**CHEM 101-080 Fall 2004**
**Problem-Solving Session 5**
**Chapters 9, 10, 11**
**November 8, 2004**

# Ch. 11: Aqueous Solutions

## (1) Percent by Mass (Sec. 11-3)

| Group | Problem No p. 346 | Solution |
|---|---|---|
| 1 | 14 | $100\times\frac{14.15}{14.15+75.55}=15.77\ wt\%$ |
| 2 | 16 | $100\times\frac{15.0}{15.0+x}=8.50,\ \text{x}=161.5$ |
| 3 | 20 | $Note: ppm\equiv\frac{mg}{kg}\ \ and\ \ ppb\equiv\frac{mg}{kg}$<br>$\frac{0.5\,mg\ Hg}{kg\ fish}\times 1\,kg\ fish=0.5\,mg\ Hg$<br>$\frac{0.5\,mg\ Hg}{kg\ fish}\times\frac{1000\,mg}{mg}=500\frac{mg\ Hg}{kg\ fish}=500\,ppb\ Hg$ |
| 4 | 22 | $5000\,gal\times\frac{3.785\,l}{gal}\times\frac{1.00\,kg}{l}\times\frac{50\,mg\ Pb}{kg}\times\frac{mg}{1000\,mg}=946\,mg\ Pb$ |

## (2) Molarity (Sec. 11-4)

| Group | Problem 24 - p. 346 | Solution |
|---|---|---|
| 1 | b, c | See answers in text: p. A-69 |
| 2 | d, e | " |
| 3 | f, g | " |
| 4 | h, i | " |

## (3) Molarity - continued

| Group | Problem No. p. 346 | Solution |
|---|---|---|
| 1 | 25 | $345\,g \times \frac{mol}{246.48\,g} \times \frac{1}{7.50\,l} = 0.187\,M$ |
| 2 | 26 | $2.58\,l \times \frac{0.0784\,mol}{l} \times \frac{110.99\,g}{mol} = 22.45\,g$ |
| 3 | 27 | $37.5\,g \times \frac{mol}{56.11\,g} \times \frac{l}{0.250\,mol} = 2.67\,l$ |
| 4 | 30 | $Al_2(SO_4)_3 \rightarrow 2Al^{3+} + 3SO_4^{2-}$<br>$25.0\,g \times \frac{mol\ salt}{342.15\,g} \times \frac{2\,mol\ Al^{3+}}{1\,mol\ salt} \times \frac{1}{0.250\,l} = 0.585\,M\ Al^{3+}$<br>$25.0\,g \times \frac{mol\ salt}{342.15\,g} \times \frac{3\,mol\ SO_4^{2-}}{1\,mol\ salt} \times \frac{1}{0.250\,l} = 0.877\,M\ SO_4^{2-}$ |

## Ch. 10: Solids & Liquids Ref. Chem101_Thermo.PDF

### (1) Solid and Liquid States

| Group | Problem No. p. 318 | Solution |
|---|---|---|
| 1 | 21 | (a) Diamond: Strong covalent bonds<br>(b) $CF_4$: London<br>(c) $CrF_2$: Ionic<br>(d) $SCl_2$: Dipole-Dipole |
| 2 | 29 | Low heat of vaporization |
| 3 | 34 | BP: Temp. where vapor pres. = external pres.<br>NBP: Temp. where vapor pres. = 1 atm |
| 4 | 36 | Water: 89 °C<br>Ethyl alcohol: 70 °C<br>Ethyl Ether: 23 °C |

### (2) Heats of Fusion and Vaporization

| Group | Problem No. p. 319 | Solution |
|---|---|---|
| 1 | 52 | $3.50\,kg \times \frac{1000\,g}{kg} \times \frac{2260\,J}{g} \times \frac{kJ}{1000\,J} = 7,910\,kJ$ |
| 2 | 54 | $8.37\,kg \times \frac{1000\,g}{kg} \times \frac{519\,J}{g} \times \frac{kJ}{1000\,J} = 4,344\,kJ$ |
| 3 | 56 | $CCl_4 : 1.00\,kJ \times \frac{1000\,J}{kJ} \times \frac{g}{192\,J} = 5.21\,g$<br>$H_2O : 1.00\,kJ \times \frac{1000\,J}{kJ} \times \frac{g}{2260\,J} = 0.442\,g$ |
| 4 | 58 | $Freon : 1.00\,kg \times \frac{1000\,g}{kg} \times \frac{38.5\,cal}{g} = 38,500\,cal$<br>$Soda\,(H_2O) : 325\,ml \times \frac{1.00\,g}{ml} \times \frac{79.8\,cal}{g} = 25,935\,cal$<br>$38,500\,cal > 25,935\,cal \Rightarrow Soda\ will\ freeze$ |

