Pharmaceutical Calculations PHT 210

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Office hours: every day except Monday

From 11 am – 12 pm

<u>By appointment only</u>

Syllabus

Week	Book chapter	Subject	Lecturer
8	12	Electrolyte solutions	Dr. Alkholief
9	11	Buffer solutions	
10	11	Isotonic solutions	
11	10	Selected clinical calculations (2nd midterm exam)	
12	15	Altering product strength, use of stock solutions and allegation method	
13	*22*	Kinetic problems	
14	*22*	Kinetic problems	

Reference:

- Pharmaceutical Calculations 13th and 14th editions. Howard C. Ansel

Electrolytes

19/10/2015

6/1/1437

Introduction

- Mixtures:

- Two or more different substances that are mixed with each other.
- Can be either heterogeneous or homogenous.

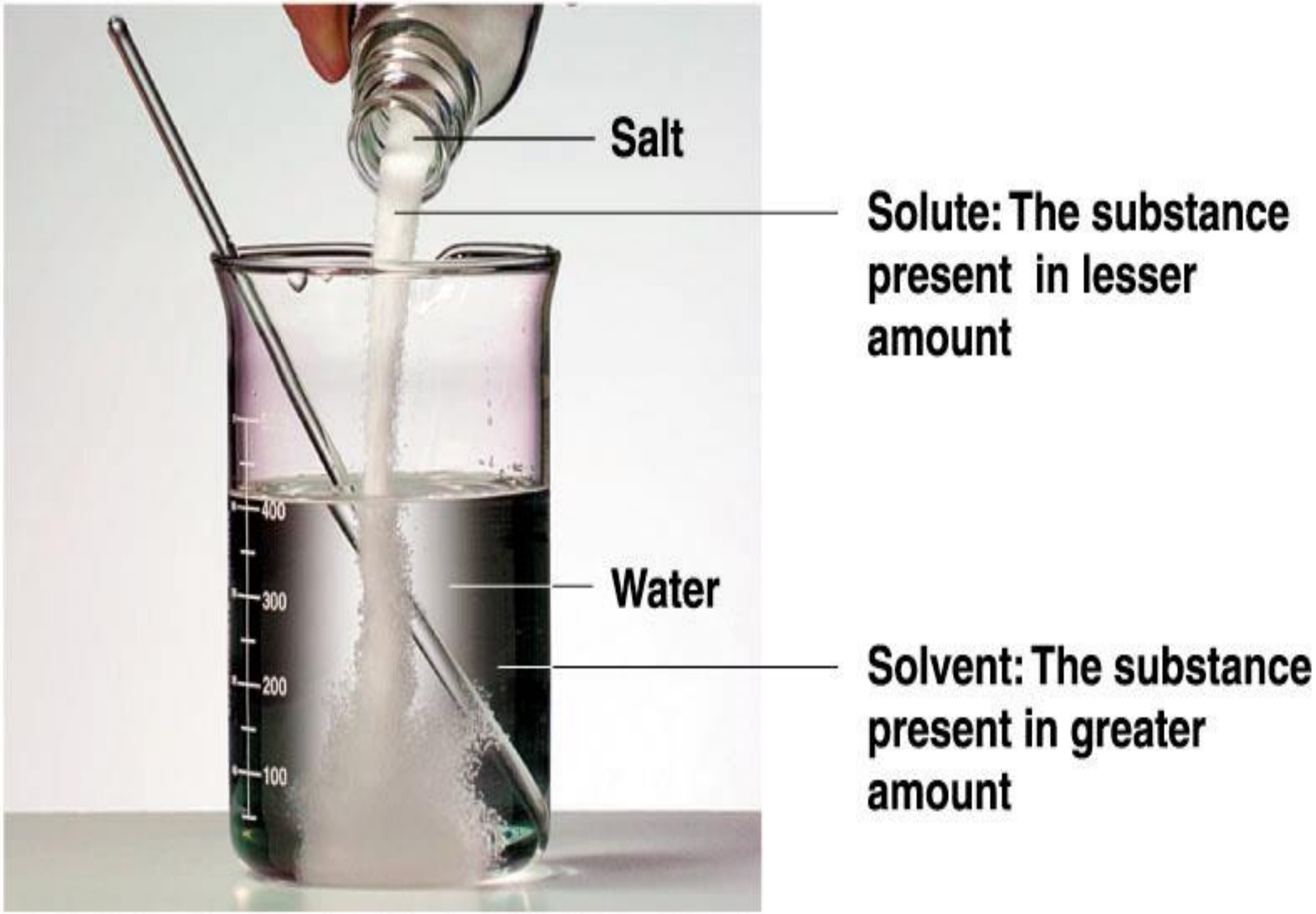
alterecofoods.com

Solutions:

- Homogenous mixtures composed of solute and solvent.

- Solute: a substance that gets dissolved.
- Solvent: a substance that do the dissolving.

- Water is the most common solvent in nature



Timberlake, Chemistry: An Introduction to General, Organic, and Biological Chemistry, Eighth Edition.

- Depending on the chemistry of the solute, substances can dissolve in water forming either electrolytes and non electrolytes.

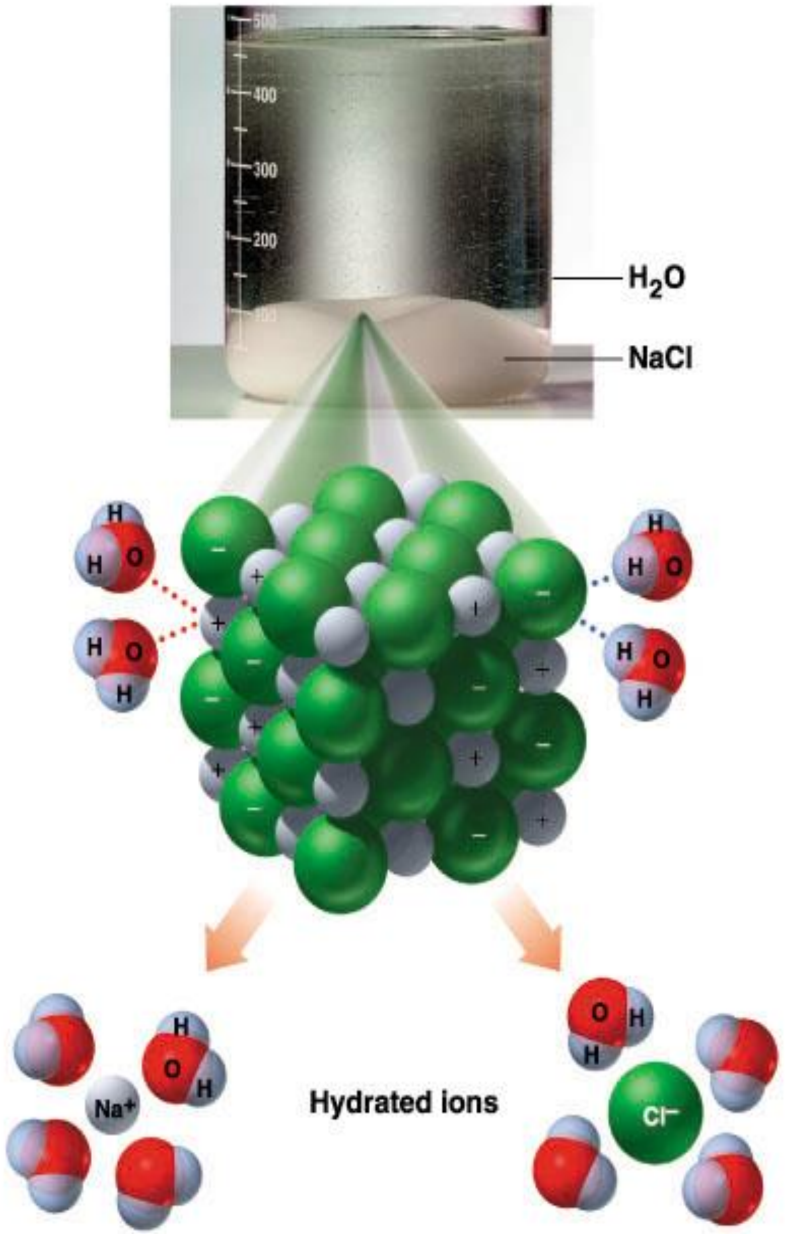
- Electrolytes:

