CHE 151 GENERAL CHEMISTRY FALL, 2004
MARIAN COLLEGE, INDIANAPOLIS

Class Test 3 Name:

Open book, open notes, take-home. Show all working. Full credit will only be given if all working is shown. Do not collaborate with other classmates or consult outsiders on the content of this test.

20 points per question; 100 points total.

1. (a) Write balanced equations for the following reactions:
   (i) $Cr_2O_3(s)$, $Al(s) \rightarrow Al_2O_3(s)$, $Cr(s)$
   (ii) $PbO(s)$, $NH_3(g) \rightarrow Pb(s)$, $N_2(g)$, $H_2O(l)$
   (iii) $CaH_2(s)$, $H_2O(l) \rightarrow Ca(OH)_2(s)$, $H_2(g)$
   (iv) $AgNO_3(aq)$, $Na_2S(aq) \rightarrow Ag_2S(s)$, $NaNO_3(aq)$

(b) Name the following compounds:
(i) KIO_3 (ii) N_2O_4 (iii) H_2SO_3 (iv) K_2CO_3 (v) $NaHCO_3$

(c) Determine the oxidation numbers of:
(i) P in H_3PO_4
(ii) Each N in NH_4NO_3
(iii) Mn in $KMnO_4$
(iv) O in O_3

2. (a) Selenium, an element used in the manufacture of photoelectric cells, forms two oxides, one with 28.8% O by mass, the other with 37.8% O by mass. Calculate empirical formulas for these oxides and name them.

(b) What mass of K_2CrO_4 is required to make up 400mL of 1.0M K_2CrO_4?

(c) You have a 50mL graduated cylinder and three volumetric flasks of volume 100mL, 500mL, and 1000mL respectively. Starting from the solution in (b) above, describe (with the help of the dilution equation) how you would use these pieces of glassware to make up (i) 100mL of 0.1 M K_2CrO_4, (ii) 500mL of 0.05 M K_2CrO_4, (iii) 1.0L of 0.001 M K_2CrO_4.

3 (a) Potassium superoxide, KO_2, is used in life-support systems to replace $CO_2(g)$ in expired air with $O_2(g)$ via

$$4KO_2(s) + 2CO_2(g) \rightarrow 2K_2CO_3(s) + 3O_2(g)$$

(i) How many moles of $O_2(g)$ are produced by the reaction of 132 g $CO_2(g)$ with excess $KO_2(s)$?

(ii) If 100.0 g of $CO_2(g)$ is removed from expired air by this reaction, what mass in g of $KO_2(s)$ is consumed?

(b) 4.0 g of solid NaOH is dissolved in 50 mL of 1.0 M HCl.

(i) Predict the result (red or blue color) of a test of the solution with pH paper, and state the limiting reagent for this reaction.

(ii) How much HCl (or NaOH) would have to be added to make the solution neutral?

4 (a) For the reaction $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$

(i) Identify the oxidizing agent and the reducing agent

(ii) Write separate half-reactions for the oxidation and reduction processes.

(b) A compound is 42.9% C, 2.4% H, 16.7% N, and 38.1% O by mass. Addition of 6.45g of this compound to 50.0mL benzene (density 0.879 g/mL) lowers the freezing point by 4.16°C. The cryoscopic constant for benzene is $K_f = 5.12\ °C\ m^{-1}$. What is the molecular formula of the compound?

5 (a) (i) Propose an acceptable Lewis structure for the carbonate ion, CO_3^{2-}. (Show each logical step in the construction process.) (ii) Calculate the formal charges on all atoms in this species. (iii) Predict the shape of this ion according to the VSEPR rules. (iv) Experimentally, all carbon-oxygen bonds in this species are equal in length. Does this imply that the picture of the bonding given by the Lewis structure is wrong? Explain.

(b) Draw four possible isomers of C_4H_6O, ensuring that each has an acceptable Lewis structure.