## (3) Heating Curve

| Group | Problem No. p. 319 | Solution |
|---|---|---|
| 1 | 62 | (1) $135\,g\ H_2O_{(s)} \times \frac{334\,J}{g} = 45{,}090\,J$<br>(2) $135\,g\ H_2O_{(l)} \times \frac{4.18\,J}{g \cdot {}^oC} \times \left(75\,{}^oC - 0\,{}^oC\right) = 42{,}323\,J$<br>*Total* : $87{,}413\,J$ |
| 2 | 70, 71, 73, 74 | See answers in textbook (p. A-68).<br>70 - Melting & boiling<br>71 - Same<br>73 - Steam<br>74 - No, it only boils faster |
| 3 | 66 | $H_2O_{(g)}\,@100\,{}^oC \rightarrow H_2O_{(s)}\,@-25\,{}^oC$<br>(1) $2660\,g\ H_2O_{(g)} \times \frac{-2260\,J}{g} = -6{,}011{,}600\,J$<br>(2) $2660\,g\ H_2O_{(l)} \times \frac{4.18\,J}{g \cdot {}^oC} \times \left(0\,{}^oC - \left(100\,{}^oC\right)\right) = -1{,}111{,}880\,J$<br>(3) $2660\,g\ H_2O_{(l)} \times \frac{-334\,J}{g} = -888{,}440\,J$<br>(4) $2660\,g\ H_2O_{(s)} \times \frac{2.06\,J}{g \cdot {}^oC} \times \left(-25\,{}^oC - 0\,{}^oC\right) = -136{,}990\,J$<br>*Total* : $8{,}148{,}910\,J$ *or* $8{,}149\,kJ$ |
| 4 | 75 | $H_2O_{(g)}\,@100\,{}^oC \rightarrow H_2O_{(s)}\,@\,0\,{}^oC$<br>(1) $18.0\,g\ H_2O_{(g)} \times \frac{-2260\,J}{g} = -40{,}680\,J$<br>(2) $18.0\,g\ H_2O_{(l)} \times \frac{4.18\,J}{g \cdot {}^oC} \times \left(0\,{}^oC - \left(100\,{}^oC\right)\right) = -7{,}524\,J$<br>(3) $18.0\,g\ H_2O_{(l)} \times \frac{-334\,J}{g} = -6{,}012\,J$<br>*Total* : $54{,}216\,J \times \frac{cal}{4.18\,J} \times \frac{kcal}{1000\,cal} = 13.0\,kcal$ |

## Ch. 9: Gas Laws Ref. Chem101_Ideal_Gas_Laws.PDF

### (1) Stoichiometry

| Group | Problem No. - p. 287 | Solution |
|---|---|---|
| 1 | 91 | See below. |
| 2 | 92 | " |
| 3 | 93 | " |
| 4 | 94 | " |

**Solutions**

**91.** $$115\,g\,CaCO_3 \times \frac{mol\,CaCO_3}{100.09\,g\,CaCO_3} \times \frac{1\,mol\,CO_2}{1\,mol\,CaCO_3} \times \frac{22.4\,l\,@\,STP}{mol\,CaCO_3} = 25.74\,l$$

**92.** $$5.80\,l\,O_2\,@\,STP \times \frac{mol\,O_2}{22.4\,l\,O_2} \times \frac{2\,mol\,Mg}{1\,mol\,O_2} \times \frac{24.305\,g\,Mg}{mol\,Mg} = 12.6\,g\,Mg$$

**93.**
$$n = \frac{PV}{RT} = \frac{(1atm)(14.5l)}{\left(0.0821\frac{l \bullet atm}{mol \bullet K}\right)(298K)} = 0.5927\,mol\,O_2$$
$$0.5927\,mol\,O_2 \times \frac{2\,mol\,KNO_2}{1\,mol\,O_2} \times \frac{85.1\,g\,KNO_2}{mol\,KNO_2} = 100.9\,g\,KNO_2$$

**94.**
$$5.00\,g\,H_2O \times \frac{mol\,H_2O}{18.0\,g\,H_2O} \times \frac{1\,mol\,C_2H_2}{2\,mol\,H_2O} = 0.139\,mol\,C_2H_2$$
$$V = \frac{nRT}{P} = \frac{(0.139\,mol)\left(0.0821\frac{l \bullet atm}{mol \bullet K}\right)(298K)}{\left(\frac{745}{760}atm\right)} = 3.47\,l\,C_2H_2$$

## (2) Molar Volume and Density

| Group | Problem No. - p. 287 | Solution |
|---|---|---|
| 1 | 80 | See below. |
| 2 | 82 | " |
| 3 | 85 | " |
| 4 | 87 | " |