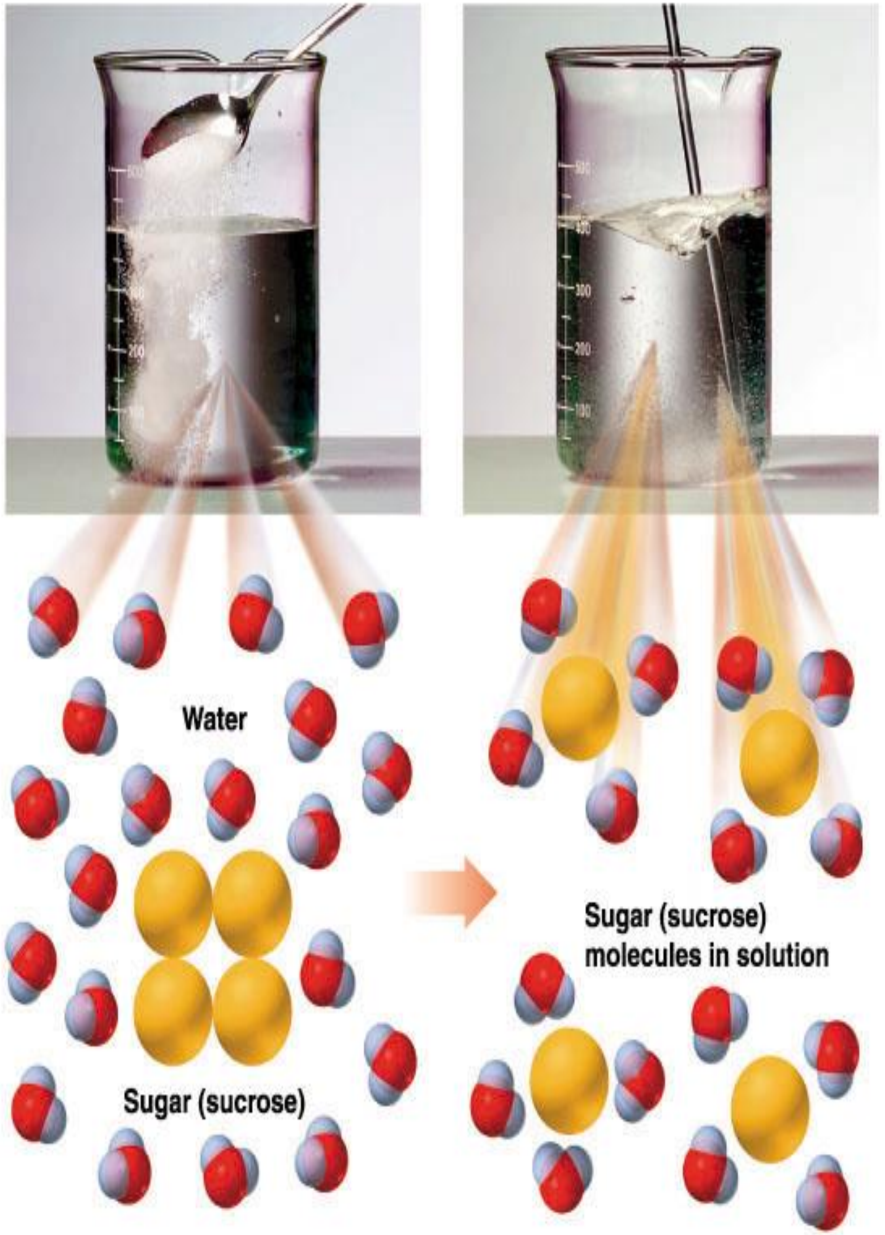
- Substances that dissociate partly or completely in water yielding ions.

