**Simple gravimetric chemical analysis –
weighing molecules the microscale way**

Activity 2: Calculation details

The formula of hydrated copper(II) sulfate can be determined by calculating the ratio of the number of moles of copper(II) sulfate to the number of moles of water present in the complex.

To calculate the number of moles of copper(II) sulfate and water present in the hydrated complex, the masses of copper(II) sulfate and water present in the complex need to be calculated.

The mass of water present can be found by calculating the mass of water removed by heating. This is done by subtracting the mass of copper(II) sulfate after heating (which removes the water molecules, making the compound anhydrous) from the mass of hydrated copper sulfate (which has water molecules present) before heating.

The mass of anhydrous copper(II) sulfate after heating will be the mass of copper(II) sulfate in the complex.

Calculate the number of moles of copper(II) sulfate. This can be done by dividing the mass of anhydrous copper(II) sulfate by the gram formula mass of copper(II) sulfate. The gram formula mass of copper(II) sulfate is 159.5.

Once the mass of water is calculated, calculate the number of moles of water used in the reaction. This can be done by dividing the mass of water by the gram formula mass of water, which is 18.

Divide the number of moles of water by the number of moles of copper(II) sulfate. This value should then be rounded to the nearest whole number. The value should be close to five, giving a molar ratio of approximately five moles of water to one mole of copper(II) sulfate, which suggests the formula of hydrated copper(II) sulfate is $CuSO_4 \cdot 5H_2O$.

Worked example

Mass of hydrated copper(II) sulfate used = 1.20 g

Mass of anhydrous copper(II) sulfate after heating = 0.78 g

Mass of water removed by heating = 1.20 − 0.78 = 0.42 g

Number of moles of copper sulfate ($CuSO_4$) left after water was removed = 0.78/159.6 = 0.0049

Number of moles of water removed by heating = 0.42/18 = 0.023

Ratio of moles of water to copper sulfate = 0.023/0.0049 = 4.9, which is 5 when rounded to nearest whole number.