1. The molality of pure water is
(a) 55.5
(b) 50.5
(c) 18
(d) 60.5
Answer/Explanation: A
Explanation:
(a) Molality = Number of moles/kg of solvent
\[
\text{Molality} = \frac{1000}{18} = 55.5 \text{ moles/kg}
\]

2. The number of moles of NaCl in 3 litres of 3M solution is
(a) 1
(b) 3
(c) 9
(d) 27
Answer/Explanation: C
Explanation:
(c) 3M solution means 3 moles in 1 litre.
∴ 9 moles in 3 litre.

3. 4L of 0.02 M aqueous solution of NaCl was diluted by adding one litre of water. The molality of the resultant solution is ________.[NCERT Exemplar]
(a) 0.004
(b) 0.008
(c) 0.012
(d) 0.016
Answer/Explanation: D
Explanation:
(d) \( M_1 V_1 = M_2 V_2 \)
\[
0.02 \times 4 = M_2 \times (4 + 1)
\]
\[
M_2 = \frac{0.08}{5} = 0.016
\]

4. Low concentration of oxygen in the blood and tissues of people living at high altitude is due to ________.[NCERT Exemplar]
(a) low temperature
(b) low atmospheric pressure
(c) high atmospheric pressure
(d) both low temperature and high atmospheric pressure
Answer/Explanation: b
Explanation:
(b) Low atmospheric pressure will lead to low concentration of oxygen blood.

5. Considering the formation, breaking and strength of hydrogen bond, predict which of the following mixtures will show a positive deviation from Raoult’s law? [NCERT Exemplar]
(a) Methanol and acetone.
(b) Chloroform and acetone.
(c) Nitric acid and water.
(d) Phenol and aniline.
6. Which of the following aqueous solutions should have the highest boiling point? (a) 1.0 M NaOH (b) 1.0 M Na₂SO₄ (c) 1.0 M NH₄NO₃ (d) 1.0 M KNO₃

Answer/Explanation : B
Explanation:
(b) Because \( i = 3, \Delta T_b \propto i, \) Boiling point \( \propto \Delta T_b. \)

7. In comparison to a 0.01 M solution of glucose, the depression in freezing point of a 0.01 M MgCl₂ solution is _________.
(a) the same (b) about twice (c) about three times (d) about six times

Answer/Explanation : C
Explanation:
(c) It will be nearly 3 times because number of particles in \( \text{MgCl}_2 \rightarrow \text{Mg}^{2+} + 2\text{Cl}^- \) are thrice than glucose.

8. An unripe mango placed in a concentrated salt solution to prepare pickle, shrivels because _________.

[NCERT Exemplar]
(a) it gains water due to osmosis.
(b) it loses water due to reverse osmosis.
(c) it gains water due to reverse osmosis.
(d) it loses water due to osmosis.

Answer/Explanation : B
Explanation:
(d) Concentrated salt solution is hypertonic solution, therefore, fluids inside mango will come out and it shrivels.

9. Which of the following statements is false?
(a) Two different solutions of sucrose of same molality prepared in different solvents will have the same depression in freezing point.
(b) The osmotic pressure of a solution is given by the equation \( \pi = CRT \) (where \( C \) is the molarity of the solution).
(c) Decreasing order of osmotic pressure for 0.01 M aqueous solutions of barium chloride, potassium chloride, acetic acid and sucrose is \( \text{BaCl}_2 > \text{KCl} > \text{CH}_3\text{COOH} > \text{sucrose} \).
(d) According to Raoult’s law, the vapour pressure exerted by a volatile component of a solution is directly proportional to its mole fraction in the solution.

Answer/Explanation : A
Explanation:
(a) is false because \( \Delta T_f \) will depend upon nature of solvent and their \( K_f \).

10. The value of Henry’s constant \( K_H \) is _________
(a) greater for gases with higher solubility.
(b) greater for gases with lower solubility.
(c) constant for all gases.
(d) not related to the solubility of gases.

Answer/Explanation : B
Explanation: (b) Higher the value of \( K_H \), lower will be solubility.
11. Consider the figure and mark the correct option.

![Diagram of osmosis](image.png)

(a) water will move from side (A) to side (B) if a pressure lower than osmotic pressure is applied on piston (B).
(b) water will move from side (B) to side (A) if a pressure greater than osmotic pressure is applied on piston (B).
(c) water will move from side (B) to side (A) if a pressure equal to osmotic pressure is applied on piston (B).
(d) water will move from side (A) to side (B) if pressure equal to osmotic pressure is applied on piston (A).

