Stoichiometry

Web Resources

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Section 1: Definitions

Define the following terms

Average Atomic mass -

Molecule -

Molecular mass -

Moles -

Avagadro's Number -

Conservation of matter -

Percent composition -

Empirical Forumula -

Molecular Formula -

Mole Ratio -

Section 2: Mass to Moles

To determine moles of a substance divide the given mass by the molecular mass.

Example

How many moles are in $25.0 \cdot grams \cdot C_2 \cdot H_6$

1. Calculate the molecular mass of C2H6.

$$\frac{1.01 \cdot g}{mol} \cdot 6 + \frac{12.0 \cdot g}{mol} \cdot 2 \qquad \frac{30.06 \cdot g}{mol}$$

this means that there are 30.06 g of C2H6 for every one mole of C2H6.

2. Calculate the number of moles in 25.0 g of C2H6. by dividing the number of grams by the molar mass.

$$25.0 \cdot \_g \cdot \left(\frac{1 \cdot \_mol}{30.1 \cdot \_g} \right) \qquad .830565 \cdot \_mol$$

there are 30.1 grams in one mole we are given 25 grams which is less than 30.1g therefore the number of moles should be less than one.

To determine the number of moles follow the following steps.

1. Calculate the molecular mass.
2. Using proper units divide the given mass by the molecular mass.

1. 18.0 g H2O

2. 36.0 g H2O

3. 5.00 g H2O

4. 40.0 g NaOH

5. 12.0 g NaOH

6. 0.256 g H2O

Section 3: Moles to atoms

Avagadro's number is the number of things in one mole of substance.

$$1 \cdot \_mol = 6.022 \cdot x10^{23} \cdot \_things$$

To determine the number of atoms given a certain mass follow this procedure.

1. **Convert mass into moles**
2. **Multiply the number of moles by Avagadro's number.**

Example:

Given 2.57 grams of Mg how many atoms of Mg are present?

1. Determine the number of moles.

$$2.57 \cdot \_g \cdot \left(\frac{1 \cdot \_mol}{24.31 \cdot \_g} \right) \qquad .105718 \cdot \_mol$$

2. Calculate the number of atoms.

$$.106 \cdot \_mol \cdot \left(\frac{6.022\text{E}23 \cdot \_atoms}{1 \cdot \_mol} \right) \qquad 6.38332e22 \cdot \_atoms$$

Calculate the number of atoms in each of the following problems.

1. 4.56 g Na

2. 27.45 g Ca

3. 27.3 g Al

4. 6.571g Ti

Section 4: grams to moles to molecules

Let's look at the calculation of molecules instead of just atoms. to calculate molecules use the same procedure determine the moles of molecules and multiply the moles by Avagadro's number to determine molecules.

45.6 g NaOH how many molecules of NaOH are present.

1. Calculate the moles.

$$45.6 \cdot \_g \cdot \left(\frac{1 \cdot \_mol}{40.0 \cdot \_g} \right) \qquad 1.14 \cdot \_mol$$

2. Determine the number of molecules by multiplying by Avagadro's number.

$$1.14 \cdot \_mol \cdot \left(\frac{6.022\text{E}23 \cdot \_molecules}{1 \cdot \_mol} \right) \qquad 6.86508e23 \cdot \_molecules$$

Calculate the number of molecules in each of the following.

1. 12.4 g NaOH

2. 100.56 g HC2H3O2

3. 56.7 g AgNO3

4. 1200.4 g NaCl

Section 5: molecules to moles to grams

Calculation of grams from moles, molecules and atoms.

1. From atoms or molecules calculate the number of moles by dividing by Avagadro's number.
2. Multiply the moles by the atomic mass or molecular mass.

Example:

How many grams does 7.25x10^23 molecules of NaCl weigh?

1. Calculate moles

$$7.25\text{E}23 \cdot \_molecules \left(\frac{1 \cdot \_mol}{6.022\text{E}23 \cdot \_molecules} \right) \qquad 1.20392 \cdot \_mol$$

2. Convert moles to mass

$$1.20 \cdot \_mol \cdot \left(\frac{58.0 \cdot \_g}{1 \cdot \_mol} \right) \qquad 682.543 \cdot \left(\frac{\_m}{\_s^2} \right)$$

Determine the following grams of each substance.

1. 2.57 moles of MgCl2

2. 8.57x10^24 molecules of AlCl3

3. 450.3 moles of Pb3(PO4)2

4. 1.34x10^12 atoms of H

Section 6:

In stoichiometry balancing and determing the number of atoms or moles needed for a reaction is very important.

In the following reaction

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

the ratio of Mg to HCl is 1 Magnesium for every 2 HCl. This means that for this reaction to occur that there needs to be 1 atom of Mg for every 2 atoms of HCl. This can be translated to a larger scale by saying that for every 1 mole of Mg there must be 2 moles of HCl.

With this infromation we can determine the following.

If we are given 1.5 moles of Mg how many moles of HCl will be needed to completely react the Mg?

Remember that Mg and HCl are in a 1 to 2 ratio.

$$1.5 \cdot \_mol\_Mg \left(\frac{2 \cdot \_mol\_HCl}{1 \cdot \_mol\_Mg} \right) \qquad 3. \cdot \_hcl \cdot \_mol$$

There for if we have 1.5 mol Mg we need 3.0 mol HCl.

For the following reaction determine the unknown number of moles.

$$Cu(NO_3)_2(aq) + 2NaOH(aq) \rightarrow Cu(OH)_2(s) + 2NaNO_3(aq)$$

1. 1 mol Cu(NO3)2 how many moles of NaOH are needed?

2. 0.735 mol NaOH how many moles of Cu(NO3)2 are needed?

3. 100.45 mol NaOH how many moles of NaNO3 will be produced?

4. 25.4 g of Cu(NO3)2 how many grams of NaNO3 will be produced?

Section 7: Determination of percent composition

Percent composition is the percent by mass of each component in a chemical formula.

Record the process for determining the percent composistion.
Guide sheet to mole calculations

Determine the percent composistion for each of the following elements in the compounds below.

1. NaCl

2. H_2SO_4

3. $HC_2H_3O_2$

4. $C_6H_{12}O_6$