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Chemistry 1094 Spring 2018 Test 2

Wednesday, February 28, 2018 Time: 1 hour 50 minutes

Name: ANSWERS Student Number: _____

*This test consists of **six** pages of questions, a periodic table, and a page with the solubility rules. Please ensure that you have a complete paper and, if you do not, obtain one from me **immediately**. There are **62.5** marks available. Good luck!*

1) **[4 marks]** Given the following reactivity series:

F > Cl > Br > I
Ba > Sr > Ca > Mg > Be
Au < Ag < Cu
H < Li < Na < K < Rb < Cs

Predict whether a reaction would occur for each pair of reactants. You do not need to complete the reactions; only predict whether or not the two chemicals mixed would react. Circle your choice in each case.

NaCl and Br_2	reaction	(no reaction)
Ca and $Mg(NO_3)_2$	(reaction)	no reaction
Ag and $CuSO_4$	reaction	(no reaction)
H_2 and Rb_2SO_4	reaction	(no reaction)

2) **[4 marks]** Using the solubility rules provided with the test, predict whether a reaction would occur for each pair of reactants. You do not need to complete the reactions; only predict whether the two chemicals mixed would react. Circle your choice in each case.

NaCl and $Hg_2(NO_3)_2$	(reaction)	no reaction
$Ca(NO_3)_2$ and $FeBr_3$	reaction	(no reaction)
$Ca(NO_3)_2$ and Na_3PO_4	(reaction)	no reaction
$Al(NO_3)_3$ and $Ba(OH)_2$	(reaction)	no reaction

3) **[12 marks]** Complete and balance the following reactions. Give the phases of all products, and assume a reaction occurs in each case.

a) ____ $Al_2(CO_3)_3(s) \xrightarrow{\Delta} Al_2O_3(s) + 3CO_2(g)$

b) ____ $TiO_2(s)$ + 2 $CO_2(g) \xrightarrow[\text{pressure}]{\text{high}} Ti(CO_3)_2(s)$

c) 2 $Mg(s)$ + ____ $O_2(g) \longrightarrow 2MgO(s)$

d) 2 $C_3H_7OH(l)$ + 9 $O_2(g) \longrightarrow 6CO_2(g) + 8H_2O(l)$

e) 2 $NaBr(aq)$ + ____ $Cl_2(aq) \longrightarrow 2NaCl(aq) + Br_2(aq)$

f) ____ $K_2CO_3(aq)$ + 2 $HBr(aq) \longrightarrow 2KBr(aq) + CO_2(g) + H_2O(l)$

4) **[3 marks]** For the following (balanced) molecular equation:

$3HCl(aq) + Na_3PO_4(aq) \longrightarrow 3NaCl(aq) + H_3PO_4(aq)$

a) Write the full ionic equation.

$3H^+(aq) + 3Cl^-(aq) + 3Na^+(aq) + PO_4^{3-}(aq) \rightarrow 3Na^+(aq) + 3Cl^-(aq) + H_3PO_4(aq)$

b) Identify any spectator ions.

Na^+, Cl^-

c) Write the net ionic equation.

$3H^+(aq) + PO_4^{3-}(aq) \longrightarrow H_3PO_4(aq)$

5) **[6.5 marks]** Complete the following table:

Nuclide symbol	Z	n	e^{-1}	A	charge
$^{38}_{17}Cl^{-1}$	17	21	18	38	-1
$^{28}_{12}Mg^{2+}$	12	16	10	28	+2
$^{54}_{26}Fe^{+}$	26	28	25	54	+1
$^{29}_{13}Al^{-1}$	13	16	14	29	-1

6) **[6 marks total]** Given the following table for magnesium (Mg, periodic table mass 24.305):

Nuclide symbol	Mass	percent abundance
$^{24}_{12}Mg$	23.9850	$x = 78.99$
$^{25}_{12}Mg$	24.9858	$88.99 - x = 10$
$^{26}_{12}Mg$	25.9826	11.01

} Must add to 88.99

a) **[5 marks]** Complete the table.

$$23.985 \cdot \frac{x}{100} + 24.9858 \cdot \frac{(88.99-x)}{100} + 25.9826 \cdot \frac{11.01}{100} = 24.305$$

$$23.985x + 24.9858(88.99-x) + 25.9826 \cdot 11.01 = 2430.5$$

$$23.985x + 2223.486342 - 24.9858x + 286.068426 = 2430.5$$

$$-1.0008x = -79.054768$$

$$x = 78.99$$

b) **[1 mark]** Which isotope of magnesium has the most electrons in a neutral atom?

They all will have the same # of electrons in a neutral atom.

7) **[4 marks]** Avogadro's number is currently $6.022\ 140\ 857 \times 10^{23}$. Suppose the mole had been defined so that one mole of atoms was the number that made ^{12}C have a mass of 1 gram exactly, instead of the way it is now.

a) What would be the molar mass of F, in grams?

$\frac{1}{12} \times 18.998 = 1.5832 \frac{g}{mol}$

b) What would be the value of Avogadro's number?