- A solution that has ions can conduct electricity.

- Non Electrolytes:

- Substances that dissolve in water without dissociating, rather they remain as molecules. (no ions, no conductivity)


H_2O
NaCl
Hydrated ions
Na^+
Cl^-


Water
Sugar (sucrose)
Sugar (sucrose) molecules in solution

Electrolytes:

- Dissociate into ions, either +ve (cathode) or –ve (anode).
- Depending on the degree of dissociation, they can be either:

1- Strong electrolytes:

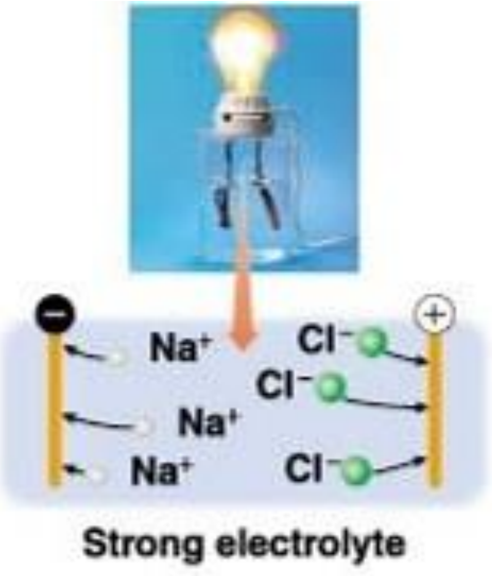
- Completely ionized in water.
- Strong conductor.
- Example:

$$NaCl_{(s)} \xrightarrow{H_2O} Na^+_{(aq)} + Cl^-_{(aq)}$$

2- weak electrolytes:

- Partly ionized in water
- Weak conductor.
- Example:

$$CH_3COOH_{(l)} \rightleftharpoons H^+_{(aq)} + CH_3COO^-_{(aq)}$$



Timberlake, Chemistry: An Introduction to General, Organic, and Biological Chemistry, Eighth Edition.

In our bodies..

- Cations present include: Na^+, K^+, Ca^{++} and Mg^{++} and the anions Cl^-, HCO_3^-, HPO_4^{--} and SO_4^{--}.
- These electrolytes play important role in maintaining acid-base balance in the body.
- In addition, they control body water volume and regulate body metabolism.

As a dosage forms:

- Pharmaceutical dosage forms containing electrolytes are used to treat electrolyte disturbance of body fluids in the form of I.V infusion, tablets, capsules, oral rehydrating solution (ORS) .


0.9% Sodium Chloride
Injection USP
500 mL


PEDIATRIC
ELECTROLYTE


Hydralyte™
Orange Flavoured
Electrolyte Powder
Helps replace water and electrolytes lost due to vomiting, diarrhoea, heavy sweating vigorous exercise and excess alcohol consumption
Australian made and owned
10 sachets
Oral Powder with 200 mL measuring cup
AUST L 122627
Dehydration due to:

Electrolyte concentration can be expressed as:

- Percent solutions (w%) (w/v)
- Millimoles (mmol) and Micromoles (µmol)
- Milliequivalents (mEq)
- Milliosmoles (mOsmol)

1- Percent solutions

- Ratio of solute to solvent expressed as percentage (w%)

  = weight in GRAMS/ 100 ml volume of a solution (w/v)

- Commonly seen in IV bags and medical solutions.

- Example

\- 5% Dextrose ➔ 5 g dextrose in 100 ml solution

2- Millimoles and Micromoles

- Mole= $\frac{weight\ (g)}{MW}$
- Millimoles = 10^{-3} of a mole
- Micromoles= 10^{-6} of a mole

