ARANMORE CATHOLIC COLLEGE

CHEMISTRY 3A3B - 2011

TEST 3: SOLUTIONS AND STOICHIOMETRY

NAME SOLUTIONS **DATE** 20/5/11

INSTRUCTIONS

1. Time allowed: 55 minutes
2. Total marks: 50 marks
3. A Chemical Data Sheet is provided
4. A Curriculum Council approved calculator is required.

BCBC BCDDCA

PART 1 **MULTIPLE CHOICE** **10 MARKS**

Circle or cross the letter of your answer to the questions below.

1. Which of the following 0.1 mol L^{-1} solutions when mixed will produce only a white precipitate?

a. Zinc nitrate	Copper sulfate	Barium chloride	Sodium carbonate
(b.) Barium chloride	Sodium nitrate	Potassium chloride	Aluminium sulfate
c. Zinc nitrate	Potassium chloride	Sodium nitrate	Aluminium nitrate
d. Barium nitrate	Sodium hydroxide	Potassium chloride	Copper nitrate

2. 1.0 mol of an unknown metal reacts with excess hydrochloric acid to produce 1.5 mol of hydrogen gas. What is the charge on the metal ion?
   a. + 1
   b. + 2
   (c.) + 3
   d. + 4

3. Which of the following fertilizers has the greatest percentage of nitrogen by mass?
   a. $(NH_4)_2SO_4$
   (b.) NH_2CONH_2
   c. NH_4NO_3
   d. $(NH_4)_2CO_3$

4. Which of the following pairs of compounds could easily be distinguished by colour alone?
   a. $KCl_{(s)}$ and $KBr_{(s)}$
   b. $CaCl_{2(s)}$ and $AlCl_{3(s)}$
   (c.) $CuO_{(s)}$ and $CuSO_{4(s)}$
   d. $AlCl_{3(s)}$ and $ZnCl_{2(s)}$

5. Which of the following combinations of 0.100 mol L^{-1} solutions will **not** produce a precipitate on mixing?

a.	Sodium nitrate	Barium chloride	Ammonium carbonate	Potassium hydroxide
(b.)	Potassium nitrate	Barium chloride	Ammonium nitrate	Magnesium chloride
c.	Barium chloride	Calcium nitrate	Potassium sulfate	Mercury (II) nitrate
d.	Barium nitrate	Sodium sulfate	Ammonium chloride	Calcium iodide

6. 100 g of mineral water was found to contain 0.00584 g of NaCl. What is the concentration of NaCl in parts per million by mass?
   a. 1.00
   b. 5.84
   (c.) 58.4
   d. 584

7. In a sample of ground water, iron in the form of Fe^{2+} was found to have a concentration of 9.00×10^{-3} mol L^{-1}. Assuming the density of the water sample is 1.00 g mL^{-1}, what is the concentration of Fe^{2+} expressed in ppm?
   a. 0.503 ppm
   b. 9.00 ppm
   c. 50.3 ppm
   (d.) 503 ppm

8. A solution of nitric acid is produced by adding 1.00 L of 3.00 mol L^{-1} $HNO_{3(aq)}$ to 2.00 L of distilled water. Choose the correct statement regarding the resulting solution.

   a. The concentration of nitric acid is 6.00 mol L^{-1}
   b. The moles of nitric acid will now be 1.00 mol
   c. The concentration of nitric acid is 3.00 mol L^{-1}
   (d.) The moles of nitric acid are the same as in the original 1.00 L of solution

9. Which of the following 1.0 mol L^{-1} solutions has the greatest total concentration of ions?
   a. $CaCl_2$
   b. KNO_3
   (c.) $AlCl_3$
   d. Na_2SO_4

10. A one litre solution contains 1.5 mol of $Ca(NO_3)_2$ and 2.0 mol of $NaNO_3$. What is the concentration of $NO_3^-{}_{(aq)}$ ions in this solution?

    (a.) 5.0 mol L^{-1}
    b. 3.5 mol L^{-1}
    c. Less than 3.5 mol L^{-1}
    d. Greater than 5.0 mol L^{-1}

PART 2 **SHORT ANSWERS** **3 QUESTIONS** **22 MARKS**

Answer each of the following questions in the spaces provided.

1. Write the equation for the reaction that occurs in each of the following procedures. If no reaction occurs, write 'no reaction'.

   Following this, describe **in full** what you would observe in each case, including any
   - Colours
   - Odours
   - Precipitates (give the colour)
   - Gases evolved (give the colour or describe as colourless).

   If no change is observed, you should state this.

   a. Barium chloride solution is added to sodium phosphate solution. (3 Marks)

   Equation $3\,Ba^{2+}_{(aq)} + 2\,PO_4^{3-}{}_{(aq)} \rightarrow Ba_3PO_{4(s)}$

   Observations TWO COLOURLESS SOLNS MIX AND FORM A WHITE PPT.

   b. Dilute hydrochloric acid solution is added to magnesium metal. (3 Marks)

   Equation $Mg_{(s)} + 2H^+_{(aq)} \rightarrow Mg^{2+}_{(aq)} + H_{2(g)}$

   Observations SILVER SOLID DISSOLVES AND COLOURLESS, ODOURLESS GAS IS PRODUCED.

   c. Iron (III) nitrate solution is added to sodium sulfide solution. (3 Marks)

   Equation $2\,Fe^{3+}_{(aq)} + 3\,S^{2-}_{(aq)} \rightarrow Fe_2S_{3(s)}$

   Observations PALE BROWN SOLN FADES AND A BLACK PPT FORMS.

   d. Dilute sulfuric acid is added to a copper (II) nitrate solution. (3 Marks)

   Equation N.R.

