

Fluid Therapy Course:

Getting more comfortable with clinical calculations

The terminology and calculations associated with the various solutions used in biology and medicine can be intimidating. The example problems below are provided so that you can become more comfortable with these types of calculations. The terminology first is summarized, followed by example problems that are relevant to clinical practice. If you want more practice, look at *Laboratory Mathematics: Medical and Biological Applications* (edition 4) by June M. Campbell and Joe B. Campbell (St. Louis, CV Mosby Co, 1990).

One mole (mol) of any substance is the molecular (or atomic) weight of the substance in grams. One millimole (mmol) is 0.001 mol or the molecular (or atomic) weight of the substance in milligrams. One mol of any nondissociable substance contains Avogadro's number of particles: 6.023×10^{23} .

Charged ions (cations and anions) combine according to their ionic charge (valence) and not according to their weight. The concept of electrochemical equivalence refers to the combining power of an ion. *One equivalent is the weight in grams of an element or compound that combines with or replaces one gram of hydrogen ions.*

It is very important to remember the following relationship: **mEq = mmol x valence**

The *osmolality* of a solution refers to the concentration of osmotically active particles in that solution. Osmolality is a function only of the number of particles and is not related to their molecular weight, size, shape, or charge. One mol of a non-dissociating substance (e.g. glucose, urea) dissolved in one kg of water decreases the freezing point of the resultant solution by 1.86°C . Such a solution has an osmolality of 1 Osm/kg or 1000 mOsm/kg. *Osmolarity* refers to the number of particles of solute per liter of solution whereas the term *osmolality* refers to the number of particles of solute per kg of solvent. When considering body fluids, the difference between osmolality and osmolarity is negligible because body fluids typically are dilute aqueous solutions.

An osmole (osmol) is the amount of a substance that dissociates in solution to form one mole of osmotically active particles. A milliosmole (mosmol) is 0.001 osmol. If a substance is nondissociable, one mol equals one osmol. If a substance dissociates into two particles one mol equals 2 osmols (or 0.5 mol equals 1 osmol). If a substance dissociates into three particles one mol equals 3 osmols (or 0.33 mol equals 1 osmol).

In biology and medicine, solutions typically are described in terms such as: percent, molarity, molality, normality, osmolarity, or osmolality.

The term percent refers to parts per 100. A percent solution refers to the number of parts per 100 parts of solution. These usually are expressed in terms of weight per unit volume, usually grams of solute per 100 mL (i.e. 1 dL) water.

Molarity is the number of moles of solute per liter of solution whereas molality is number of moles of solute per kilogram of solvent.

Normality is the number of equivalent weights per liter of solution. An equivalent weight is the amount of a substance (element or compound) that will combine with or replace one mole (one gram) of hydrogen ions in a chemical reaction.

Use the following atomic or molecular weights in the examples:

| <i>Element or compound</i> | <i>Chemical symbol</i> | <i>Atomic or molecular weight</i> | <i>Valence</i> |
|----------------------------|---------------------------------------|-----------------------------------|----------------|
| Acetate ion | $\text{C}_2\text{H}_3\text{O}_2^-$ | 59.0 | -1 |
| Bicarbonate ion | HCO_3^- | 61.0 | -1 |
| Calcium ion | Ca^{+2} | 40.1 | +2 |
| Carbon | C | 12.0 | 0 |
| Chloride ion | Cl^- | 35.5 | -1 |
| Gluconate ion | $\text{C}_6\text{H}_{11}\text{O}_7^-$ | 195.0 | -1 |
| Hydrogen ion | H^+ | 1.0 | +1 |
| Lactate ion | $\text{C}_3\text{H}_5\text{O}_3^-$ | 89.0 | -1 |
| Magnesium ion | Mg^{+2} | 24.3 | +2 |
| Nitrogen | N | 14.0 | 0 |
| Oxygen | O | 16.0 | 0 |
| Phosphorus | P | 31.0 | 0 |
| Potassium ion | K^+ | 39.1 | +1 |
| Sodium ion | Na^+ | 23.0 | +1 |
| Glucose | $\text{C}_6\text{H}_{12}\text{O}_6$ | 180.0 | 0 |
| Phosphate ion | PO_4^{-3} | 95.0 | -3 |
| | | | |

| | | | |
|-------------|-----------------------------|------|----|
| | HPO_4^{-2} | 96.0 | -2 |
| | $\text{H}_2\text{PO}_4^{-}$ | 97.0 | -1 |
| Sulfate ion | SO_4^{-2} | 96.1 | -2 |

[GO TO EXAMPLE PROBLEMS](#)

[VM 613 HOME](#)