CONCENTRATION

- When you discuss a solution, you need to be aware of:
  - what materials are in the solution
  - how much of each material is in the solution

- CONCENTRATION is the amount of one substance compared to the others in a solution. This sounds vague, but that's because there are many different ways to specify concentration!

- We will discuss four different concentration units in CHM 111:

(1) MASS PERCENTAGE

$$= \frac{\text{mass solute}}{\text{mass solution}} \times 100\% \qquad \%, \%\ w/w$$

(2) MOLARITY

$$= \frac{\text{moles solute}}{\text{L solution}} \qquad M \text{ or } \underline{M}$$

(3) MOLALITY

$$= \frac{\text{moles solute}}{\text{kg solvent}} \qquad m$$

(4) MOLE FRACTION

$$= \frac{\text{moles component A}}{\text{moles solution}} \qquad X_A$$

How would you prepare 455 grams of an aqueous solution that is 6.50% sodium sulfate by mass?

$$\text{mass \%} = \frac{\text{mass } Na_2SO_4}{\text{mass solution}} \times 100\%$$

6.50% ; 455 g

Start concentration calculations by writing out the definition of the unit(s) you are using!

We know everything in the definition EXCEPT mass sodium sulfate. So let's start by finding out how much sodium sulfate is in the solution

$$6.50 = \frac{\text{mass } Na_2SO_4}{455\text{ g}} \times 100$$

① ÷ 100

② × 455 g

$$29.6\text{ g} = \text{mass } Na_2SO_4$$

We also need to know how much water to add to the sodium sulfate.

$$455\text{ g solution} - 29.6\text{ g} = 425.4\text{ g water}$$

So, mix 29.6 grams sodium sulfate with 425.4 grams water to prepare the solution.

What's the MOLALITY and MOLE FRACTION OF SOLUTE of the previous solution?

29.6 g Na_2SO_4, 425.4 g water ← previous solution

$$m = \frac{\text{mol } Na_2SO_4 \text{ (solute)} \ ①}{\text{kg } H_2O \text{ (solvent)} \ ②}$$

① Convert 29.6 grams sodium sulfate to moles. Use formula weight.

② Convert 425.4 grams water to kg.

Na_2SO_4: Na : 2 x 22.99
S : 1 x 32.07
O : 4 x 16.00
142.05 g Na_2SO_4 = mol Na_2SO_4

$$29.6 \text{ g } Na_2SO_4 \times \frac{\text{mol } Na_2SO_4}{142.05 \text{ g } Na_2SO_4} = 0.208377733 19 \text{ mol } Na_2SO_4 \ ①$$

kg = 10^3 g

$$425.4 \text{ g} \times \frac{\text{kg}}{10^3 \text{ g}} = 0.4254 \text{ kg} \ ②$$

$$m = \frac{0.208377733 19 \text{ mol } Na_2SO_4}{0.4254 \text{ kg}}$$

$$= \boxed{0.490 \text{ m } Na_2SO_4}$$

29.6 g Na_2SO_4, 425.4 g water ← previous solution

$$\chi_{Na_2SO_4} = \frac{\text{mol } Na_2SO_4}{\text{total moles solution}} \quad (1) \quad (2)$$

(1) Convert 29.6 grams sodium sulfate to moles. We did this already to find molality, so we'll just copy that number down.

(2) Find moles water from mass water, then add to moles sodium sulfate.

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(1) 0.208377733 19 mol Na_2SO_4

H_2O H: 2 × 1.008
O: 1 × 16.00
18.016 g H_2O = mol H_2O

$$425.4 \text{ g } H_2O \times \frac{\text{mol } H_2O}{18.016 \text{ g } H_2O} = 23.6123445 8 \text{ mol } H_2O$$

total = 0.208377733 19 mol + 23.6123445 8 mol
= 23.8207219 1 mol

$$\chi_{Na_2SO_4} = \frac{0.208377733 19 \text{ mol}}{23.8207219 1 \text{ mol}} = \boxed{0.00875}$$