MOLARITY AND AVOGADRO’S NUMBER

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Moles
A mole in chemistry (unlike the picture above) is the molecular mass of a compound expressed in grams.

Examples:
A mole of carbon dioxide (CO₂) weighs 44g. How is this determined?
• The atomic mass of carbon is twelve (12) and there is one carbon atom in a molecule of CO₂
• The atomic mass of oxygen is sixteen (16) and there are two atoms of oxygen in CO₂ 16 × 2 = 32
• Adding 12 and 32 yields 44.

A mole of glucose (C₆H₁₂O₆) weighs 180g. How is this determined?
• An atom of carbon has an atomic mass of 12. Since there are six atoms of carbon in a molecule of glucose 12 × 6 = 72
• An atom of hydrogen has an atomic mass of 1. Since there are 12 atoms of hydrogen in glucose 1 × 12 = 12
• An atom of oxygen has an atomic mass of 16. Since there are 6 atoms of oxygen in glucose 16 × 6 = 96.
• Adding 72 + 12 + 96 yields 180 grams.

Avogadro’s number
One mole of any substance has 6.02 × 10²³ molecules (called Avogadro’s number).
Both a mole of CO₂ and a mole of glucose each contains 6.02 × 10²³ molecules even though a mole of glucose weighs 180g and a mole of CO₂ only weighs 44g. Think of it in this way. A dozen jumbo eggs and a dozen medium eggs each contains twelve eggs, but the dozen jumbo eggs weigh more than the dozen medium eggs.

Molarity (M) is the number of moles in a liter
A solution with a molarity of one (1) has the molecular mass in grams of the solute dissolved in a liter (1000ml) of the solvent (usually water).
Examples:

- If one wanted to make a liter of a one molar solution (1\textit{M}) of glucose (C$_{6}$H$_{12}$O$_{6}$ - molecular mass of 180) one would add 180 grams of glucose to a liter of water.

- If one wanted to make a liter of a 0.5\textit{M} solution of glucose one would add 90 grams of glucose to a liter of water. How was this determined? Set up a ratio as follows:

\[
\frac{180 \text{ grams}}{1 \text{ mole}} = \frac{x \text{ grams}}{0.5 \text{ moles}}
\]

Cross multiply and you get \( x = 90 \text{ grams} \)

- If one wanted to make up only 10 ml of a 0.2\textit{M} solution of glucose one would add 0.36g of glucose to 10 ml of water. How was this determined? This takes two steps.

Step 1 - Determine how many grams of glucose to add to make 10 ml of a one molar solution.

\[
\frac{180 \text{ grams}}{1000 \text{ ml}} = \frac{x \text{ grams}}{10 \text{ ml}}
\]

Cross multiply and you get \( x = 1.8 \text{ grams} \)

Step 2 - Now determine how many grams to add to 10 ml to make a 0.2 molar solution.

\[
\frac{1.8 \text{ grams}}{1 \text{ mole}} = \frac{x \text{ grams}}{0.2 \text{ moles}}
\]

Cross multiply and you get \( x = 0.36 \text{ grams} \)