

Percentage by Mass

Exam tip: You need to learn this equation.

$$\text{percentage by mass of an element} = \frac{\text{total relative atomic mass of the atoms of that element}}{\text{relative formula mass of compound (M}_r\text{)}} \times 100$$

1. Calculate the percentage by mass of the following elements:

(give your answer to 4 significant figures in each case)

a. Zinc in zinc oxide (ZnO). $A_r \text{ Zn} = 65$, $M_r \text{ ZnO} = 81$.

b. Potassium in potassium nitrate (KNO₃). $A_r \text{ K} = 39$, $M_r \text{ KNO}_3 = 101$.

c. Fluorine in magnesium fluoride (MgF₂). $A_r \text{ F} = 19$, $M_r \text{ MgF}_2 = 62$.

d. Oxygen in sulfuric acid (H₂SO₄). $A_r \text{ O} = 16$, $M_r \text{ H}_2\text{SO}_4 = 98$.

2. Iron oxide has the formula Fe₂O₃.

a. Calculate the percentage by mass of iron in iron oxide. $A_r \text{ Fe} = 56$, $M_r \text{ Fe}_2\text{O}_3 = 160$.

(give your answer to the nearest whole number)

b. A student calculated the percentage by mass of iron in iron oxide. Their answer was 143%.

Explain why their answer must be incorrect and suggest the error they made in their calculation.

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Please note that this topic is not in earlier versions of the workbook but was added after an update to the specification. To download the worksheet, please visit freesciencelessons.co.uk/faq

1a	There is one atom of zinc in zinc oxide. This has a relative atomic mass of 65. $(65 / 81) \times 100 = 80.25\%$ to 4 significant figures.
1b	There is one atom of potassium in potassium nitrate. This has a relative atomic mass of 39. $(39 / 101) \times 100 = 38.61\%$ to 4 significant figures.
1c	There are two atoms of fluorine in magnesium fluoride. These have a combined relative atomic mass of 38. $(38 / 62) \times 100 = 61.29\%$ to 4 significant figures.
1d	There are four atoms of oxygen in sulfuric acid. These have a combined relative atomic mass of 64. $(64 / 98) \times 100 = 65.31\%$ to 4 significant figures.
2a	There are two atoms of iron in iron oxide. These have a combined relative atomic mass of 112. $(112 / 160) \times 100 = 70\%$ (to the nearest whole number).
2b	<p>We know that the student's answer must be incorrect. This is because you cannot have a percentage by mass of an element in a compound greater than 100%.</p> <p>By definition, a compound contains different elements chemically combined. This means that the percentage by mass of any individual element in a compound must be LESS than 100%.</p> <p>The error that the student made was to invert their calculation. Rather than dividing 112 by 160, they must have divided 160 by 112. Inverting the calculation is a common mistake when calculating a percentage.</p>