The Relationship Between the Formula of a Compound and the Elements Which Make It Up - A 2nd Conversion Factor

- consider the formula H_2O H : O = 2 : 1

1 unit H_2O = 2 units of H
= 1 unit of O

1 mole H_2O = 2 moles H c.f.
1 mole H_2O = 1 mole O

- these are c.f.'s which allow the conversion from the compound to a single element in the compound

Note: In terms of the numbers of particles, molecules or formula units are used for compounds and atoms are used for elements

In general:

1 mole compound = subscript # moles of element

or

1 molecule compound = subscript # atoms of element

e.g. How many moles of O are present in 2.5 moles of $CuSO_4$?

1 molecule $CuSO_4$ = 4 moles of O atoms c.f.

$$2.5 \text{ moles of } CuSO_4 \times \frac{4 \text{ moles of O}}{1 \text{ mol } CuSO_4} = 10 \text{ moles of O atoms}$$

e.g How many atoms of O are present in 3.01×10^{23} molecules of $CuSO_4$?

1 molecule $CuSO_4$ = 4 atoms O

$$3.01 \times 10^{23} \text{ molecules of } CuSO_4 \times \frac{4 \text{ atoms O}}{1 \text{ molecule } CuSO_4}$$

$$= 1.2 \times 10^{24} \text{ atoms O}$$

Review

How many molecules of $Na_2S_2O_3$ are present in 0.25 moles of $Na_2S_2O_3$?

c.f. 1 mole of $Na_2S_2O_3$ = 6.02×10^{23} molecules of $Na_2S_2O_3$

$$0.25 \text{ moles of } Na_2S_2O_3 \times \frac{6.02 \times 10^{23} \text{ molecules of } Na_2S_2O_3}{1 \text{ mole } H_2O}$$

$$= 1.5 \times 10^{23} \text{ molecules of } Na_2S_2O_3$$

e.g. How many atoms of S are present in 1.5×10^{23} molecules of $Na_2S_2O_3$?

1 molecule $Na_2S_2O_3$ = 2 atoms S

$$1.5 \times 10^{23} \text{ molecules of } Na_2S_2O_3 \times \frac{2 \text{ atoms S}}{1 \text{ molecule } Na_2S_2O_3}$$

$$= 3.0 \times 10^{23} \text{ atoms S}$$

Two Conversion Factors:

1. N_A

mol element ---^{NA}--> # atoms element

mol compound ---^{NA}--> # molecules compound

2. formula subscript

mol compound —^{subscript}--> # moles element

molecules —^{subscript}--> # atoms of element

Note: You cannot go directly from moles of a compound to atoms of an element. You must use two steps.

e.g. How many atoms of S are present in 0.25 moles of $Na_2S_2O_3$?

1 mole $Na_2S_2O_3$ = 2 moles S 1 mole S = 6.02×10^{23} atoms S

$$0.25 \text{ moles of } Na_2S_2O_3 \times \frac{6.02 \times 10^{23} \text{ molecules of } Na_2S_2O_3}{1 \text{ mole } H_2O}$$

$$= 1.5 \times 10^{23} \text{ molecules of } Na_2S_2O_3$$

$$1.5 \times 10^{23} \text{ molecules of } Na_2S_2O_3 \times \frac{2 \text{ atoms S}}{1 \text{ molecule } Na_2S_2O_3}$$

$$= 3.0 \times 10^{23} \text{ atoms S}$$