COVENANT UNIVERSITY
NIGERIA

TUTORIAL KIT
OMEGA SEMESTER

PROGRAMME: CHEMISTRY

COURSE: CHM 223

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Hemoglobin is the protein that is responsible for the red color of blood and for transporting oxygen from the lungs to the tissues. A solution with 11.2 mg of hemoglobin per mL has an osmotic pressure of 2.9 mmHg at 5°C. What is the molecular mass of hemoglobin? R = 0.0821 L atm $M^{-1} K^{-1}$ (1 atm = 760 mmHg)

Ans:) $\Pi = MRT$

Π- osmotic pressure

M- molarity

R- gas constant (0.0821 L atm /mol k)

T- temperature

1 atm = 760 mmHg

Then 2.9 mmHg = $\frac{2.9 \times 1}{760} = 0.00381$ atm

$M = \frac{0.003821}{0.0821 \times 278} = 0.000166$ M

Converting 11.2 mg/ ml to g/l = 11.2 g/l

Molar mass of hemoglobin = $\frac{11.2}{0.000166} = 67{,}469.87$g/mol

1. How many grams of KNO_3 must be added to water to produce the same boiling point elevation as a solution of 2.03 g of $MgCl_2$ in a total volume of 120.0 mL of solution, assuming complete dissociation? If the van't Hoff factor for $MgCl_2$ at this concentration is 2.73, how much KNO_3 would be needed?
2. The freezing point of pure benzene was measured as 5.49 °C. The freezing point of a solution prepared by dissolving 5.782 g of an unknown substance (sometimes sold in stores as "moth balls") in 100.2 g of benzene was found to be 3.48 °C. K_f for benzene is 5.12°C/m. calculate the MW of the unknown. In a separate analysis of the unknown, it was found to contain 49.0% carbon, 48.2% chlorine, and 2.75% hydrogen. What is the molecular formula of the unknown.
3. How much NaCl would you have to add to 2.0 L of water at a mountain lodge at an elevation of 7350 ft, where the pressure is 0.78 atm and the boiling point of water is 94°C, to get the water to boil at the same temperature as in New Orleans, Louisiana, where the pressure is 1.00 atm?
4. A 3.00 g sample of water was added to 50.0 g of ethanol (C_2H_5OH). Use the table below to calculate the boiling point of the solution.

	T^0_b	K_b (^{0}C/m)
Water	100.0	0.51
Ethanol	73.8	1.07

5. At a constant temperature, the vapor pressure of water is 6.77 kPa and the vapor pressure of ethanol, C_2H_5OH, is 8.24 kPa. Assuming they behave like ideal solutions, what is the total vapor pressure if 50.0 g of water and 30.0 g of ethanol are mixed?
6. A conductance cell had a resistance of 174 ohms when filled with 0.02 molar KCl solution at 25^{o}C. For such a solution specific conductance is 0.00277 mhos/cm. The same cell filled with 0.01 molar NaCl had a resistance of 358 ohms. Calculate specific conductance and equivalent conductance of the solution.

7. The melting point depression of biphenyl (melting point = 69.0°C) can be used to determine the molecular mass of organic compounds. A mixture of 100.0 g of biphenyl and 2.67 g of naphthalene ($C_{10}H_8$) has a melting point of 68.50°C. If a mixture of 1.00 g of an unknown compound with 100.0 g of biphenyl has a melting point of 68.86°C, what is the molar mass of the unknown compound?
8. Experiment shows that 10 g of sugar cane (mol mass = 342) in 1 X 10^{-3} m^3 of the solution produces an osmotic pressure of 6.68 X 104 N m^{-2} at 273 K . Calculate the value of *R* in SI units.
9. A benzene/toluene solution with a mole fraction of benzene of 0.6589 boils at 88°C at 1 atm. The vapor pressures of pure benzene and toluene at this temperature are 1.259 atm and 0.4993 atm, respectively. What is the composition of the vapor above the boiling solution at thistemperature?
10. The resistance of decinormal solution of a salt occupying a volume between two platinum electrodes 1.58 cm apart and 2.7 cm^2 in area was found to be 32 ohms. Calculate the equivalent conductance of the solution.
11. The conductivity of a solution containing 1 g of anhydrous $BaCl_2$ in 200 cm^3 of water has been found to be 0.0058 ohm^{-1} cm^{-1}. What is the molar conductance and equivalent conductance of the solution? (Atomic mass of Ba = 137 and Cl = 35.5)
12. The equivalent conductance at infinite dilution of NH_4Cl, NaOH and NaCl at 18^{o}C is respectively; 129.8, 227.4 and 108.9 ohm^{-1} cm^2 g $equiv^{-1}$. The equivalent conductance of NH_4OH at infinite dilution at 18^{o}C will be --- ?
13. A current 4.0 amperes is passed for 8 hours between nickel electrodes in 500 ml of 2 ml of 2 M solution of nickel nitrate. What will the molarity of the solution at the end of electrolysis?
14. 0.5 Normal solution of a salt placed between two platinum electrodes, 20 cm apart and of area of cross-section 4.0sq cm has resistance of 25 ohms. Calculate the specific conductance of the solution.

16. The rate of the reaction between haemoglobin (Hb) and carbon monoxide (CO) was studied at 20^{o}C.

The following data were collected with all concentration units in µmol/L.