Table 1 SUMMARY OF MAIN LABORATORY STUDIES UPON ADMISSION

Laboratory parameters	Results	Unit	Reference range
Admission serum urea	47	mg/dL	10 – 50
Admission serum creatinine	2.64	mg/dL	0.9 – 1.3
Total serum calcium	13.6	mg/dL	8.4 – 11.0
Ionized calcium	1.99	mmol/L	1.10 – 1.30
PTH	< 3	pg/mL	12.0 – 72.0
Serum alkaline phosphatase	78	u/L	27 – 100
25 (OH) vitamin D	150	ng/mL	30 – 60
1,25 (OH)2 vitamin D	26.8	pg/mL	18.0 – 78.0
24-hour urinary calcium	429.7	mg/24 h	< 200 mg/24 h
Serum pH	7.38	NA	7.35 – 7.45
Serum bicarbonate	28.7	mmol/L	22.0 – 26.0
Spot urinary sodium	19	mmol/L	NA
Serum phosphorus	4.52	mg/dL	2.50 – 4.50
Serum sodium	136	mmol/L	135 – 148
Serum potassium	4.4	mmol/L	3.6 – 5.0
Serum uric acid	10.5	mg/dL	2.5 – 7.0
Serum CPK	90	u/L	24 – 195
AST	77	u/L	11 – 39
ALT	47	u/L	11 – 41
Serum albumin	3.6	g/dL	3.5 – 5.0
White blood cell count	13350	cells/mm^3	4000 – 10000
Hemoglobin	15.2	g/dL	13.0 – 16.5
Platelet count	230,000	cells/mm^3	130,000 – 370,000

Note: Conversion factors for units: urea in mg/dL to blood urea nitrogen in mg/dL, ÷ 2.2; vitamin D in ng/mL to nmol/L, x 2.5; NA: not applicable.

3- Milliequivalents

- It is concerned with the total number of ions in a solution (related to valency).
- It is a measurement of the chemical activity of an electrolyte.

$$mEq = \frac{mg}{equivalent\ weight}$$

- <u>Equivalent weight:</u>

- The amount of a substance that will either:

supply or react with one mole of hydrogen ions (H+) in an acid-base reaction; or

supply or react with one mole of electrons in a redox reaction.

Equivalent weight= $\frac{atomic,molelcular,or\ formula\ weight}{valence}$

Therefore,

mEq= $\frac{mg\ x\ valence}{atomic,molecular,or\ formual\ weight}$

And

mg= $\frac{mEq\ x\ atomic,molecular,or\ formula\ weight}{valence}$

- You can always represent mEq and mg as mEq/ml and mg/ml

TABLE 12.3 VALUES FOR SOME IMPORTANT IONS

ION	FORMULA	VALENCE	ATOMIC OR FORMULA WEIGHT	EQUIVALENT WEIGHT[a]
Aluminum	Al^{+++}	3	27	9
Ammonium	NH_4^+	1	18	18
Calcium	Ca^{++}	2	40	20
Ferric	Fe^{+++}	3	56	18.7
Ferrous	Fe^{++}	2	56	28
Lithium	Li^+	1	7	7
Magnesium	Mg^{++}	2	24	12
Potassium	K^+	1	39	39
Sodium	Na^+	1	23	23
Acetate	$C_2H_3O_2^-$	1	59	59
Bicarbonate	HCO_3^-	1	61	61
Carbonate	CO_3^{--}	2	60	30
Chloride	Cl^-	1	35.5	35.5
Citrate	$C_6H_5O_7^{---}$	3	189	63
Gluconate	$C_6H_{11}O_7^-$	1	195	195
Lactate	$C_3H_5O_3^-$	1	89	89
Phosphate	$H_2PO_4^-$	1	97	97
	HPO_4^{--}	2	96	48
Sulfate	SO_4^{--}	2	96	48

[a] Equivalent weight $= \dfrac{\textit{Atomic or formula weight}}{\textit{Valence}}$

4- Osmolarity

- Takes into account the number of particles of solute in the solution.
- The unit of osmotic concentration is the milliosmole (mOsmol).
- For electrolytes (as NaCl) in which dissociation occurs:

1 mmole of NaCl = 2 mOsmol ($Na^+ + Cl^-$)

1 mmole of $CaCl_2$ = 3 mOsmol ($Ca^{++} + 2Cl^-$)

- N.B.: For any atom in solution, No. of species= 1

$$\text{mOsmol} = \frac{weight\ (g)}{MW} \text{ X number of species X 1000}$$

$$= \text{moles X number of species X 1000}$$

Can be represented as mOsmol/L and gram/L

$$\text{mOsmol/L} = \frac{weight\ (\frac{g}{L})}{MW} \text{ X number of species X 1000}$$

- For non-electrolytes (as dextrose) in which no dissociation occurs, *mmole= mOsmol*.

