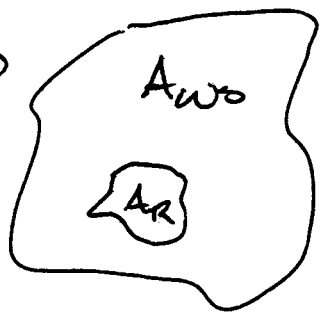
CIVE 375 Assignment 1 Solutions

(1) Occupancy = 200 persons per day over 40 trailer spaces, and a 20 unit lodge, a coffee shop + visitor center

- Estimate water demand
- Assume maximum occupancy = 200 person

Look at Table 1.6 on page 10 in text. There you should come up values of average water consumption for conditions asked in the question. There is no right answer, just make sure however that you answer is logical.

(2)



Area of watershed (A_{WS}) = 1000 hs
$= 10^7 m^2$

Annual precipitation = 0.6m
Annual evaporation = 2.0m
Fraction of runoff = 0.3

Water Balance:

Σ water into reservoir = Σ water out of reservoir

water in = precipitation + runoff from A_{WS}

$= 0.6 A_R + (A_{WS} - A_R) \cdot 0.6 \cdot 0.3$

$= 1.8 \times 10^6 + 0.42 A_R$

water out = evaporation

$= 2 A_R$

Solve for A_R: $1.8 \times 10^6 = (2 - 0.42) A_R$

$\therefore A_R = 1.14 \times 10^6 m^2$

$= 114$ hs

(3) Dissolve 49g of H_2SO_4 in 500g water
- Find molality

$$\text{Molality } (m) = \frac{\text{moles of solute}}{\text{mass of solvent}} \quad \left[\frac{mol}{kg}\right]$$

$$MW_{H_2SO_4} = 2(1\,g/mol) + 32\,g/mol + 4(16\,g/mol)$$
$$= 98\,g/mol$$

$$\frac{49g \text{ of } H_2SO_4 \;\Big|\; \frac{mol}{98g}}{} = 0.5 \text{ moles of } H_2SO_4$$

$$m = \frac{0.5 \text{ mol } H_2SO_4}{0.5 \text{ kg } H_2O} = 1 \; mol/kg$$

(4) 95% H_2SO_4 by mass $\rho_{H_2SO_4} = 1.83\,kg/L$
- Find Molarity + Mole Fraction

$$\text{Molarity } (M) = \frac{\text{moles of solute}}{\text{volume of solution}} \quad \left[\frac{mol}{L}\right]$$

$$\text{Mole Fraction } (X) = \frac{\text{moles of solute}}{\text{moles of solution}} \quad \left[\frac{mol}{mol}\right]$$

Consider 1 kg of solution where water is the solvent

0.95 kg H_2SO_4
0.05 kg H_2O

$MW_{H_2SO_4} = 98\,g/mol$ $\quad MW_{H_2O} = 2(1) + 16 = 18\,g/mol$

cont'd ↘

$$\text{Moles}_{H_2SO_4} = \frac{0.95\ kg \mid mol \mid 1000g}{\mid 98g \mid kg} = 9.69\ mol$$

$$\text{Moles}_{H_2O} = \frac{0.05\ kg \mid mol \mid 1000g}{\mid 18g \mid kg} = 2.78\ mol$$

$$\text{Moles of solution} = \text{Moles}_{H_2SO_4} + \text{Moles}_{H_2O}$$
$$= 12.47\ mol$$

$$\text{Volume of solution} = \frac{0.95\ kg}{1.83\ kg/L} + \frac{0.05\ kg}{1\ kg/L}$$
$$= 0.569\ L \text{ solution}$$