$[Hb]_0$ µmol/L	$[CO]_0$ µmol/L	Initial Rate (µmol/L.s)
2.21	1.00	0.619
4.42	1.00	1.24
4.42	3.00	3.71

i) Determine the orders of reaction with respect to Hb and CO

ii) Determine the rate law.

iii) Calculate the value of the rate constant

iv) What would be the initial rate for an experiment with $[Hb]_0 = 3.36$ µmol/L and $[CO]_0 = 2.40$ µmol/L?

17 Compound A decomposes to form B and C the reaction is first order. At 25^0C the rate constant for the reaction is 0.450 s^{-1}. What is the half-life of A at 25 ^{o}C?

18 The energy of activation for a reaction is 5.65×10^{-3} at 303 K and 11.1×10^{-3} at 214 K. Calculate the energy of activation of the reaction.

19 The gas –phase reaction between methane (CH4) and diatomic sulphur (S2) is given by the equation

At 550^{o}C the rate constant for this is 1.1 / mol^{-1} sec and at 625 ^{o}C the rate constant is 6.41 mol^{-1} sec. Calculate Ea for this reaction.

20. In a reaction, the initial concentration of the reactant is 2.34 M. The equilibrium mixture contains 1.12 M of the reactant. Equilibum was achieved in 523 sec. What is the average rate of the reaction?

SOLUTION

Ans 2: $\Delta T_F = K_f\, m$

$\Delta T_F = 5.49 - 3.48 = 2.01°C$

$m = \frac{?}{?} = \frac{2.01}{5.12} = 0.3925$

m(molality) =

n(no of moles of solute) = mass in Kg of solvent × m(molality)

= 0.1002 × 0.3925 =0.03933

MW = $\frac{\text{mass}}{\text{no of moles}} = \frac{5.782}{0.03933} =$ 147.01g

From empirical formula;

Carbon	chlorine	Hydrogen
49.0%	48.2%	2.75%
Divide by their molar masses,		
4.08	1.35	2.75
Divide by the smallest number		
3.00	1	2.03

Empirical formula is C_3H_2Cl

Thus molecular formula is $(C_3H_2Cl)_n = 147g$

$73.5n = 147$

$n = 2$

: molecular formula of unknown compound = $C_6H_4Cl_2$.....

Ans 4:

Only 3.00 g of water are present compared to the 50.0 grams of ethanol. By implication water is the solute and not the solvent.

Mole of solute, n = $\frac{\text{mass}}{\text{molar mass}} = 0.166\text{mol}$

Molality = $\frac{0.166}{0.0500} = 3.33\text{m}$

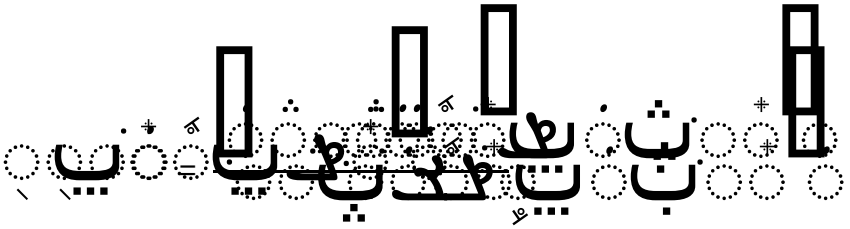
$T_b - T_b^0 = m\,k_b$

$T_b - 73.8^0c = 3.33\ (1.07^0C)$

$T_b - 73.8^0c = 3.56$

$T_b = 77.4^0c$

Ans 6:



Given conductance of KCl = 0.00277mhos/cm^{-1}

Observed conductance = of KCl = mhos

Therefore cell constant = = 0.48198 cm^{-1}

Specific conductance NaCl = cell constant X observed conductance

= 0.48198 X = 0.00135 $ohm^{-1}cm^{-1}$

Equivalent conductance of NaCl =

= = 135 $ohm^{-1}cm^2eqvt^{-1}$

Ans 10: Length = 1.58 cm and A = 2.7 cm^2

Cell constant = = = 0.5852 cm^{-1}

Observed conductance =

Since the solution is N/10, V = 10,000ml

Specific conductance = **X** X observed conductance

K = 0.5852 x = 0.0183

= ?

= 0.0183 X 10,000 = 183 mhos cm^2 $equiv^{-1}$

Ans 12: Equivalent conductance NH_4OH = ?

Equivalent conductance of NaOH = 227.4

Equivalent conductance of NaCl = 108.9

Equivalent conductance of NH_4Cl = 129.8

Therefore equivalent conductance of NH4OH =227.4- (129.8 – 108.9) = 248.3 $ohm^{-1}cm^2gequiv^{-1}$

Ans 14: l = 20 cm A = 4.0 sq cm R = 25 ohms

Specific conductance = $\frac{l}{RA}$ = $\frac{20}{25 \times 4.0}$ = 0.2 mho

Ans 17: $t_{1/2} = \frac{0.693}{k} = \frac{0.693}{0.4500} = 1.54$ s

Ans 19: $k1$ = 1.1 litre mol^{-1} sec. T_1 = 550 +273 = 823 K

$k2$ = 6.4 litremol^{-1}sec. T_2 = 625 + 273 = 898 K

Substituting the values in the equation

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\ln\left(\frac{6.4}{1.1}\right) = \frac{E_a}{8.3145}\left(\frac{1}{823} - \frac{1}{898}\right)$$

Solving for E_a gives

$$E_a = \frac{8.3145 \times \ln\left(\frac{6.4}{1.1}\right)}{\left(\frac{1}{823} - \frac{1}{898}\right)} = 1.4 \times 10^{5}$$