$\frac{1}{12} \times 6.022140857 \times 10^{23} = 5.018... \times 10^{22}$

8) **[1 mark]** Determine the molar mass of mercury(I) phosphate, $(Hg_2)_3(PO_4)_2$.

6×200.59

$+ 2 \times 30.974$

$+ 8 \times 15.999$

$1393.48 \frac{g}{mol}$

9) **[12 marks total]** The molar mass of iron(III) nitrate, $Fe(NO_3)_3$, is 241.857 grams.

a) **[1 mark]** How many moles of oxygen atoms are in 0.50 moles of $Fe(NO_3)_3$?

$$0.5 \text{ moles } Fe(NO_3)_3 \times \frac{90}{1 Fe(NO_3)_3} = \boxed{4.5 \text{ moles O}}$$

b) **[1 mark]** If you wanted 1.20 moles of N, how many moles of $Fe(NO_3)_3$ would you need?

$$1.2 \text{ moles N} \times \frac{1 Fe(NO_3)_3}{3N} = \boxed{0.4 \text{ moles } Fe(NO_3)_3}$$

c) **[2 marks]** How many grams of iron are in 0.25 moles of $Fe(NO_3)_3$?

$$0.25 \text{ moles } Fe(NO_3)_3 \times \frac{1 Fe}{1 Fe(NO_3)_3} \times \frac{55.845 \text{ g}}{\text{mol}} = \boxed{13.96125 \text{ g Fe}}$$

d) **[2 marks]** If you wanted 31.998 grams of oxygen, how many moles of $Fe(NO_3)_3$ would you need?

$$31.998 \text{ g O} \times \frac{1 \text{ mole}}{15.999 \text{ g}} \times \frac{1 Fe(NO_3)_3}{90} = \boxed{0.22 \text{ moles } Fe(NO_3)_3}$$

e) **[3 marks]** How many grams of nitrogen are in 20.00 grams of $Fe(NO_3)_3$?

$$20 \text{ g } Fe(NO_3)_3 \times \frac{1 \text{ mol}}{241.857 \text{ g}} \times \frac{3N}{1 Fe(NO_3)_3} \times \frac{14.007 \text{ g}}{1 \text{ mol}} = \boxed{3.4749 \text{ g N}}$$

f) **[3 marks]** If you wanted 10.00 grams of nitrogen, how many grams of $Fe(NO_3)_3$ would you need?

$$10 \text{ g N} \times \frac{1 \text{ mol}}{14.007 \text{ g}} \times \frac{1 Fe(NO_3)_3}{3N} \times \frac{241.857 \text{ g}}{1 \text{ mol}} = \boxed{57.5562 \text{ g } Fe(NO_3)_3}$$

10) **[4 marks]** Caffeine has the molecular formula $C_8H_{10}N_4O_2$. Determine the percent by mass of each element in caffeine.

$8 \times 12.011 = 96.088$

$10 \times 1.0079 = 10.079$

$4 \times 14.007 = 56.028$

$2 \times 15.999 = 31.998$

194.193

$\%\,C = \frac{96.088}{194.193} \times 100 = 49.481\%$

$\%\,H = \frac{10.079}{194.193} \times 100 = 5.1902\%$

$\%\,N = \frac{56.028}{194.193} \times 100 = 28.852\%$

$\%\,O = \frac{31.998}{194.193} \times 100 = 16.477\%$

11) **[6 marks]** Erythropoietin (EPO) is a (very) large biomolecule used to stimulate red blood cell production; it has been used as a performance-enhancing drug in sports competitions. EPO has been found to be 53.2122 percent carbon, 7.2157 percent hydrogen, 17.7409 percent nitrogen, 20.9597 percent oxygen, and the rest sulphur, all by mass. What formula for EPO is predicted by these percentages?

$\%\,S = 100 - 53.2122 - 7.2157 - 17.7409 - 20.9597 = 0.8715$

Assume 100 g sample then...

$53.2122\text{ g C} \times \frac{1\text{ mol}}{12.011\text{ g}} = 4.43...\text{ mol C}$

$7.2157\text{ g H} \times \frac{1\text{ mol}}{1.0079\text{ g}} = 7.159...\text{ mol H}$

$17.7409\text{ g N} \times \frac{1\text{ mol}}{14.007\text{ g}} = 1.266...\text{ mol N}$

$20.9597\text{ g O} \times \frac{1\text{ mol}}{15.999\text{ g}} = 1.31...\text{ mol O}$

$0.8715\text{ g S} \times \frac{1\text{ mol}}{32.065\text{ g}} = 0.0271...\text{ mol S}$

$C_{4.43}H_{7.159}N_{1.266}O_{1.31}S_{0.0271}$

$\downarrow\downarrow$

$C_{163}H_{263.4}N_{46.6}O_{48.2}S$

$\downarrow\downarrow \times 5$

$C_{815}H_{1317}N_{233}O_{241}S_5$