ Zn_{(s)} + 2\ HCl_{(aq)} \rightarrow 1\ ZnCl_{2\,(aq)} + 1\ H_{2\,(g)}$

- Coefficients can be read as either # of molecules or moles.
- **Mole ratios** are ratios between the coefficients in an equation

The mole ratios for the above equation are:

$\frac{1\ mol\ Zn}{2\ mol\ HCl}$ $\frac{2\ mol\ HCl}{1\ mol\ ZnCl_2}$

$\frac{1\ mol\ Zn}{1\ mol\ ZnCl_2}$ $\frac{2\ mol\ HCl}{1\ mol\ H_2}$

$\frac{1\ mol\ Zn}{1\ mol\ H_2}$ $\frac{1\ mol\ ZnCl_2}{1\ mol\ H_2}$

- Mole ratios can be used to find the amount of reactants needed or to predict the amount of product made.
- Write the ratio as a conversion factor as the unknown/known

$$\text{amount unknown} = \text{mol known} \times \text{mole ratio}\left(\frac{\text{mol unknown}}{\text{mol known}}\right)$$

Ex 1. $3MgCl_2 + 2Na_3P \rightarrow Mg_3P_2 + 6NaCl$

3 2 1 6

a) If 9 mol of $MgCl_2$ is consumed, how many mol NaCl is produced?

$$n_{NaCl} = 9\ mol\ MgCl_2 \times \frac{6\ mol\ NaCl}{3\ mol\ MgCl_2}$$

$$= 18\ mol\ NaCl$$

∴ 18 mol NaCl are produced

b) If 9 mol of $MgCl_2$ is consumed, how many mol of Na_3P react?

$$n_{Na_3P} = 9\ mol\ MgCl_2 \times \frac{2\ mol\ Na_3P}{3\ mol\ MgCl_2}$$

$$= 6\ mol\ Na_3P$$

∴ 6 mol Na_3P react.

$3\,MgCl_2 + 2Na_3P \rightarrow Mg_3P_2 + 6\,NaCl$

c) If 3.2 mol of Na_3P react, what mass of Mg_3P_2 is produced?

$$n_{Mg_3P_2} = 3.2\ mol\ Na_3P \times \frac{1\ mol\ Mg_3P_2}{2\ mol\ Na_3P}$$

$$= 1.6\ mol\ Mg_3P_2$$

$$M_{Mg_3P_2} = 3(24.305) + 2(30.974)$$

$$= 134.863\ g/mol$$

$$m_{Mg_3P_2} = 1.6\ mol \times \frac{134.863\ g}{mol} = 215.78\ g$$

$$= 220\ g\ (s.f.)$$

steps OR line

d) If 10 g of NaCl was produced, how many moles of Na_3P was reacted?

$$M_{NaCl} = 58.443\ \frac{g}{mol}$$

$$n_{Na_3P} = 10\ g\ NaCl \times \frac{1\ mol\ NaCl}{58.443\ g\ NaCl} \times \frac{2\ mol\ Na_3P}{6\ mol\ NaCl}$$

$$= 0.06\ mol\ Na_3P$$

* try line first

1. Consider the following reaction:
   $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

   a) Write the all the mole ratios

   b) How many moles of O_2 are required to react with 100 moles of H_2?

   c) How many moles of water are formed when 2478 moles of O_2 react?

   d) How many moles of H_2 are required to react completely with 6.02×10^{23} moles of O_2?

2. Aluminum bromide can be prepared by reacting small pieces of aluminum foil with liquid bromine at room temperature. The reaction is accompanied by flashes of red light.

   a) Write a balanced chemical equation of the above reaction.

   b) How many moles of bromine are needed to produce 5 mol of aluminum bromide?

   c) How many moles of aluminum are needed to react?