# 3. CONCENTRATION – CONSUMER PRODUCTS

CH30S UNIT 3 – SOLUTIONS WIEBE

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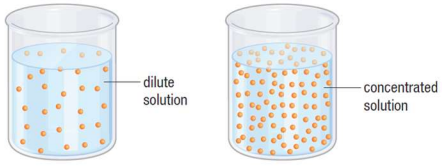
## REMEMBER…

- The **concentration of a saturated solution** of a salt is called the **solubility** of that solute. Every salt has its own unique solubility at a given temperature.
- The **concentration of an unsaturated solution varies** depending on the amount of solute and solvent present.

$$\text{Concentration} = \frac{\text{quantity of solute}}{\text{quantity of solution}}$$

**Quantities can be :**

- **Mass (grams)**
- **Volume (millilitres)**
- **Moles (mol)**

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## WHY IS CONCENTRATION IMPORTANT?

- Prescription drugs in the correct concentration make you better.
- In higher concentration they can kill you.
- In lower concentration, they aren't effective, and you could get sicker.

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## OTHER AREAS WHERE CONCENTRATION IS IMPORTANT…

- Pesticide/fertilizer use
- Food additives
- Blood alcohol content.
- Consumer products

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# CONCENTRATION IN CONSUMER PRODUCTS

**1. Percent Concentration**

*v = volume (mL)  m = mass (g)*

$$\%\frac{V}{V} = \frac{volume\ solute}{volume\ solution} \times 100$$

$$\%\frac{W}{V} = \frac{mass\ solute}{volume\ solution} \times 100$$

$$\%\frac{W}{W} = \frac{mass\ solute}{mass\ solution} \times 100$$



**IF THE UNITS FOR BOTH ARE THE SAME, DON'T CONVERT!**

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# CONCENTRATION IN CONSUMER PRODUCTS

**2. Parts Per Million/Billion**

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

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

**Table 1** Parts Per Million, Billion, Trillion

| Part per | Equivalent to |
|---|---|
| 1 ppm | 1 drop in a bathtub full of water<br>30 s out of a year |
| 1 ppb | 1 drop in 250 full barrels<br>3 s out of a century |
| 1 ppt | 1 drop in 20 Olympic-sized pools<br>3 s out of 100 000 years |

*v = volume (mL)  m = mass (g)*

**IF THE UNITS FOR BOTH ARE THE SAME, DON'T CONVERT!**

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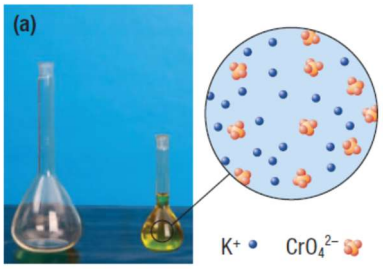
## EXAMPLE #1 – DETERMINING CONCENTRATION FROM MEASURED VALUES

0.35 g of solid potassium chromate is dissolved in enough water to make 0.50 L of solution. What is concentration of the solution expressed in:

**1. percent concentration** **2. ppm**

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## EXAMPLE #2 – DETERMINING CONCENTRATION FROM MEASURED VALUES

A cleaning solution is created by adding 100.0 mL of Pine Sol to 4.0 L of water. What is % concentration of the solution?

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# WHICH MILK IS WHICH?

**Nutrition Facts**
Serving Size 1 Container (150g)

| Amount Per Serving | |
|---|---|
| **Calories** 110 Cals from Fat 15 | |
| | **% Daily Value*** |
| **Total Fat** 1.5g | **2%** |
| Saturated Fat 1g | **5%** |
| *Trans* Fat 0g | |
| **Cholesterol** 15mg | **4%** |
| **Sodium** 380mg | **16%** |
| **Total Carbohydrate** 5g | **2%** |
| Dietary Fiber 0g | **0%** |
| Sugars 4g | |
| **Protein** 19g | **38%** |
| Vitamin A 2% • Vitamin C 0% | |
| Calcium 15% • Iron 0% | |

*Percent Daily Values are based on a 2,000 calorie diet.