$$\text{or} \quad M = \frac{9.69\ mol}{0.569\ L} = 17.0\ mol/L$$

$$X = \frac{9.69}{12.47} = 0.78\ mol/mol$$

(5) 43% ethyl alcohol by volume Find M, m, X

consider 1L → 0.43L C_2H_5OH $\rho = 0.79\ kg/L$
0.57L H_2O $\rho = 1\ kg/L$

$$MW_{C_2H_5OH} = 2(12) + 5 + 16 + 1 = 46\ g/mol$$

$$\text{Mass solute} = 0.43L \times 0.79\ kg/L = 0.34\ kg$$

$$\text{moles solute} = \frac{0.34\ kg}{46\ g/mol} \times 1000\ g/kg = 7.39\ mol$$

$$\text{moles solvent} = \frac{0.57\ kg}{18\ g/mol} \times 1000\ g/kg = 31.67\ mol$$

$$\text{moles solution} = 39.06\ mol$$

$$M = \frac{7.39}{1L} = 7.39\ mol/L \qquad m = \frac{7.39}{0.57} = 12.96\ mol/kg$$

$$X = \frac{7.39}{39.06} = 0.19\ mol/mol$$

(6) Normality (N) = $\frac{\text{equivalents of solute}}{\text{volume of solution}}$ $\left[\frac{eq}{L}\right]$

Assume complete dissociation (no solids remaining)

a) 1.25g H_2SO_4 MW = 98 g/mol

$$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$$

z = # of replaceable H^+ ions = 2 eq/mol

Consider 1L of solution

$$N = \frac{1.25\,g}{1\,L\ \text{solution}} \left| \frac{mol}{98\,g} \right| \frac{2\,eq}{mol} = 0.026\ eq/L$$

$$= 25.5\ meq/L$$

Follow the same process for b) through d)

b) $H_3PO_4 \rightarrow 3H^+ + PO_4^{3-}$ z = 3 eq/mol

c) $Ca(OH)_2 \rightarrow Ca^{2+} + 2(OH^-)$ z = 2 eq/mol

d) $H_2S \rightarrow 2H^+ + S^{2+}$ z = 2 eq/mol

(7) Sugar cube $C_{12}H_{22}O_{11}$ @ 2.55 g/cube × 2 cubes

Volume of coffee is 255 mL

a) $\frac{2\ cubes}{} \left| \frac{2.55\,g}{cube} \right| \frac{1000\,mg}{g} \left| \frac{}{255\,mL} \right| \frac{1000\,mL}{L}$

$$= 20000\ mg/L$$

b) $ppm = \left(\frac{2 \times 2.55\,g}{2 \times 2.55 + 255}\right) \times 10^6 = 19600\ ppm$

c) MW = 366 g/mol $\rightarrow \frac{2 \times 2.55\,g}{366\,g/mol} = 0.014\ mol$

$$M = \frac{0.014\ mol}{0.255\,L} = 0.546\ mol/L$$

d) $X = \frac{0.014}{0.014 + 14.17} = 9.8 \times 10^{-4}\ mol/mol$

(8) a) $BaCl_2 \rightarrow Ba^{2+} + 2Cl^-$ $z = 2\ eq/mol$

$$EW = \frac{MW}{z} = \frac{208\ g/mol}{2\ eq/mol} = 104\ g/eq$$

Follow the same steps for the remaining parts

b) $Ag_2SO_4 \rightarrow 2Ag^+ + SO_4^{2-}$ $z = 2$

c) $Al_2(SO_4)_3 \rightarrow 2Al^{3+} + 3(SO_4^{2-})$ $z = 6$

d) $K_2HPO_4 \rightarrow 2K^+ + PO_4^{3-} + H^+$

i) with respect to K^+ $z = 2$

ii) with respect to PO_4^{3-} $z = 3$

(9) $AgNO_3$ $z = 1\ eq/mol$ $MW = 170\ g/mol$

$$EW = \frac{170}{1} = 170\ g/eq$$

$$0.23\ eq/L \cdot 170\ g/eq = 39.1\ g/L$$

$$39.1\ g/L \cdot 0.635\ L = 24.8\ g\ of\ AgNO_3$$

Have a great Weekend

Mason