Chemistry 101 Midterm Test #2 KEY
150 points 2/16/07

average ± std deviation = 81±36 (54%) High = 155/150
A rough estimate of letter grade for this test (in terms of scantron score) :

A = 129 or higher (i.e. 86% or higher)

B = 114 to 128 (i.e. 76% to 85%)

C = 75 - 113 (i.e. 50% to 75%)

D = 55 – 73 (i.e. 42% to 54%)

1) [30 pts]
Solution:
M_1 = (82.0g KCl)(1mol KCl/74.6g)/0.500L =2.20 M KCl (stock solution) [10pts]
V_1 = ?
M_2 = (4.4 x10^{-3}mol K^+/0.100 L)(1 mol KCl/1 mol K^+) = 4.4x10^{-2} M KCl [10pts]
V_2 = 10.0 L
Use: $M_1V_1 = M_2V_2$ => $V_1 = M_2V_2/M_1$ = (4.4x10^{-2} M KCl)(10.0 L)/(2.20 M KCl) =0.200 L=200 mL [10pts]

Take 200. mL of stock solution and add enough distilled water to make up 10.0L of solution. [5 pts bonus]

2) [40 pts total]
A. 10 pts] Solution: $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

B [10 pts]

Solution: Assume first that C_2H_2 is limiting, calculate the amount of O_2 needed for the reaction to proceed to completion: g O_2 needed = 23.0 g C_2H_2 (1 mol/30 g)(7 mol O_2/2 mol C_2H_6)(32g O_2/mol O_2)= 86 g < 100g
So, indeed, **C_2H_6 is limiting.**

C. [20 pts]

Solution: # g CO_2 produced = 23.0 g C_2H_2 (1 mol/30 g)(4 mol CO_2/2 mol C_2H_6)(44g O_2/mol O_2)= 67.4 g

3) [40 pts total]

a) [10] Solution: $H_3PO_4 + 3\ OH^- \rightarrow 3\ H_2) + PO_4^{3-}$

b) [10] Solution: [NaOH] = (6.00 NaOH)(1mol/40g)/0.050L= 3.00 M NaOH

c) [10] Solution: [H_3PO_4] = (mol NaOH)(1mol H_3PO_4/3mol NaOH)/L H_3PO_4
= (6.00g)(1mol/40g)(1/3)/(.0250L) = 2.00M

d) [10 pts] Solution: Quick way is to use the hint that half of the NaOH has reacted:

[NaOH] = (1/2)(total mol NaOH)/(total volume)
= (1/2)(6.00 NaOH)(1mol/40g)/(0.050L+0.0125) = 1.20 M

Another (longer) way is to say that in general:
$[NaOH]_{remaining}$ = {(total mols NaOH)-(mol NaOH reacted)} /total resulting volume

$[NaOH] = \{M_{NaOH}V_{NaOH} - M_{H3PO4}V_{H3PO4}(3mol\ NaOH/mol\ H_3PO_4)\}/\{V_{NaOH}+V_{H3PO4}\}$

= (3.00M(50.0mL) – 3(2.00M)(12.5mL))/(50.0+12.5) = (150mmol-75mmol)/(62.5mL)=1.20M NaOH

4) a) [5] solution: Yes (since Zn has a greater tendency to oxidize and form cations than Cu)

b) [6] solution: $Cu^{2+} + Mg \rightarrow Cu + Mg^{2+}$

c) [10]

$$5\ H_2C_2O_4 + 6H^+ + 2\ MnO_4^- \rightarrow 10\ CO_2\ (g) + 2\ Mn^{2+} + 14\ H_2O$$

solution: +3 +7 +4 +2

Since there is a change in oxidation numbers, this is a redox reaction

d) [9] solution: Mn is undergoing reduction
C is undergoing oxidation
MnO_4^- is the oxidant (oxidizing agent). It itself undergoes reduction.

e) [10] solution: % atom economy = mass of Mn x 100%/mass of total reactants (refer to chapt 4.6, page 149 and your lecture notes)

%atom economy = (55)(2)(100%)/{5(2+24+64)+2(55+64)+6)= 11000/694=15.9%