**DETERMINE THE % CONCENTRATION OF FAT IN EACH OF THE MILK LABELS.**

**Nutrition Facts**
**Valeur nutritive**
Per 1 cup (250 mL) / par 1 tasse (250 mL)

| Amount<br>Teneur | % Daily Value<br>% valeur quotidienne |
|---|---|
| **Calories / Calories** 160 | |
| **Fat / Lipides** 8 g | **13** % |
| Saturated / saturés 5 g<br>+ Trans / trans 0.2 g | **26** % |
| **Cholesterol / Cholestérol** 30 mg | |
| **Sodium / Sodium** 110 mg | **5** % |
| **Carbohydrate / Glucides** 12 g | **4** % |
| Fibre / Fibres 0 g | **0** % |
| Sugars / Sucres 11 g | |
| **Protein / Protéines** 9 g | |
| Vitamin A / Vitamine A | 10 % |
| Vitamin C / Vitamine C | 0 % |
| Calcium / Calcium | 30 % |
| Iron / Fer | 0 % |
| Vitamin D / Vitamine D | 45 % |

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# WORKING WITH % CONCENTRATIONS

The concentration of ethanol (alcohol) in a 750 mL bottle of wine is 13.5% V/V. If wine has the same density as water, calculate the volume of ethanol in the bottle.

LEARNING **TIP**

**Working with Percentages**
To determine the percentage of a number, remember that the word "of" means "multiplied by." Simply multiply the number by the percentage written as a decimal. For example,
13.5 % of 750 = (0.135)(750) = 101

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# WORKING WITH % CONCENTRATIONS

Glucose ($C_6H_{12}O_6$) is used to prepare intravenous feeding solutions. What volume of 5.0% W/V glucose solution can be prepared using 125 g of glucose?

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# WORKING WITH PPM/PPB CONCENTRATIONS

Swimming pool manufacturers recommend maintaining the chlorine concentration of a pool at 3.0 ppm. What mass of chlorine powder must be added to a pool containing 3.4 x $10^6$ L of water to achieve this concentration?

LEARNING **TIP**

**Percentages and Exponents**
"ppm" is similar to the symbol "%" in the equations involving percentage concentration. You could think of the "$\times$ 100" in the above equations as "$\times$ $10^2$." You could even think of "%" as "pph"—parts per hundred!

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# WORKING WITH PPM/PPB CONCENTRATIONS

Health Canada guidelines state that the maximum concentration of mercury that is acceptable in drinking water is 1 ppb. What volume of water would be required to have 5.0 g of Hg dissolved in it and still be acceptable?

**LEARNING TIP**

**Percentages and Exponents**
"ppm" is similar to the symbol "%" in the equations involving percentage concentration. You could think of the "× 100" in the above equations as "× $10^2$." You could even think of "%" as "pph"—parts per hundred!

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# SUMMARY

**Table 2** Measure of Concentration

| Name | Abbreviation | Equation | Application |
|---|---|---|---|
| percentage volume/volume | % V/V | $c_{v/v} = \frac{v_{solute}}{v_{solution}} \times 100\ \%$ | liquid–liquid mixtures |
| percentage weight/volume | % W/V | $c_{w/v} = \frac{m_{solute}}{v_{solution}} \times 100\ \%$ | solid–liquid mixtures |
| percentage weight/weight | % W/W | $c_{w/w} = \frac{m_{solute}}{m_{solution}} \times 100\ \%$ | solid–liquid or solid–solid mixtures |
| parts per million | ppm | $c_{ppm} = \frac{m_{solute}}{m_{solution}} \times 10^6\ ppm$ | to express small concentrations (e.g., composition of air) |
| parts per billion | ppb | $c_{ppb} = \frac{m_{solute}}{m_{solution}} \times 10^9\ ppb$ | to express very small concentrations (e.g., metal contaminants in water) |
| parts per trillion | ppt | $c_{ppt} = \frac{m_{solute}}{m_{solution}} \times 10^{12}\ ppt$ | to express extremely small concentrations (e.g., traces of medications in water) |

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