Osmolarity Chemistry Questions with Solutions

Q1. The osmolarity of a solution containing a 1M NaCl solution is ____.

a.) 1
b.) 2
c.) 3
d.) None of the above

Correct Answer– (b.) 2.

Q2. Osmolarity is independent of ____.

a.) number of partices
b.) moles
c.) nature of particles
d.) All of the above

Correct Answer– (c.) nature of particles.

Q3. The osmolarity of a solution containing a 1M $CaCl_2$ solution is ____.

a.) 1
b.) 2
c.) 3
d.) None of the above

Correct Answer– (c.) 3.

Q4. Osmolarity is the number of osmoles ____.

a.) per litre of solvent
b.) per kg of solvent
c.) per litre of solution
d.) per kg of solution

Correct Answer– (c.) per litre of solution.

Q5. A solution with high osmolarity has ____ water molecules with respect to solute particles.

a.) larger
b.) equal

c.) fewer
d.) None of the above

Correct Answer– (c.) fewer.

Q6. Define osmolarity.

Answer. Osmolarity is defined as the number of particles or the concentration of a specific solute or solutes per litre of solvent. Osmoles are used to measure osmolarity.

Q7. If 4 moles of $MgCl_2$ are dissolved in 2 L of water. What will the osmolarity be?

Answer. 1 mole of $MgCl_2$ gives 3 pieces = 3 osmoles = 12.
Therefore, the Osmolarity of 4 moles of $MgCl_2$ = 12 × ½ = 6 OsM.

Q8. How will you calculate osmolarity if there are many solutes in the solution?

Answer. If a solution contains many different types of solutes (for example, both glucose and sodium chloride), its osmolarity can be calculated using the equation
Osmolarity = Sum of all (molarity × n) of all solutes
n: the number of particles released from the solute molecule.

Q9. What is the osmolarity of a 2.6 M solution of table salt?

Answer. NaCl dissociates completely in water to form Na^+ ions and Cl^- ions.
Thus, each mole of NaCl becomes two osmoles in the solution: one mole of Na^+ and one mole of Cl^-.
Therefore, osmolarity = 2 × 2.6 M = 5.2 osmoles.

Q10. How can osmolarity be determined?

Answer. To determine the osmolarity of a solution, first, determine the number of osmoles of solute per litre of solvent. An osmole is a unit of measurement for the number of moles in a compound. A Mole is a unit of measurement for the amount of matter in a substance that contains precisely 6.02214086 × 10^{23} particles. The Avogadro constant is another name for this number. The following is a simplified formula for osmolarity. If there is more than one solute, the osmolarity is the sum of the solute molarities per litre of solvent.
Osmolarity (osmol) = Osmoles/litre

Q11. Differentiate between osmolarity and osmolality.

Answer. Osmolarity is defined as the concentration in moles per litre of solution, whereas osmolarity is defined as the concentration in moles per kilogram of solvent. However, for dilute solutions, they are numerically almost the same.

Since the volume of the solvent varies with temperature, osmolarity measurements are temperature dependent (i.e., the volume is larger at higher temperatures). In contrast, osmolality, which is based on mass of the solvent is temperature independent.

Q12. What is the osmolarity of a glass of skim milk? (There are 13 g of lactose in 236 mL)

Answer. Lactose is a kind of sugar with a molecular weight of about 342 g per mole.
13 g lactose × 1 mole/342 g = 0.038 mole.
Osmolarity = 0.038 mole / 0.236 litre = 0.16 OsM

Q13. A solution contains 312 mg of K^+ ions per 200mL. How many milliosmoles are represented in a litre of the solution?

Answer. Grams of potassium ions present in 1000 mL
Conversion of mg to g:
= 312 mg × 1g/1000mg = 0.312g

$$Grams\ of\ potassium\ ions\ present\ in\ 1L = \frac{0.312g of K ions}{200mL} = \frac{x}{1000mL} = 1.56g$$

$$milliosmoles\ per\ litre = \frac{mass\ in\ g}{molecular\ weight} \times number\ of\ particles \times 1000$$

Mass in g = 1.56 g
Molecular weight of potassium = 39
Number of particles = 1 as only potassium ions are present in the solution.

$$milliosmoles\ per\ litre = \frac{1.56}{39} \times 1 \times 1000 = 40$$

Hence, 40 milliosmoles of potassium are represented in a litre of the solution.

Q14. Calculate the osmolarity of 0.2 M of Na_2SO_4.

Answer. Given, M = 0.2 M
Osmolarity = Molarity × n
Na_2SO_4 dissociates into $2Na^+ + SO_4^{2-}$
Therefore, n = 3
Hence, osmolarity will be 0.2 × 3 = 0.6 OsM

Q15. A solution contains 1% of anhydrous dextrose in water forinjection. How many milliosmoles per litre are represented by this concentration? (m.w = 180)

Answer. 1% of anhydrous dextrose = 1g/100 mL = x/1000 mL = 10 g

$$milliosmoles\ per\ litre = \frac{mass\ in\ g}{molecular\ weight} \times number\ of\ particles \times 1000$$

Mass in g = 10 g
Molecular weight of dextrose = 180
Number of particles = 1 as dextrose is a non electrolyte

$$milliosmoles\ per\ litre = \frac{10\ g}{180} \times 1 \times 1000 = 56$$

Practise Questions on Osmolarity

Q1. The osmolarity of a solution containing 1M sucrose solution is ____.

a.) 1
b.) 2
c.) 3
d.) None of the above

Correct Answer– (a.) 1.

Q2. For dilute solutions, the value of osmolarity is ___ osmolality.

a.) greater than
b.) similar to
c.) smaller than
d.) None of the above

Correct Answer– (b.) similar to

Q3. What is the approximate osmolarity of the sugar in a can of Red Bull? (There are 27 g of sugar in a 250 mL can).

Answer. Let us assume all of the sugar is in the form of glucose. Glucose has a molecular weight of 180 g.
First, convert g to moles: 27 g × 1 mole/180 g = 0.15 mole
Since we know that the sugar molecule does not break into smaller bits, 1 M = 1 OsM.
Osmolarity is calculated as 0.15 mole / 0.25 litre = 0.60 OsM.

Q4. What is the osmolarity of seawater given the following:

Solute	g / L	Molecular weight
Cl^-	19	35
Na^+	10.5	23
Mg	1.3	24
S	0.8	32

Answer. Let us convert solutes from g to moles.

Solute	g / L	Molecular weight	Grams to moles
Cl^-	19	35	19 × 1/35 = 0.542
Na^+	10.5	23	10.5 × 1/23 = 0.456
Mg	1.3	24	1.3 × 1/24 = 0.054
S	0.8	32	0.8 × 1/32 = 0.025

Adding all the molarity = 0.54 + 0.46 + 0.054 + 0.025 = 1.079 OsM
Therefore, the osmolarity of seawater is 1.08 OsM.

Q5. Can osmolarity be calculated from osmolality. If yes, explain how?

Answer. Yes, osmolarity can be calculated from osmolality.
Osmolarity = osmolality for most diluted solutions in water.

$$Osmolarity = \frac{Moles\ of\ ions\ in\ solution}{Litres\ of\ solution}$$

$$Osmolality = \frac{Moles\ of\ ions\ in\ solution}{Kilograms\ of\ solvent}$$