Percent solutions:

$$= \frac{weight\ (g)}{100\ mL\ of\ a\ solution}$$

Millimole:

Mole= $\frac{weight\ (g)}{MW}$

millimole= mole/1000

micromole= mole/1000000

Milliequivlent:

mEq= $\frac{mg\ x\ valence}{atomic, molecular, or\ formual\ weight}$

mg= $\frac{mEq\ x\ atomic, molecular, or\ formula\ weight}{valence}$

Milliosmole:

mOsmol= $\frac{weight\ (g)}{MW}$ X number of species X 1000

1- What is the concentration in (mg/ml) of a solution containing 2 mEq of potassium chloride per milliliter?

M.W. of KCl = 74.5

$$mg/ml = \frac{mEq/ml\ x\ atomic, molecular, or\ formula\ weight}{valence}$$

$$= \frac{2 * 74.5}{1} = 149\ mg/ml$$

2- A solution containing 10 mg/100mL of K^{+1}. Express the solution in terms of milliequivalents per liter (mEq/L).

Atomic weight of K^{+1} = 39

$$mEq/ml = \frac{mg/ml\ x\ valence}{atomic, molecular, or\ formual\ weight}$$

$$= \frac{10\ mg/100ml\ x\ 1}{39}$$

= 0.2564 mEq/100 ml

= 2.56 mEq/L

3- What is the percent (w/v) of a solution containing 100 mEq of Ammonium chloride per Liter?

M.W. of NH_4Cl = 53.5

$$mg/L = \frac{mEq/L \ x \ atomic, molecular, or \ formula \ weight}{valence}$$

$$= \frac{100 \ mEq/L \ x \ 53.5}{1}$$

= 5350 mg/L

= 5.35 g/L

= 0.535 g/100 ml or 0.535 g%

4- A solution containing 10 mg/100mL of Ca^{++}. Express the solution in terms of milliequivalents per liter (mEq/L).

Atomic weight of Ca^{++} = 40

$$mEq/ml = \frac{mg/ml \ x \ valence}{atomic, molecular, or \ formual \ weight}$$

$$= \frac{10\frac{mg}{100ml} * 2}{40}$$

= 0.5 mEq/100 ml

= 5 mEq/L

5- Magnesium ions level in the blood plasma is 2.5mEq/L. Express the concentration in terms of milligrams.

Atomic weight of Mg^{++} = 24

$$mg/L = \frac{mEq/L \ x \ atomic, molecular, or \ formula \ weight}{valence}$$

$$= \frac{2.5 \ mEq/L \ x \ 24}{2}$$

= 30 mg/L

6- A person is to receive 2mEq of sodium chloride per kilogram of body weight. If the person weighs 60 kg, how many milliliters of 0.9 % sodium chloride sterile solution should be administered?

Molecular weight of NaCl = 58.5

$$mg= \frac{mEq\ x\ atomic, molecular, or\ formula\ weight}{valence}$$

Total mEq required= 2 x 60= 120 mEq

$$mg= \frac{120\ mEq * 58.5}{1} = 7020\ mg$$

0.9 g --------> 100 ml

7.020 g -----> x ml

NaCl needed= 780 ml

7- A patient is given 125 mg of phenytoin sodium (m.w. 274) three times a day. How many milliequivalents of sodium are represented in daily dose?

$$mEq = \frac{mg\ x\ valence}{atomic, molecular, or\ formual\ weight}$$

125 mg three times a day = 375 mg

$$= \frac{375\ x\ 1}{274}$$

= 1.37 mEq

8- Ringer's solution contains 0. 86% of NaCl, 0.035 % of KCl and 0.033% $CaCl_2$. How many mEq of each chloride are contained in 1 L of the injection.

m.w.: of NaCl= 58.5, KCl= 74.5 and $CaCl_2$ = 111

A- **<u>NaCl:</u>** 0.86%= 0.86 g/100 mL= 8.6 g/ L= 8600 mg/L

mEq of NaCl = (wt x valence)/ m.w.

