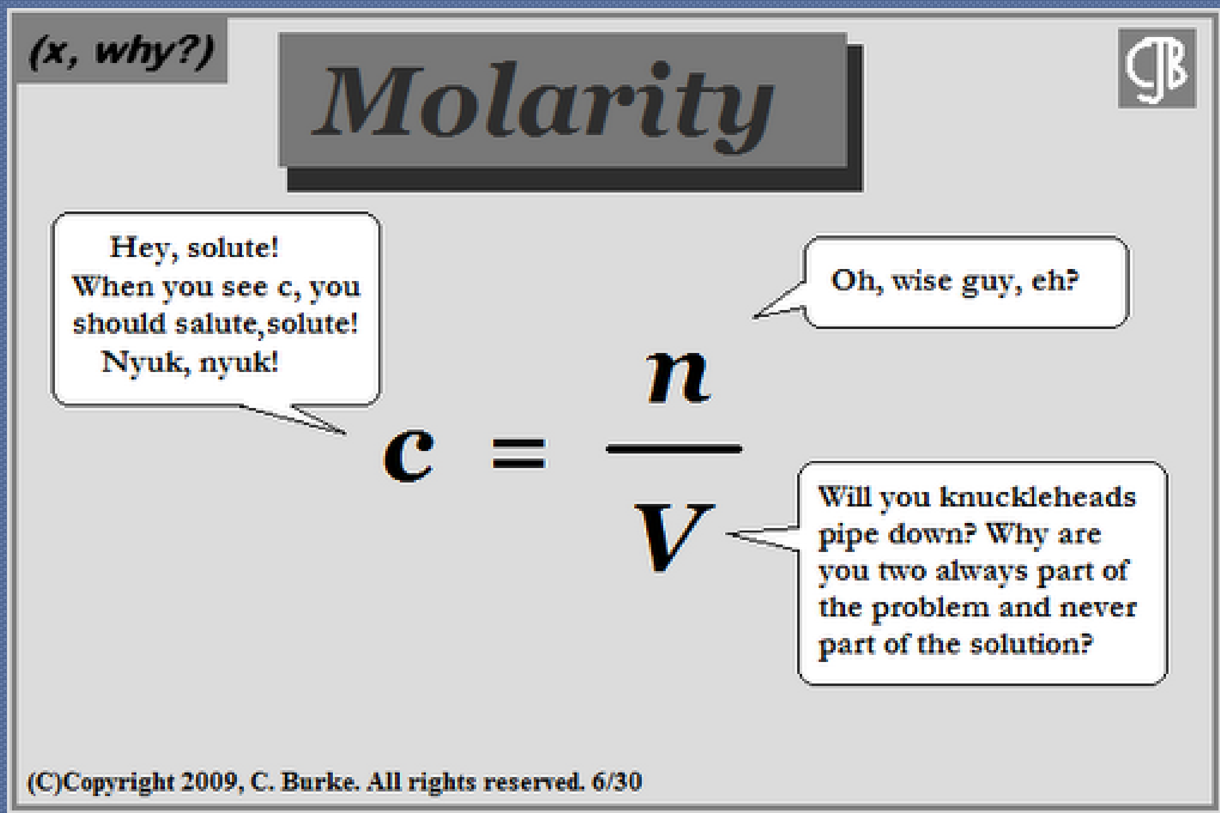
Solutions


(x, why?)
Molarity
Hey, solute! When you see c, you should salute,solute! Nyuk, nyuk!
Oh, wise guy, eh?
c = n / V
Will you knuckleheads pipe down? Why are you two always part of the problem and never part of the solution?
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Solutions Review

Recall:

Solution:
Homogeneous mixture of solute and solvent.

Solute:
Substance that gets dissolved in a solution

Solvent:
Substance that dissolves the solute.

Concentration:
The amount of solute dissolved in a certain amount of solvent.

Units for Concentration

Percent Volume/Volume (% v/v)

- States the volume of solute that 100mL of solution would contain.
- Useful when the solute is a liquid

ex) Vinegar is a 5% v/v acetic acid solution

→ **Contains 5mL of $HC_2H_3O_2$ in 100mL of total solution**

Units for Concentration

Percent Mass/Volume (%w/v)

- States the mass of solute that 100mL of solution would contain.
- Useful when the solute is a solid

ex) 5% w/v NaCl solution

→ **Contains 5g of NaCl in 100mL of total solution**

Units for Concentration

Molality (mol/Kg)

- States the number of moles of solute that 1Kg of solvent would contain.

ex) 0.5 mol/Kg NaCl solution

→ **Contains 0.5mol of NaCl in 1Kg of solvent**

- Sometimes is used instead of molarity because volume is temperature dependant, but mass is not.
- Notice that it is moles per Kg of solvent, NOT total solution (like in molarity)

When we prepare solutions, we will most often be using Molarity (mol/L) for our units.

Units for Concentration

Molarity (mol/L)

- States the number of moles of solute that 1L of solution would contain.
- Most common unit for concentration in Chemistry

ex) 0.5 mol/L NaCl solution

→ **Contains 0.5mol of NaCl in 1L of total solution**

Preparing Solutions

Steps:

1. Determine the volume and concentration needed:

   ex) 250mL of a 0.15 mol/L $NaNO_3$ solution.

