Quiz (Percentage by Mass of an Element in a Compound)

1. Bauxite is the main ore of aluminium. It contains mainly aluminium oxide (Al_2O_3). Calculate the percentage by mass of aluminium in aluminium oxide.
   (Relative atomic masses: O = 16.0, Al = 27.0)

2. Sodium hydroxide is the main ingredient of drain cleaner. Calculate the percentage by mass of sodium in sodium hydroxide.
   (Relative atomic masses: H = 1.0, O = 16.0, Na = 23.0)

3. Calculate the mass of copper in 15.0 g of copper(II) sulphate-5-water ($CuSO_4 \bullet 5H_2O$).
   (Relative atomic masses: H = 1.0, O = 16.0, S = 32.1, Cu = 63.5)

4. Calculate the mass of potassium in 7.91 g of potassium dichromate ($K_2Cr_2O_7$).
   (Relative atomic masses: O = 16.0, K = 39.1, Cr = 52.0)

5. The chloride of a metal *M* has the formula of MCl_3 and contains 34.4% by mass of *M*. Calculate the relative atomic mass of *M*.
   (Relative atomic mass: Cl = 35.5)

6. The bromide of a metal *X* has the formula of *X*Br2 and contains 25.6% by mass of *X*. Calculate the relative atomic mass of *X*.
   (Relative atomic mass: Br = 79.9)

7. A metal oxide *M*O contains 79.87% by mass of the metal *M*. Find the relative atomic mass of *M*.
   (Relative atomic mass: O = 16.0)

8. 26.88 g of a metal chloride *M*Cl contains 5.68 g of chlorine. Find the relative atomic mass of the metal *M*.
   (Relative atomic mass: Cl = 35.5)

9. What is the mass of nitrogen present in the sample of sodium nitrate ($NaNO_3$) which contains 100 g of sodium?
   (Relative atomic masses: N = 14.0, O = 16.0, Na = 23.0)

10. What is the mass of water of crystallization present in the sample of sodium carbonate-10-water ($Na_2CO_3 \bullet 10H_2O$) which contains 4.6 g of sodium?
    (Relative atomic masses: H = 1.0, C = 12.0, O = 16.0, Na = 23.0)

Suggested Answer

1. Formula mass of Al_2O_3
   = 27.0 × 2 + 16.0 × 3
   = 102.0

   Percentage by mass of Al in Al_2O_3
   = (R.A.M. of Al × No. of atoms of Al / formula mass of Al_2O_3) × 100%
   = (27.0 × 2 / 102.0) × 100%
   = 52.9%

2. Formula mass of NaOH = (23.0 + 16.0 + 1.0) g mol^{-1} = 40.0 g mol^{-1}

   Percentage by mass of Na in NaOH
   = (23.0 / 40.0) × 100%
   = 57.5%

3. Formula mass of $CuSO_4 \bullet 5H_2O$
   = 63.5 + 32.1 + 16.0 × 4 + 5 × (1.0 × 2 +16.0)
   = 249.6

   Percentage by mass of Cu in $CuSO_4 \bullet 5H_2O$
   = (R.A.M of Cu × No. of atoms of Cu / formula mass of $CuSO_4 \bullet 5H_2O$) × 100%
   = (63.5 / 249.6) × 100%
   = 25.4%

   That means for every gram of $CuSO_4 \bullet 5H_2O$, there is 25.4% (or 0.254 g) of Cu in it.

   ∴ mass of Cu in 15.0 g of $CuSO_4 \bullet 5H_2O$
   = 15.0 g × 25.4%
   = 3.81 g

4. Formula mass of $K_2Cr_2O_7$
   = (39.1 × 2 + 52.0 × 2 + 16.0 × 7) g mol^{-1}
   = 294.2 g mol^{-1}

   Percentage by mass of K in $K_2Cr_2O_7$
   = (39.1 × 2 / 294.2) × 100%
   = 26.6%

   Mass of K in 7.91 g of $K_2Cr_2O_7$
   = 7.91 g × 26.6%
   = 2.10 g

5. Let the relative atomic mass of *M* be *a*.

   Percentage by mass of *M* in MCl_3
   = (R.A.M. of *M* × No. of atoms of *M* / formula mass of MCl_3) × 100%

   34.4% = (*a* / *a* + 35.5 × 3) × 100%
   $\Rightarrow$ *a* = 55.8

   $\therefore$ the relative atomic mass of *M* is 55.8.

6. Let the relative atomic mass of *X* be *a*.

   Percentage by mass of *X* in XBr_2
   = (R.A.M. of *X* × No. of atoms of *X* / formula mass of XBr_2) × 100%

   25.6% = (*a* / *a* + 79.9 × 2) × 100%
   $\Rightarrow$ *a* = 55.0

7. Let the relative atomic mass of *M* be *a*.

   Percentage by mass of *M* in *MO*
   = (R.A.M. of *M* × No. of atoms of *M* / formula mass of *MO*) × 100%

   79.87% = (*a* / *a* + 16.0) × 100%
   $\Rightarrow$ *a* = 63.5

   $\therefore$ the relative atomic mass of *M* is 63.5.

8. Let the relative atomic mass of *M* be *a*.

   5.68 / 26.88 = 35.5 / *a* + 35.5
   $\Rightarrow$ *a* = 132.5

   $\therefore$ the relative atomic mass of *M* is 132.5.

9. Number of moles of Na = 100 / 23.0 mol = 4.35 mol
   Since 1 formula unit of $NaNO_3$ contains 1 Na,
   number of moles of $NaNO_3$ = 4.35 mol

   Mass of $NaNO_3$
   = 4.35 × (23.0 + 14.0 + 16.0 × 3) g
   = 369.75 g

   Percentage by mass of N in $NaNO_3$
   = (14.0 / 23.0 + 14.0 + 16.0 × 3) × 100% = 16.5%

   Mass of N in the $NaNO_3$ sample
   = 369.75 g × 16.5%
   = 61.0 g

10. Number of moles of Na = 4.6 / 23.0 mol = 0.2 mol

    Since 1 formula unit of $Na_2CO_3 \bullet 10H_2O$ contains 2 Na,

    number of moles of $Na_2CO_3 \bullet 10H_2O$ = 0.2 / 2 mol = 0.1 mol

    Mass of $Na_2CO_3 \bullet 10H_2O$
    = 0.1 × [(23.0 × 2 + 12.0 + 16.0 × 3) + 10 × (1.0 × 2 + 16.0)] g
    = 28.6 g

    Percentage by mass of H_2O in $Na_2CO_3 \bullet 10H_2O$
    = {10 × (1.0 × 2 + 16.0) / [23.0 × 2 + 12.0 + 16.0 × 3 + 10 × (1.0 × 2 + 16.0)]} × 100%
    = 62.9%

    Mass of H_2O in the $Na_2CO_3 \bullet 10H_2O$ sample
    = 28.6 g × 62.9%
    = 18.0 g