**Answer/Explanation**: B

**Explanation**: (b) Reverse osmosis will take place.

12. We have three aqueous solutions of NaCl labelled as ‘A’, ‘B’ and ‘C’ with concentrations 0.1M, 0.01M and 0.001M, respectively. The value of van’t Hoff factor for these solutions will be in the order __________

(a) $i_A < i_B < i_C$
(b) $i_A > i_B > i_C$
(c) $i_A = i_B = i_C$
(d) $i_A < i_B > i_C$

**Answer/Explanation**: C

**Explanation**: (c) van’t Hoff factor ($i$) does not depend upon concentration.

13. A solution containing 10 g per dm$^3$ of urea (molar mass 60 g mol$^{-1}$) is isotonic with 5% solution of non-volatile solute, M$_B$ of solute is

(a) 300 g mol$^{-1}$
(b) 350 g mol$^{-1}$
(c) 200 g mol$^{-1}$
(d) 250 g mol$^{-1}$

**Answer/Explanation**: A

**Explanation**: 
(a) $\frac{30}{60} = \frac{5}{x}$
$\Rightarrow x = 300$ g mol$^{-1}$
1000 cm$^3$ contains 10 g
100 cm$^3$ contains 1 g, i.e., 1%.

14. Cone. H$_2$SO$_4$ is 98% H$_2$SO$_4$ by mass has d = 1.84 g cm$^{-3}$. Volume of acid required to make one litre of 0.1 M H$_2$SO$_4$ is

(a) 5.55 mL
(b) 10 mL
(c) 20 mL
(d) 30 mL

**Answer/Explanation**: A

**Explanation**: 

15. What is mole fraction of solute in 1.0 m aqueous solution?
(a) 0.0354
(b) 0.0177
(c) 0.177
(d) 1.770

Answer/Explanation : B
Explaination:
\[
x_B = \frac{m}{m + \frac{1000}{M_A}} = \frac{1}{1 + \frac{1000}{18}}
\]
\[
= \frac{18}{1018} = 0.0177
\]

16. When 1 mole of benzene is mixed with 1 mole of toluene (vapour pressure of benzene = 12.8 kPa, Toluene = 3.85 kPa)
(a) The vapour will contain equal amount of benzene and toluene.
(b) Not enough information is given for prediction.
(c) The vapour will contain a higher percentage of benzene.
(d) The vapour will contain higher percentage of toluene.

Answer/Explanation : C
Explaination: (c) It is because benzene has high vapour pressure, it will form more vapours as compared to toluene.

17. At 100°C, the vapour pressure of a solution of 6.5 g of solute in 100 g of water is 732 mm. If K_b is 0.52 K/m, the boiling point of solution will be
(a) 102°C
(b) 103°C
(c) 101°C
(d) 100°C

Answer/Explanation : C
18. Which of the following is incorrect for an ideal solution?
(a) $\Delta H_{\text{mix}} = 0$
(b) $\Delta V_{\text{mix}} = 0$
(c) $\Delta P = P_{\text{obs}} - P_{\text{calculated}} = 0$
(d) $\Delta G_{\text{mix}} = 0$

**Answer/Explanation:** D

Explanation: (d) $\Delta G$ cannot be equal to zero because mixing does not lead to equilibrium.

---

19. If molality of dilute solution is doubled, the value of molal depression constant ($K_f$) will be
(a) halved
(b) tripled
(c) unchanged
(d) doubled

**Answer/Explanation:** C

Explanation: (c) $K_f$ does not depend upon ‘$mMt$ depends upon nature of solvent.

---

20. The temperature at which 10% aqueous solution of (W/V) of glucose will show the osmotic pressure of 16.4 atom is $(R = 0.082 \text{ L at m K}^{-1} \text{ mol}^{-1})$
(a) 360°C
(b) 180 K
(c) 300 K
(d) 360 K

**Answer/Explanation:** D
21. Which has the highest freezing point?
(a) 1 M glucose
(b) 1 M NaCl
(c) 1 M CaCl_2
(d) 1 M AlF_3

Answer/Explanation: A
Explaination: (a) 1 M glucose solution has highest freezing point because it has lowest \( \Delta T_f \) because \( i = 1 \). 

Note: In the following questions two or more options may be correct. (Q.22 to Q.24)

22. Which of the following is correct.
(a) KJ decreases with increase in temperature (KH is Henry’s law constant).
(b) Solubility of gas in liquid decreases with increase in temperature.
(c) KJ decreases with increase in temperature.
(d) Solubility of gas in liquid increases with increase in temperature.

Answer/Explanation: A
Explaination: (a) and (b) are correct \( p_{gas} = K_H \times x_{gas} \)
\( K_H \) increases with increase in temperature, decreases, i.e., solubility of gas in liquid decreases with increase in temperature.