2. Determine the mass of solute that you need:

3. Weigh the amount of solid as accurately as possible, and add to a volumetric flask.
4. Half-fill the flask with deionized/distilled water, then mix to dissolve all the solute.
5. Dilute the solution "to the mark".
6. Stopper and invert the flask several times to ensure thorough mixing.

Notes on Preparing Solutions

Volumetric analysis techniques (ex. titrations) depend on the ability to prepare solutions of an exactly known concentration → most solids cannot do this!

Example:

NaOH crystals are very hydroscopic (absorb moisture from the air). If you use NaOH to make a solution:

- Part of the measured mass will be from the moisture that has been absorbed.
- This will result in less moles of NaOH being dissolved, which means the actual concentration will be less than calculated.

Notes on Preparing Solutions

Because of this issue, we will often make a solution, then standardize it using another solid that is called a Primary Standard.

Primary Standards are usually:

- Available in pure form (>99.9% pure)
- Stable under normal storage condidtions
- Not hydroscopic or reactive with air
- Reasonably soluble in water

By reacting a sample of a solution with a primary standard, we can get a much more accurate value for the true concentration of the solution.

Dilutions

Often it is necessary to take a concentrated solution and dilute it to a more desirable concentration.

→ *increasing the amount of solvent, without affecting the amount of solute.*

The formula for dilution is:

$$M_1V_1 = M_2V_2$$

Where,

M_1 = starting concentration (mol/L)

V_1 = volume (L)

M_2 = final concentration (mol/L)

V_2 = final volume (L)

It is important to note that V2 is not the amount of solvent added, it is total volume after diluting.

Dilution Example Problems

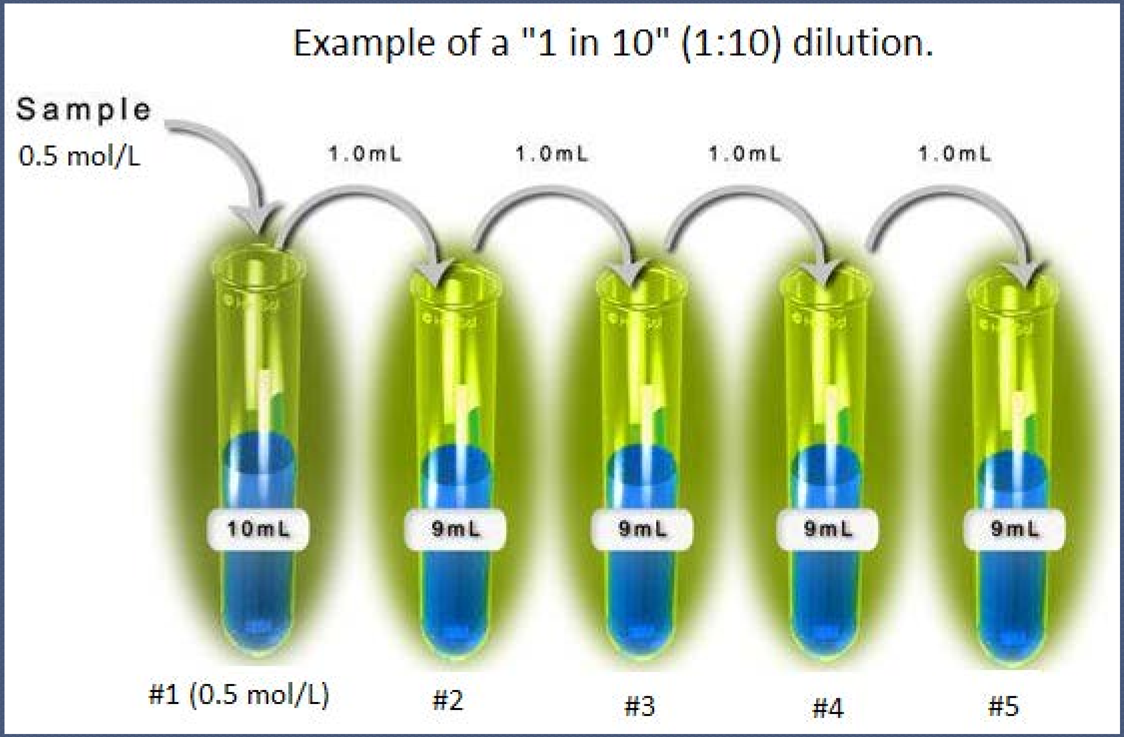
1. 50mL of concentrated Hydrochloric Acid (12 mol/L) is to be diluted to 0.5 mol/L. How much water must be added?

2. What volume of concentrated Hydrochloric Acid must be diluted to prepare 500mL of a 0.1 mol/L solution?

Serial Dilutions

A Serial dilution is the stepwise dilution of a substance in solution used to accurately create highly diluted solutions as well as solutions for experiments resulting in concentration curves with a logarithmic scale.

Usually the dilution factor at each step is constant, resulting in a geometric progression of the concentration in a logarithmic fashion.



Serial Dilutions

Use the dilution formula to calculate the concentration in test tubes 2-5.