**80.** $$850\,l\,CO\,@\,STP\times\frac{mol\,CO}{22.4\,l\,CO}\times\frac{28.01\,g\,CO}{mol\,CO}=1063\,g\,CO$$

**82.** $$\frac{39.8\,g\,gas}{6.5\,l\,gas\,@\,STP\times\dfrac{mol\,gas}{22.4\,l\,gas}}=137\,g/mol$$

$$Lab17\,(p.121, Eq.3):\ M=\frac{dRT}{P},\ \ where\ d=\frac{m}{V}$$

**85.** $$d=\frac{PM}{RT}=\frac{(1atm)\left(67.81\dfrac{g}{mol}\right)}{\left(0.0821\dfrac{l\bullet atm}{mol\bullet K}\right)(273K)}=3.03\,g/l$$

**87.** $$M=\frac{dRT}{P}=\frac{\left(6.14\dfrac{g}{l}\right)\left(0.0821\dfrac{l\bullet atm}{mol\bullet K}\right)(273K)}{(1atm)}=138\,g/mol$$

## (3) Ideal Gas Law

| Group | Problem No. - p. 286 | Solution |
|---|---|---|
| 1 | 59 | See below. |
| 2 | 61 | " |
| 3 | 62 | " |
| 4 | 64 | " |

**59.** $T = \frac{PV}{nR} = \frac{(2.25\,atm)(4.5\,l)}{(0.332\,mol)\left(0.0821\frac{l \bullet atm}{mol \bullet K}\right)} = 371.5\,K \text{ or } 98.5\,^{o}C$

**61.** $n = \frac{PV}{RT} = \frac{(0.955\,atm)(16.4\,l)}{\left(0.0821\frac{l \bullet atm}{mol \bullet K}\right)(250\,K)} = 0.763\,mol\ NH_3 \text{ or } 13.0\,g\ NH_3$

**62.** $P = \frac{nRT}{V} = \frac{\left(0.250\,g\ O_2 \times \frac{mol\ O_2}{32.0\,g\ O_2}\right)\left(0.0821\frac{l \bullet atm}{mol \bullet K}\right)(273 + 29\,K)}{(0.250\,l)} = 0.775\,atm \text{ or } 589\,torr$

**64.** $n = \frac{PV}{RT} = \frac{(1.15\,atm)(3.5\,l)}{\left(0.0821\frac{l \bullet atm}{mol \bullet K}\right)(296\,K)} = 0.166\,mol\ Ne \text{ or } 3.34\,g\ Ne$

## (4) Avogadro's Law

| Group | Problem No. - p. 286 | Solution |
|---|---|---|
| 1 | 54 | See below. |
| 2 | 55 | " |
| 3 | 56 | " |
| 4 | 58 | " |

**54.** $V_2 = \frac{n_2}{n_1} V_1 = \frac{(0.0750\,mol)}{(0.112\,mol)}(2.54\,l) = 1.70\,l$

**55.** $n_2 = \frac{V_2}{V_1} n_1 = \frac{(275\,l)}{(188\,l)}(8.40\,mol) = 12.3\,mol \Rightarrow 12.3 - 8.40 = 3.9\,mol\ needed$

$n_2 = \frac{V_2}{V_1} n_1 = \frac{(400\,ml)}{(275\,ml)}(0.0212\,mol) = 0.0308\,mol$

**56.** $0.0308\,mol - 0.0212\,mol = 0.0096\,mol$

$0.0096\,mol \times \frac{28.02\,g\ N_2}{mol} = 0.27\,g\ N_2$

**58.** $V_2 = \frac{n_2}{n_1} V_1 = \frac{\left(48.0\,g\ O_2 \times \frac{mol\ O_2}{32.0\,g\ O_2}\right)}{\left(48.0\,g\ SO_2 \times \frac{mol\ SO_2}{64.1\,g\ SO_2}\right)}(30.0\,l) = 60.1\,l$

## (5) Combined Gas Law

| Group | Problem No. - p. 285 | Solution |
|---|---|---|
| 1 | 46 | See below. |
| 2 | 47 | " |
| 3 | 48 | " |
| 4 | 49 | " |

**46.** $P_2 = \frac{T_2}{T_1} \times \frac{V_1}{V_2} \times P_1 = \frac{308\,K}{273\,K} \times \frac{5.50\,l}{4.75\,l} \times 0.950\,atm = 1.24\,atm$

**47.** $V_2 = \frac{T_2}{T_1} \times \frac{P_1}{P_2} \times V_1 = \frac{273\,K}{373\,K} \times \frac{6.00\,atm}{1\,atm} \times 17.5\,l = 76.8\,l$

**48.** $V_2 = \frac{T_2}{T_1} \times \frac{P_1}{P_2} \times V_1 = \frac{308\,K}{273\,K} \times \frac{1\,atm}{0.845\,atm} \times 88.7\,ml = 118.4\,ml$

**49.** $T_2 = \frac{P_2}{P_1} \times \frac{V_2}{V_1} \times T_1 = \frac{155\,torr}{78.0\,torr} \times \frac{9.55 \times 10^{-5}\,ml}{4.78 \times 10^{-4}\,ml} \times 223\,K = 88.5\,K$