AP Chemistry

Name _____
Period ___ Date ___/___/___

8 • Solutions

Released FRQs

Since there is no exam for Unit 8, I am giving you many FRQ questions to study from.

1971

Molarity and molality are two ways of expressing concentration.

(a) Clearly distinguish between them

(b) Indicate an experimental situation where expressing concentrations as molarity is particularly appropriate.

(c) Indicate an experimental situation where expressing concentration as molality is particularly appropriate.

Answer:

(a) molarity (M) - molar concentration; composition or concentration of a solution expressed as number of moles of solute per liter of solution.

molality (*m*) - solution concentration expressed as number of moles of solute per kilogram of solvent.

many possibilities, examples:

(b) Acid - base titrations

(c) Molecular weight determination by freezing point depression change.

1975 D

Alcohol dissolves in water to give a solution that boils at a lower temperature than pure water. Salt dissolves in water to give a solution that boils at a higher temperature than pure water. Explain these facts from the standpoint of vapor pressure.

Answer:

An alcohol-water solution has a higher than normal (pure water) vapor pressure because alcohol is a volatile solute and contributes substantially to the vapor of the solution. The higher the vapor pressure, the lower the boiling point. A salt-water solution has a lower than normal vapor because salt is a non-volatile solute and solute-solvent interaction decrease the vapor of the solution, the lower the vapor pressure, the higher the boiling point.

1976 B

(a) Calculate the molality of a 20.0 percent by weight aqueous solution of NH4Cl. (Molecular weight: NH4Cl = 53.5)

(b) If this NH4Cl solution is assumed to be ideal and is completely dissociated into ions, calculate the pressure of this solution at 29.0˚C.

(c) Actually a solution of NH4Cl of this concentration is not ideal. Calculate the apparent degree of dissociation of the NH4Cl if the freezing point of this solution is -15.3˚C? (Molal freezing point constant = 1.86˚C)

Answer:

(a)

(b) P1 = (P˚)(*X*1)

mol ions = (2)(4.67 mol) = 9.34 mol

1 kg water = 55.6 mol water

P1= (29.8 mm Hg)(0.856) = 25.5 mm Hg

(c) Assume no dissociation.

ΔT = k*f**m* = (1.86)(4.67) = 8.69˚C

i = 15.3 / 8.69 = 1.76

(1.76 - 1.00)(100) = 76% dissociated

1980 B

(a) A solution containing 3.23 grams of an unknown compound dissolved in 100.0 grams of water freezes at -0.97˚C. The solution does not conduct electricity. Calculate the molecular weight of the compound. (The molal freezing point depression constant for water is 1.86˚C kg mole-1)

(b) Elemental analysis of this unknown compound yields the following percentages by weight H=9.74%; C=38.70%; O=51.56%. Determine the molecular formula for the compound.

(c) Complete combustion of a 1.05 gram sample of the compound with the stoichiometric amount of oxygen gas produces a mixture of H2O(g) and CO2(g). What is the pressure of this gas mixture when it is contained in a 3.00 liter flask at

127˚C?

Answer:

(a) $\Delta Tf = kfm$; 0.97˚C = (1.86˚Cm-1)(m)

m = 0.52 mol solute/kg solvent

In this solution, 3.23 g solute in 100.0 g water or 32.3 g solute in 1 kg of water

(b)

= C2H6O2

(c) 2 C2H6O2 + 5 O2 ∅ 6 H2O(g) + 4 CO2(g)

= 0.0847 mol gas

P = (nRT) / V

1985 B

The formula and the molecular weight of an unknown hydrocarbon compound are to be determined by elemental analysis and the freezing-point depression method.

(a) The hydrocarbon is found to contain 93.46 percent carbon and 6.54 percent hydrogen. Calculate the empirical formula of the unknown hydrocarbon.

(b) A solution is prepared by dissolving 2.53 grams of p-dichlorobenzene (molecular weight 147.0) in 25.86 grams of naphthalene (molecular weight 128.2). Calculate the molality of the p-dichlorobenzene solution.

(c) The freezing point of pure naphthalene is determined to be 80.2˚C. The solution prepared in (b) is found to have an initial freezing point of 75.7˚C. Calculate the molal freezing-point depression constant of naphthalene.

(d) A solution of 2.42 grams of the unknown hydrocarbon dissolved in 26.7 grams of naphthalene is found to freeze initially at 76.2˚C. Calculate the apparent molecular weight of the unknown hydrocarbon on the basis of the freezing-point depression experiment above.

(e) What is the molecular formula of the unknown hydrocarbon?

Answer:

(a) Assume 100. g sample of the hydrocarbon

(b)

(c) $\Delta T_f = (80.2 - 75.7)^\circ C = 4.5^\circ C$
$k_f = \Delta T_f / m = 4.5^\circ C / 0.666 \text{ molal} = 6.8^\circ C/\text{molal}$

(d) $\Delta T_f = (80.2 - 76.2)^\circ C = 4.0^\circ C$

=154 g/mol

(e) $C_6H_5 = 77$
empirical units/mol = 154/77 = 2
molecular formula = $(C_6H_5)_2 = C_{12}H_{10}$

1986 D

Give a scientific explanation for each of the following observations. Use equations or diagrams if they seem relevant.

(a) Graphite is used to make electrodes, while diamond, another allotrope of carbon, is a very poor conductor of electricity.

(b) Putting rock salt on an icy driveway melts the ice even when the air temperature is -10˚C.

(d) Carbon dioxide, rather than a stream of water, should be used to extinguish an oil fire.

Answer:

(a) Distinction or correctly implied distinction between the structures of graphite and diamond.
Freedom of movement of electrons in graphite resulting from the structure.

(b) The rock salt forms a concentrated solution with very little water from the ice. The solution now has a freezing point lower than the temperature of the ice, therefore, the ice melts.

(c) [question and answer in the GASES section]

(d) Carbon dioxide is more dense than air and so pushes the air away from the fire.
Water is more dense than the oil and so ends up below the oil, leaving the oil still in contact with the air; or the hot burning oil quickly vaporizes the water creating steam that spatters the oil into the air.

1993 A

Elemental analysis of an unknown pure substance indicated that the percent composition by mass is as follows.

Element	Percent by Mass
Carbon	49.02%
Hydrogen	2.743%
Chlorine	48.23%

A solution that is prepared by dissolving 3.150 grams of the substance in 25.00 grams of benzene, C_6H_6, has a freezing point of 1.12˚C. (The normal freezing point of benzene is 5.50˚C and the molal freezing-point depression constant, K_f, for benzene is 5.12˚C/molal.)

(a) Determine the empirical formula of the unknown substance.

(b) Using the data gathered from the freezing-point depression method, calculate the molar mass of the unknown substance.

(c) Calculate the mole fraction of benzene in the solution described above.

(d) The vapor pressure of pure benzene at 35˚C is 150. millimeters of Hg. Calculate the vapor pressure of benzene over the solution described above at 35˚C.

Answer:

(a) moles / 100 g C H Cl

= 4.081 = 2.722 = 1.360

mol ratio 3 2 1

empirical formula: C_3H_2Cl

(b) $\Delta T_f = (K_f)(m)$

(c) mol fraction = mol benzene / total mol

(d) vapor pressure = mol fraction ∞ P_o

= (0.938)(150 mm) = 141 mm Hg