= (8600 x 1)/ 58.5 = 147 mEq

B- **KCl:** 0.03%= 0.03 g/100 mL= 0.3 g/ L= 300 mg/L

mEq of KCl = (wt x valence)/ m.w.

= (300 x 1)/ 74.5 = 4.03 mEq

C- **$CaCl_2$:** 0.033%= 0.033 g/100 mL= 0.33 g/ L= 330 mg/L

mEq of $CaCl_2$ = (wt x valence)/ m.w.

= (330 x 2)/ 111 = 5.95 mEq

9- How many Millimoles of dibasic sodium phosphate in 100 g of substance? M.W. of dibasic sodium phosphate is 138.

$$\text{Number of moles} = \frac{weight\ (g)}{MW} = \frac{100\ g}{138} = 0.725 \text{ moles} = 725 \text{ mmoles}$$

10- How many milligrams would 3 mmoles of dibasic sodium phosphate weigh? M.W. of dibasic sodium phosphate is 138.

$$\text{Number of moles} = \frac{weight\ (g)}{MW} \Rightarrow \text{weight (g)} = \text{moles} * \text{MW}$$

$$= 0.003 * 138 = 0.414 \text{ g} = 414 \text{ mg}$$

11- Convert *Tobramycin* blood plasma levels of 0.5 μg/mL and 2 μg/mL into μmoles.

M.W. of *Tobramycin* is 467.5.

$$\text{Mole} = \frac{weight\ (g)}{MW}$$

$$\text{Millimole} = \frac{weight\ (mg)}{MW}$$

$$\text{Micromole} = \frac{weight\ (\mu g)}{MW}$$

$$= \frac{0.5}{467.5} = 1.07 \text{ x } 10^{-3} \ \mu\text{mole}$$

And,

$$\frac{2}{467.5} = 4.27 \text{ x} 10^{-3} \ \mu\text{mole}$$

12- What is the osmolarity of 0.9%w/v NaCl injection?

$$\text{mOsmol} = \frac{weight\ (g)}{MW} \text{ X number of species X 1000}$$

0.9% w/v= 0.9 g/ 100 mL = 9 g/L

$$\text{mOsmol} = \frac{9}{58.5} \text{ X 2 X 1000}$$

= 308 mOsmol

= 0.308 Osmol

13- A solution contains 156 mg of K^+ ions per 100 mL. How many mOsmoles are represented in a liter of the solution? Atomic weight of K^+ =39

mOsmol/L = No. of moles x No. of species x 1000

156 mg/100 mL = 0.156 g/ 100 mL= 1.56 g/L

Number of moles= weight/ atomic Wt= 1.56/39= 0.04

mOsmol/L = 0.04 x 1 x 1000= 40 mOsmol/L

14- A solution contains 10 mg% of Ca^{++} ions. How many milliosmoles are represented in one liter of the solution?

Atomic weigh of Ca^{++} = 40

mOsmol/L = No. of moles x No. of species x 1000

10 mg%= 10 mg/100mL = 100 mg/L= 0.1 g/L

Number of moles= weight/ atomic wt= 0.1/40= 0.0025

mOsmol/L = 0.0025 x 1 x 1000= 2.5 mOsmol/L

15- A parenteral solution contains 5% dextrose. How many mOsmoles per liter are represented by this concentration?

M.W. of dextrose = 180

$$\text{mOsmol/L} = \frac{weight\ (g/L)}{MW} \text{ X number of species X 1000}$$

5% = 5 g/100 mL = 50 g/ L

Dextrose is non-electrolye, so, number of species = 1

$$\text{mOsmol/L} = \frac{50}{180} \text{ X 1 X 1000}$$

= 278 mOsmol/L