Gravimetric Analysis

Gravimetric Analysis is determining the quantities (masses) of substances present in a sample is called gravimetric analysis. It is an analysis by weight or by mass.

• describe situations in which gravimetric analysis supplies useful data for chemists and other scientists

Gravimetric analysis can be used in many other industries and laboratories.
It can be used to determine the:

- percentage by weight of ingredients (sugar, fat, fibre) in food. This analysis is recorded on the packaging.
- purity and composition of alloys used for building construction
- extent of heavy metal pollution in river water and human food
- percentage composition of new compounds produced by chemical and medical research.

- to decide whether a newly discovered mineral deposit contains a sufficiently high percentage of the required compound to make its extraction from that deposit economically viable

- to determine the composition of soil in a particular location to see if it is suitable for growing a certain crop

- to decide whether a particular commercial mixture has the same percentage composition as a similar mixture being marketed by a rival company.

Example

A team of geologists discovered a new mineral in a remote desert location; it was a mixture of barium sulfate and magnesium sulfate. Its composition was determined as follows. They first ground up a 3.61 g sample with water; magnesium sulfate dissolves, barium sulfate does not. The barium sulfate was filtered off, dried and its mass determined to be 1.52 g. They evaporated the filtrate to dryness to recover the magnesium sulfate, and determined its mass to be 2.07 g. Calculate the percentage composition of the sample.

First we should check that the sample does in fact contain only barium and magnesium sulfates. The total mass of the two sulfates is 1.52 + 2.07 = 3.59 g. This is within experimental error of 3.61 g (less than 1% discrepancy), so the sample contains no other substance.

$$\text{Percentage of barium sulfate} = \frac{\text{mass of barium sulfate present}}{\text{total mass of the sample}} \times 100$$

$$= \frac{1.52}{3.61} \times 100$$

(It does not matter whether we use 3.61 or 3.59; there is some experimental error.)

$$= 42\%$$

Since there are only two components in the mixture:

$$\text{percentage of magnesium sulfate} = 100 - 42$$

$$= 58\%$$

The sample consists of 42% barium sulfate and 58% magnesium sulfate, with accuracies of about ±1%.

We could have calculated:

$$\text{percentage of magnesium sulfate} = \frac{2.07}{3.59} \times 100 = 58\%$$

Exercises

26 The suitability of water for irrigating crops or for animals to drink depends upon the amount of dissolved solids present. To assess the suitability of water from a particular bore, a grazier took 500 g of the water, evaporated it to dryness, then determined the mass of solids remaining to be 3.63 g. Calculate the percentage of dissolved solids in this water. In addition, express the concentration of solids in parts per million, ppm; that is, grams of solids per million grams of the water.

27 Upon analysis a 3.67 g sample of a certain NPK fertiliser (nitrogen, phosphorus, potassium) was found to contain 1.79 g urea and 0.81 g ammonium phosphate with the rest being potassium chloride. Calculate the per cent composition of this fertiliser.

28 The product of a certain industrial process was a mixture of three alcohols: ethanol (ordinary alcohol), ethylene glycol (motor car anti-freeze) and glycerol (used in sweets and cosmetics). The boiling points are 78°C, 198°C and 290°C respectively. 18.33 g of this mixture was carefully distilled. 3.79 g of distillate was collected while the thermometer in the apparatus registered 78°C. The temperature rose to 198°C and 8.64 g of a second distillate was collected. When the temperature started to rise above 200°C the distillation was stopped. Assuming that what was left in the distillation flask was glycerol, calculate the per cent composition of the original mixture.

Answers

26 0.73%; 7300 ppm
27 49% urea, 22% ammonium phosphate, 29% potassium chloride
28 20.7% ethanol, 47.1% ethylene glycol, 32.1% glycerol