Osmotic pressure and osmolarity

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Osmolarity

Sum of all osmotically active particles (OAP) in a solution

One of the colligative properties: only number of particles counts, not their kind !

Units: moles of osmotically active particles (osm) per liter

Example:

NaCl 0.15 mol/l, in solutions exists as ions Na^+, Cl^- … 2 OAP

….. Osmolarity **0.3 mol OAP/l (0.3 osm/l)**

Osmotic pressure

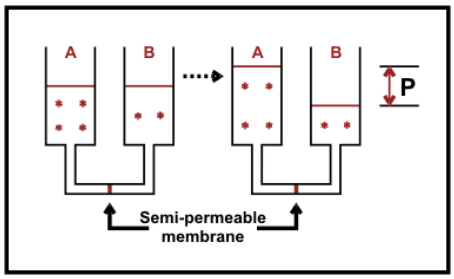


Figure from: http://www.bbc.co.uk/dna/h2g2/A686766

$\Pi = n . C . R . T$

Π: osmotic pressure in kPa

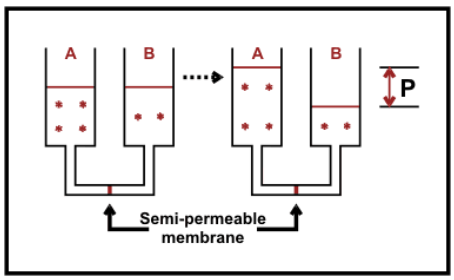
n: number of OAP per mole

C: molar concentration in mol/l

R: universal gas constant ($8.31441\ N.m.mol^{-1}.K^{-1}$)

T: temperature in K

Osmotic pressure



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Osmolarity

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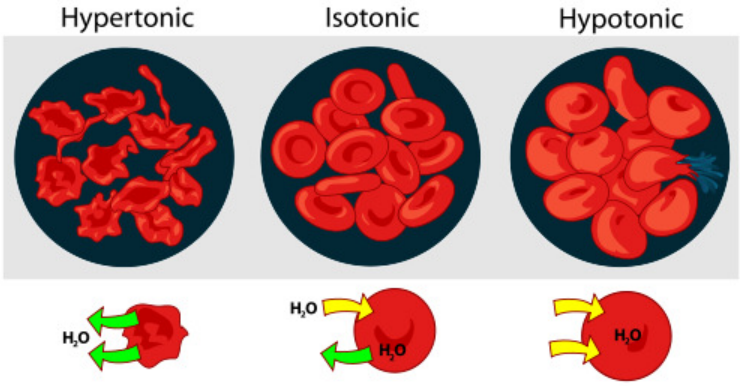
Osmolarity is important in medicine



- Isotonic: osmolarity = 0.3 osm/l (NaCl 0.15 mol/l)
- Hypotonic: osmolarity < 0.3 osm/l
- Hypertonic: osmolarity > 0.3 osm/l

Figure from: Wikipedia

Calculations of osmolarity/osmotic pressure

Example I: Calculate <u>osmolarity</u> of Na_2HPO_4 solution of c = 21 g /l.
(AW of Na: 23, P: 31, O: 16, H: 1)

FW of Na_2HPO_4 : 46+1+31+4x16 = 142

Molar concentration = Mass conc. (g/l) / FW

= 21 / 142 = <u>0.15 mol/l</u>

3 OAP: 2x Na^+, 1x HPO_4^{2-}

Osmolarity: 0.15 x 3 = <u>0.45 mol OAP/l</u>

Calculations of osmolarity/osmotic pressure

Example II: Calculate osmotic pressure of Na_2HPO_4 solution of c = 21 g /l at 37 °C.
(AW of Na: 23, P: 31, O: 16, H: 1; R = 8.31441 $N.m.mol^{-1}.K^{-1}$)

FW of Na_2HPO_4 : 46+1+31+4x16 = 142

Molar concentration = Mass conc. (g/l) / FW

= 21 / 142 = 0.15 mol/l

3 OAP: 2x Na^+, 1x HPO_4^{2-}

Osmolarity: 0.15 x 3 = 0.45 mol OAP/l

Osmotic pressure: $\Pi = n \cdot C \cdot R \cdot T$

Π = 3 x 0.15 x 8.31441 x (273.15 + 37) = 1160 kPa

(hypertonic)

Calculations of osmolarity/osmotic pressure

Example III: 0.2 M KCl solution is combined with an equal volume of 0.5 M glucose solution.
What is the resulting osmolarity?

After mixing:

KCl:

c= 0.1 mol/l, 2 OAP: contribution to osmolarity 0.2 mol/l

Glucose:

c=0.25 mol/l, 1 OAP: contribution to osmolarity 0.25 mol/l

Total osmolarity: 0.2 + 0.25 = 0.45 mol OAP/l