23. Benzoic acid, when dissolved in benzene, which of the following is correct. [NCERT Exemplar]
(a) The benzoic acid will undergo dissociation.
(b) The benzoic acid will undergo association.
(c) Observed molar mass of benzoic acid in benzene will less than normal molar mass.
(d) Observed molar mass of benzoic acid in benzene is more than normal molar mass.

Answer/Explanation: B
(b) and (d) C_6H_5-C=O---H--O--C---C_6H_5
Molar mass will be nearly double due to dimerisation.

24. Relative lowering of vapour pressure is a colligative property because _______
(a) It depends on the concentration of a non electrolyte solute in solution and does not depend on the nature of the solute molecules.
(b) It depends on number of particles of electrolyte solute in solution and does not depend on the nature of the solute particles.
(c) It depends on the concentration of a non electrolyte solute in solution as well as on the nature of the solute molecules.
(d) It depends on the concentration of an electrolyte or nonelectrolyte solute in solution as well as on the nature of solute molecules.

Answer/Explanation: A
Explaination:
(a) and (b) colligative property depends upon number of particles of solute in both electrolyte and non-electrolyte.
25. Match the items given in Column I with the type of solutions given in Column II.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Sóda water</td>
<td>(i) A solution of gas in solid</td>
</tr>
<tr>
<td>(b) Sugar solution</td>
<td>(ii) A solution of gas in gas</td>
</tr>
<tr>
<td>(c) German silver</td>
<td>(iii) A solution of solid in liquid</td>
</tr>
<tr>
<td>(d) Air</td>
<td>(iv) A solution of solid in solid</td>
</tr>
<tr>
<td>(e) Hydrogen gas in palladium</td>
<td>(v) A solution of gas in liquid</td>
</tr>
<tr>
<td></td>
<td>(vi) A solution of liquid in solid</td>
</tr>
</tbody>
</table>

**Answer/Explanation**

(a) – (v)
(b) – (iii)
(c) – (iv)
(d) – (ii)
(e) – (i)

26. In the following question a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(c) Assertion is correct statement but reason is wrong statement.
(d) Assertion and reason both are incorrect statements.
(e) Assertion is wrong statement but reason is correct statement.

Assertion: When methyl alcohol is added to water, boiling point of water increases.
Reason: When a volatile solute is added to a volatile solvent elevation in boiling point is observed.

**Answer/Explanation:** D

**Explaination:** (d) Assertion and reason both are incorrect statements.

27. Mole fraction of glycerine \( C_3H_5(OH)_3 \) in solution containing 36 g of water and 46 g of glycerine is

(a) 0.46
(b) 0.40
(c) 0.20
(d) 0.36

**Answer:** C

28. Out of molality (\( m \)), molarity (\( M \)), formality (\( F \)) and mole fraction (\( x \)), those which are independent of temperature are

(a) \( M, m \)
(b) \( F, x \)
(c) \( m, x \)
(d) \( M, x \)

**Answer:** C

29. Which of the following condition is not satisfied by an ideal solution?

(a) \( \Delta H_{\text{mixing}} = 0 \)
(b) \( \Delta V_{\text{mixing}} = 0 \)
(c) Raoult’s Law is obeyed
(d) Formation of an azeotropic mixture

**Answer:** D
30. The boiling point of an azeotropic mixture of water and ethanol is less than that of water and ethanol. The mixture shows
(a) no deviation from Raoult’s Law.
(b) positive deviation from Raoult’s Law.
(c) negative deviation from Raoult’s Law.
(d) that the solution is unsaturated.
Answer: B

31. Which has the lowest boiling point at 1 atm pressure?
(a) 0.1 M KCl
(b) 0.1 M Urea
(c) 0.1 M CaCl$_2$
(d) 0.1 M AlCl$_3$
Answer: B

32. Osmotic pressure of a solution is 0.0821 atm at a temperature of 300 K. The concentration in moles/litre will be
(a) 0.33
(b) 0.666
(c) 0.3 × 10$^{-2}$
(d) 3
Answer: C

33. People add sodium chloride to water while boiling eggs. This is to
(a) decrease the boiling point.
(b) increase the boiling point.
(c) prevent the breaking of eggs.
(d) make eggs tasty.
Answer: B

34. The van’t Hoff factor (i) accounts for
(a) degree of solubilisation of solute.
(b) the extent of dissociation of solute.
(c) the extent of dissolution of solute.
(d) the degree of decomposition of solution.
Answer: B

