

Concentrations

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Solution Concentrations

The concentration of a substance in solution is very important.

Concentration refers to amount of solute per quantity of solvent.

These quantities of solvent or solute can be measured in **mass** or **volume**.

Mass/Volume Percent

This calculation is usually used for a solid dissolved in a liquid.

$$P_{m/v} = \frac{m_{\text{solute}}}{V_{\text{solution}}}$$

This formula assumes that all of the solid solute is dissolved.

Ex. 20g of herbicide is dissolved in water and the resultant solution has a volume of 55ml. What is the mass/volume percent?

$$P_{m/v} = \frac{m_{\text{solute}}}{V_{\text{solution}}} = \frac{20\text{g}}{55\text{ml}} = 0.36\frac{\text{g}}{\text{ml}} = 36\% \text{ m/v}$$

What is the concentration of the pesticide in g /100 ml?

$$P_{m/v} = \frac{m_{\text{solute}}}{V_{\text{solution}}} = \frac{20\text{g}}{100\text{ml}} = 0.2\frac{\text{g}}{\text{ml}} = 20\% \text{ m/v}$$

How much herbicide would you need to add to make 1.5 L of solution?

$$P_{m/v} = \frac{m_{\text{solute}}}{V_{\text{soln.}}} \quad \frac{20\text{g}}{100\text{ml}} = \frac{x\text{g}}{1500\text{ml}} \quad \boxed{x\text{g} = 300\text{g}}$$

Mass/Mass Percent

This calculation is usually used for solids with solids and solid with liquids.

$$P_{m/m} = \frac{m_{\text{solute}}}{m_{\text{solution}}}$$

Ex. The concentration of gold is measured in Karats with 24 k being pure gold. Calculate karat value for a piece of gold that contains 2.86 g of gold and has a total mass of 4.9 g.

$$P_{m/m} = \frac{2.86\text{g}}{4.9\text{g}} = 0.58 = 58\%$$

You are interested in a gold ring that a jeweler says he made himself and claims it to be 18 K gold. He says he put 35 g of gold into it and the ring weighs 45 g. Is the jeweler telling the truth?

A gold chain weighs 57.5g and is 14 K gold. If gold sells for \$ 22.00/g how much did the gold cost in the chain?

Volume/Volume Percent

This calculation is usually used for liquids with liquids.

To calculate the volume/volume percent use the following formula.

$$P_{v/v} = \frac{V_{\text{solute}}}{V_{\text{solution}}}$$

Ex. Rubbing alcohol is 70% by volume propanol. How much propanol would be in 500 ml of rubbing alcohol?

$$P_{v/v} = \frac{V_{\text{solute}}}{V_{\text{solution}}} = 0.7 = \frac{V_{\text{solute}}}{500\text{ml}}$$

$350\text{ml} = V_{\text{solute}}$

ppm and ppb

Very dilute solutions contain small quantities of solute for a given quantity of solution.

ppm = parts per million ppb = parts per billion

Both of these measurements relate the mass of solute to the mass of the solution.

These measurements do **not** deal with particles even though this is what their name implies.

$$\text{ppm} = \frac{m_{\text{solute}}}{m_{\text{solution}}} \times 10^6$$

$$\text{ppb} = \frac{m_{\text{solute}}}{m_{\text{solution}}} \times 10^9$$

$$\frac{1\text{g}}{1,000,000\text{g}} = \frac{0.001\text{g}}{1000\text{g}} = \frac{1\text{mg}}{\text{kg}} = \text{PPM} = \frac{1\text{mg}}{\text{L}}$$

$$\frac{1\text{g}}{1,000,000,000\text{g}} = \frac{0.000001\text{g}}{1000\text{g}} = \frac{1\mu\text{g}}{\text{kg}} = \text{PPB} = \frac{1\mu\text{g}}{\text{L}}$$

Ex. When the water of local beaches reaches 60 ppm E. coli bacteria health regulations say it must be closed. If a 5 liter water sample is found to contain 0.7 mg of E. coli bacteria does the beach need to be closed?

$$\text{PPM} = \frac{0.7\text{mg}}{5\text{L}} = 0.14 \frac{\text{mg}}{\text{L}} = 0.14 \text{PPM}$$

Ex. Mercury is present in soils but is considered safe bellow 90 ppb. What is the safe amount of mercury in a 400 g soil sample?

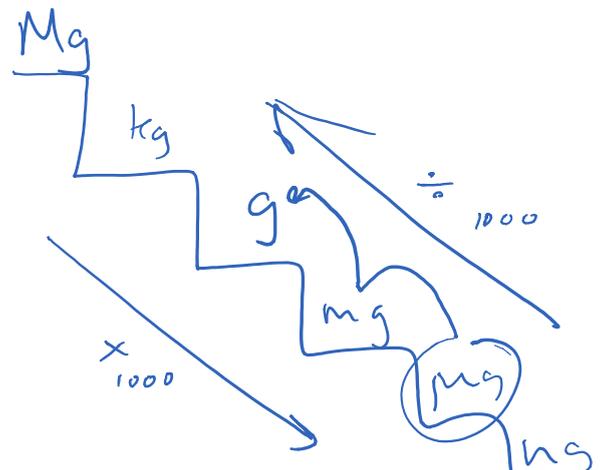
$$\text{PPb} = \frac{\mu\text{g}}{\text{kg}}$$

$$90\text{ppb} = \frac{90\mu\text{g}}{\text{kg}} = \frac{x\mu\text{g}}{0.4\text{kg}}$$

$$90\text{PPb} = \frac{\mu\text{g}}{0.4\text{kg}}$$

$36\mu\text{g} = \mu\text{g}$

$$36\mu\text{g} = 0.000036\text{g}$$





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