

O-level

PERCENTAGE

We calculate the percentage of an element in a compound if we know the relative atomic masses e.g.

$$\text{Percentage} = \frac{\text{Mass of an element or component in a compound} \times 100}{\text{Relative formula mass of compound}}$$

Example 1

What is the percentage of Fe in Iron II sulphate ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$)

$$[\text{Fe} = 56, \text{S} = 32, \text{O} = 16, \text{H} = 1]$$

Solution:

R.F.M of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$

$\text{Fe} + \text{S} + 4\text{O} + 7(2\text{H} + \text{O})$

$$56 + 32 + (4 \times 16) + 7(2 + 16) = 278$$

There are 56 parts of iron in 278 parts of the compound

$$\text{Therefore, the percentage of Iron by mass} = \frac{56 \times 100}{278}$$

$$= 20.1\%$$

Example 2

What is the percentage of nitrogen in ammonium sulphate? $[(\text{NH}_4)_2\text{SO}_4]$
($\text{N} = 14, \text{H} = 1, \text{S} = 32, \text{O} = 16$)

Solution:

$$\begin{aligned} \text{R.F.M of } (\text{NH}_4)_2\text{SO}_4 &= 2(14 + 4) + 32 + 16 \times 4 \\ &= 36 + 32 + 64 \\ &= 132 \end{aligned}$$

$$\text{Therefore, the percentage} = \frac{28 \times 100}{132}$$

$$= 21.2\%$$

Exercise:

- Calculate the percentage of Cu in CuSO_4
- Calculate the percentage of Nitrogen in lead nitrate $\text{Pb}(\text{NO}_3)_2$

$$\text{Cu} = 64, \text{S} = 32, \text{O} = 16, \text{N} = 14, \text{Pb} = 207$$

Exercise

- The percentage by mass of water of crystallization in $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is
A. $\frac{90 \times 100\%}{250}$ B. $\frac{18 \times 100\%}{250}$ C. $\frac{90 \times 100\%}{160}$ D. $\frac{18 \times 100\%}{250}$
(Cu = 64, S = 32, O = 16 H = 1)
- The percentage by mass of phosphorus in calcium phosphate, $\text{Ca}_3(\text{PO}_4)_2$, is
A. 8% B. 10% C. 17% D. 20%
(Ca = 40, P = 31, O = 16)
- What is the percentage of sulphur in Iron (III) sulphate, $\text{Fe}_2(\text{SO}_4)_3$?
(O = 16, Fe = 56, S = 32)
A. $\frac{32 \times 100\%}{400}$ B. $\frac{96 \times 100\%}{400}$ C. $\frac{112 \times 100\%}{400}$ D. $\frac{128 \times 100\%}{250}$
- The percentage by mass of oxygen in $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is
A. $\frac{16 \times 100\%}{250}$ B. $\frac{64 \times 100\%}{250}$ C. $\frac{16 \times 100\%}{160}$ D. $\frac{144 \times 100\%}{250}$
(Cu = 64, S = 32, O = 16 H = 1)
- The percentage composition of nitrogen in ammonium nitrate, NH_4NO_3 is
(N = 14, H = 1 O = 16)
A. $\frac{14 \times 100\%}{80}$ B. $\frac{76 \times 100\%}{80}$ C. $\frac{58 \times 100\%}{80}$ D. $\frac{28 \times 100\%}{80}$
- The percentage of phosphorus in H_3PO_4 is given by
A. $\frac{82 \times 100\%}{31}$ B. $\frac{31 \times 100\%}{82}$ C. $31 \times 32 \times 100$ D. $\frac{82 \times 31}{100}$
- The percentage of water of crystallization in hydrated iron (II) sulphate, $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ is (FeSO₄ = 152, O = 16, H = 1)
A. $\frac{126 \times 100\%}{278}$ B. $\frac{278 \times 100\%}{8}$ C. $\frac{126 \times 100\%}{152}$ D. $\frac{152 \times 100\%}{126}$

Answers

1. A 2. D 3. B 4. D 5. D 6. B 7. A

Working

1. Formula mass of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O} = 64 + 32 + 16 \times 4 + 5(16 + 1 \times 2) = 250$
Mass of water of crystallization = $5(1 \times 2 + 16) = 90$
Percentage of water of crystallization = $\frac{90 \times 100\%}{250}$
2. Formula mass of $\text{Ca}_3(\text{PO}_4)_2 = 40 \times 3 + 2(31 + 16 \times 4) = 310$
Mass of phosphorus = $31 \times 2 = 62$
Percentage phosphorus = $\frac{62 \times 100\%}{310} = 20\%$
3. Formula mass of $\text{Fe}_2(\text{SO}_4)_3 = 56 \times 2 + 3(32 + 16 \times 4) = 400$
Mass of sulphur in $\text{Fe}_2(\text{SO}_4)_3 = 3 \times 32 = 96$
Percentage of water of crystallization = $\frac{96 \times 100\%}{400}$
4. Formula mass of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O} = 64 + 32 + 16 \times 4 + 5(16 + 1 \times 2) = 250$
Mass of oxygen in $\text{CuSO}_4 \cdot 5\text{H}_2\text{O} = 16 \times 4 + 5 \times 16 = 144$
Percentage of water of crystallization = $\frac{144 \times 100\%}{250}$
5. Formula mass of $\text{NH}_4\text{NO}_3 = (14 + 1 \times 4 + 14 + 16 \times 3) = 80$
Mass of nitrogen = $14 \times 2 = 28$
Percentage of nitrogen = $\frac{28 \times 100\%}{80}$
6. Formula mass of $\text{H}_3\text{PO}_4 = (1 \times 3 + 31 + 16 \times 4) = 82$
Mass of phosphorus = 31
Percentage of nitrogen = $\frac{31 \times 100\%}{82}$
7. Formula mass of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O} = 152 + 7(1 \times 2 + 16) = 278$
Mass of water of crystallization = $7(1 \times 2 + 16) = 126$
Percentage of water of crystallization = $\frac{126 \times 100\%}{278}$