35. Which relationship is not correct?
\[
\Delta T_b = \frac{K_b \cdot 1000 \cdot W_2}{M_2 \cdot W_1}\quad \text{(a)}
\]
\[
M_2 = \frac{K_f \cdot 1000 \cdot W_1}{W_2 \cdot \Delta T_b}\quad \text{(b)}
\]
\[
\pi = \frac{n_2}{V}\quad \text{(c)}
\]
\[
\frac{p^o - p_\delta}{p^o} = \frac{W_2}{M_2} \times \frac{M_1}{W_1}\quad \text{(d)}
\]
Answer: B

36. The molal elevation constant depends upon
(a) nature of solute.
(b) nature of the solvent.
(c) vapour pressure of the solution.
(d) enthalpy change.
Answer: B

37. The process used for desalination of water is __________.
Answer/Explanation: reverse osmosis
38. Vapour pressure is ______ proportional to temperature.  
**Answer/Explanation**: directly

39. Ethylene glycol is used as ______.  
**Answer/Explanation**: antifreeze

40. All intravenous injections must be isotonic with body fluids. [True/False]  
**Answer/Explanation**: True.

41. Diabetic patients are likely to have high blood pressure. [True/False]  
**Answer/Explanation**: True.

42. Common salt is non-electrolyte. [True/False]  
**Answer/Explanation**: False, common salt is electrolyte.

43. State the main advantage of molality over molarity as the unit of concentration.  
**Answer/Explanation**: Molality is more accurate than molarity because molality does not depend on temperature as mass does not change with temperature.

44. Define molality in terms of elevation in boiling point.  
**Answer/Explanation**: Molality is defined as the ratio of elevation in boiling point and $K_A$ (molal elevation constant).

45. State Raoult's law for a solution containing volatile components.  
**Answer/Explanation**: The vapour pressure of each component is directly proportional to the mole fraction of each component. 
\[ P_A = \frac{P^0_A}{P^0_B} x_A, \quad P_B = \frac{P^0_B}{P^0_B} x_B \] 
where $P_A$ and $P_B$ = Vapour pressure of components ‘A’ and ‘B’. 
$p^0_A$ and $p^0_B$ = Vapour pressure of pure components ‘A’ and ‘B’. 
$x_A$ and $x_B$ = Mole fractions of ‘A’ and ‘B’.

46. Two liquids A and B boil at 145 °C and 190 °C respectively. Which of them has a higher vapour pressure at 80 °C?  
**Answer/Explanation**: ‘A’ because lower the boiling point, higher will be vapour pressure.

47. What are the values of $\Delta H$ and $\Delta V$ for an ideal solution of two liquids?  
**Answer/Explanation**: $\Delta H = 0, \Delta V = 0$ for an ideal solution of two liquids.

48. Give reason when 30 mL of ethyl alcohol and 30 mL of water are mixed, the volume of resulting solution is more than 60 mL.  
**Answer/Explanation**: It is because forces of attraction between ethyl alcohol and water are less than ethanol-ethanol and water-water. It shows positive deviation.

49. 10 mL of liquid A was mixed with 10 mL of liquid B. The volume of the resulting solution was found to be 19.9 mL. What do you conclude?  
**Answer/Explanation**: It means solution shows -ve deviation from Raoult’s law due to increase in force of attraction, volume decreases, e.g. chloroform and acetone.

50. What are azeotropes? Give an example.  
**Answer/Explanation**: Azeotropes are constant boiling mixtures which distill out unchanged in their composition, e.g. ethanol and water.
51. Define Ebullioscopic constant or molal elevation constant.

**Answer/Explanation**: Molal Elevation Constant (Ebullioscopic Constant): It is equal to elevation in boiling point of 1 molal solution, i.e. 1 mole of solute is dissolved in 1 kg of solvent. It is also called ebullioscopic constant. The units of $K_b$ is K/m or °C/m or K kg mol$^{-1}$, where ‘m’ is molality.

52. Calculate the freezing point of a solution containing 60 g of glucose (molar mass 180 g mol$^{-1}$) in 250 g of water. [$K_f$ for water = 1.86 K kg mol$^{-1}$] [CBSE 2018]

**Answer/Explanation**

\[ W_B = 60 \text{ g}, M_B = 180 \text{ g mol}^{-1}, W_A = 250 \text{ g}, \]

\[ K_f = 1.86 \text{ K kg mol}^{-1}, \Delta T_f = ? \]

\[ \Delta T_f = K_f \times \frac{W_B}{M_B} \times \frac{1000}{W_A} \]

\[ = 1.86 \times \frac{60}{180} \times \frac{1000}{250} \]

\[ = \frac{1.86 \times 4}{3} \]

\[ = 0.62 \times 4 \]

\[ = 2.48 \]

**Freezing point of solution**

\[ = \text{Freezing point of solvent} - \Delta T_f \]

\[ = 2.7315 \text{ K} - 2.48 \]

\[ = 270.67 \text{ K} \]

53. What is anti-freeze?

**Answer/Explanation**: Anti-freeze is a substance which is added to solvent to lower its freezing point. It is used in car radiators to lower the freezing point of water, e.g. ethylene glycol.

54. What is ‘semipermeable’ membrane?

**Answer/Explanation**: It is the membrane which has sub-microscopic pores through which small solvent molecules like water can pass but bigger solute particles cannot pass.

55. Define osmotic pressure.

**Answer/Explanation**: It is the extra pressure which must be applied on solution side so as to prevent the flow of solvent molecules from solution through semipermeable membrane.

56. Measurement of which colligative property is preferred for determination of molar mass 112 la\^etAen-Objective Type Questions of macromolecules such as proteins and polymers.

**Answer/Explanation**: Osmotic pressure.

57. A person suffering from high blood pressure should take less common salt, why?

**Answer/Explanation**: Common salt contains Na$^+$ and Cl$^-$ which increase osmotic pressure of blood, therefore, increase blood pressure.

58. What is meant by ‘reverse osmosis’?

**Answer/Explanation**: Reverse Osmosis: If extra pressure is applied on the solution side and exceeds the osmotic pressure, the osmosis can be reversed. That is, pure water can be forced out of the solution to pass through the pores of the membrane in the opposite direction. This is called reverse osmosis.
59. Give an example of a material used for making semipermeable membrane for carrying out reverse osmosis.  
**Answer/Explanation**: Cellulose acetate.

60. A 10% solution of urea is isotonic with 20% solution of V at same temperature. Calculate molecular weight of x.  
**Answer/Explanation**

61. Why do doctors advise gargles by saline water in case of sore throat?  
**Answer/Explanation**: Saline water is hypertonic solution, therefore, fluids causing irritation in throat will come out.

62. When outer shell of two eggs are removed, one of the eggs is placed in pure water and other is placed in saturated solution of NaCl, what will be observed and why?  
**Answer/Explanation**: The egg placed in pure water will swell, whereas the egg placed in saturated solution of NaCl will shrink.

63. Of 0.1 molal solutions of glucose and potassium chloride respectively, which one will have a higher boiling point?  
**Answer/Explanation**: 0.1 molal KCl solution will have higher boiling point because KCl dissociates into K⁺ and Cl⁻ ions, therefore, number of particles will be doubled.

64. What is expected value of van’t Hoff factor for K₃[Fe(CN)₆].  
**Answer/Explanation**

\[ K₃[Fe(CN)₆] \rightarrow 3K⁺ + [Fe(CN)₆]^{3⁻} \]

\[ i = 4 \]

65. What would be the value of van’t Hoff factor for a dilute solution of K₂SO₄ in water?  
**Answer/Explanation**

\[ i = 3, \quad \therefore \quad K₂SO₄ \rightarrow 2K⁺ + SO₄^{2⁻} \]

66. In the determination of molar mass of A⁺ B⁻ using a colligative property, what may be the value of van’t Hoff factor if the solute is 50% dissociated?  
**Answer/Explanation**

\[ \alpha = \frac{i - 1}{n - 1} = \frac{i - 1}{2 - 1} \]

\[ \Rightarrow \quad i = 1.5 \]

\[ [\alpha = 50\% = 0.5, \quad n = 2, \quad \therefore \quad AB \rightarrow A⁺ + B⁻] \]

67. What possible value of ‘i’ will it have if solute molecules undergo association in solution? [AI 2014(C)]  
**Answer/Explanation**: i < 1, if solute molecules undergo association.
68. Predict whether van’t Hoff factor, (i) is less than one or greater than one in the following:
(i) CH₃COOH dissolved in water.
(ii) CH₃COOH dissolved in benzene.

Answer/Explanation:
(i) It will be more than 1 because
CH₃COOH will dissociate into CH₃COO⁻ and H⁺.
(ii) CH₃COOH dissolved in benzene will form dimer i.e. undergo association, therefore, i < 1.

69. Why is osmotic pressure of 1 M KCl is higher than that of 1 M urea solution?

Answer/Explanation:
1 M KCl solution dissociates into K⁺ and Cl⁻, therefore, its osmotic pressure is higher than that of 1 M solution of urea which does not dissociate.

70. State how does osmotic pressure vary with temperature.

Answer/Explanation: Osmotic pressure increases with increase in temperature.