   Observations

2. Suggest a reagent which when added to each of the following pairs of solutions would enable them to be distinguished. In each case state the observations you would expect.

a. 1.0 mol L^{-1} sodium sulfate and 1.0 mol L^{-1} sodium chloride (3 Marks)

Reagent e.g. $Ba(NO_3)_2$ SOLN

Observation with sodium sulfate solution WHITE PPT FORMS

Observation with sodium chloride solution NO VISIBLE RXN.

b. 1.0 mol L^{-1} sodium iodide and 1.0 mol L^{-1} sodium carbonate (3 Marks)

Reagent e.g. $Zn(NO_3)_2$ SOLN

Observation with sodium iodide solution NO RXN.

Observation with sodium carbonate solution WHITE PPT FORMS.

3. The substance $KCl_{(s)}$ is an ionic compound consisting of K^+ and Cl^- ions held in a regular lattice by strong electrostatic attraction of the oppositely charged ions. Despite this strong electrostatic attraction, water is able to dissolve $KCl_{(s)}$ so that $K^+_{(aq)}$ and $Cl^-_{(aq)}$ ions move about freely within the aqueous phase.

Explain the ability of water to dissolve $KCl_{(s)}$.

(4 Marks)

- WATER MOLECULES POLAR
  DESCRIBE OR DIAGRAM
- K^+ IONS ATTRACTED TO $O\,\delta^-$
  Cl^- IONS TO $H\,\delta^+$
- ION-DIPOLE FORCES. ABLE TO OVERCOME STRONG IONIC BONDS IN LATTICE.
- IONS DISSOLVE

PART 3 **CALCULATIONS** **2 QUESTIONS** **18 MARKS**

Answer each of the following questions in the spaces provided.

1. When concentrated nitric acid is added to copper, nitrogen dioxide gas is produced. This reaction can be represented by the following unbalanced equation

(a) $Cu + 4\ HNO_3 \rightarrow Cu(NO_3)_2 + 2\ NO_2 + 2\ H_2O$ (1)

a. Balance this equation.

If 4.56 g of copper is added to 120.0 mL of 5.55 mol L^{-1} solution of nitric acid:

b. Identify the limiting reagent.

c. What volume of NO_2 is formed at 28°C and 99.7 kPa?

d. How many moles of excess reactant is left after the reaction?

(9 Marks)

(b) $n(Cu) = \frac{m}{M} = \frac{4.56}{63.55} = 0.0718\ mol$ (1)

$n(HNO_3) = c \times V = 5.55 \times 0.120 = 0.666\ mol.$ (1)

$S.R. = \frac{4}{1} = 4.$ $A.R. = \frac{0.666}{0.0718} = 9.27$ (1)

HENCE Cu IS THE LIMITING REAGENT. (1)

(c) $n(NO_2) = 2 \times n(Cu)$

$= 2 \times 0.0718$

$= 0.1435\ mol$ (1)

$V = \frac{nRT}{P} = \frac{0.1435 \times 8.315 \times 301}{99.7}$

$V = 3.60\ L.$ (1)

(d) $n(HNO_3)_{USED} = 4 \times n(Cu)$

$= 0.2870\ mol$ (1)

$n(HNO_3)_{LEFT} = n(HNO_3)_{TOTAL} - n(HNO_3)_{USED}$

$= 0.666 - 0.287$

$= 0.379\ mol.$ (1)

2. A pesticide residue is examined by an analytical chemist. It is found to burn in air leaving no ash and qualitative analysis indicates the presence of chlorine, but no oxygen. It is thus concluded that the residue contains only the elements carbon, hydrogen, and chlorine.
A 0.1061 g sample of the residue is burnt in a current of dry air and 0.02095 g of water and 0.1536 g of carbon dioxide is produced.
A further 0.1245 g of the residue is vaporized in the absence of air at 220 °C and 102.2 kPa and found to occupy 27.4 mL.

a) Determine the empirical formula of the pesticide residue.

b) Determine the molecular formula of this compound.

(9 Marks)

(a) $n(C) = n(CO_2) = \frac{m}{M} = \frac{0.1536\,g}{44.01\,g\,mol^{-1}} = 0.003490\ mol$ (1)

$n(H) = 2 \times n(H_2O) = 2 \times \frac{m}{M} = 2 \times \frac{0.02095}{18.016} = 0.002326\ mol$

$m(C) = n(C) \times M(C) = 0.003490 \times 12.01 = 0.041915\,g$ (1)

$m(H) = n(H) \times M(H) = 0.002326 \times 1.008 = 0.002344\,g$

$m(Cl) = 0.1061 - (0.041915 + 0.002344)$ (1)

$= 0.06184\,g$

$n(Cl) = \frac{m}{M} = \frac{0.06184}{35.45} = 0.001744\ mol$ (1)

	C	H	Cl
n	0.003490	0.002326	0.001744
RATIO	2.0	1.33	1
(× 3)	6	4	3

(1)

∴ E.F. is $C_6H_4Cl_3$. (1)

(b) $n = \frac{PV}{RT} = \frac{102.2 \times 0.0274}{8.315 \times 493} = 6.83 \times 10^{-4}\ mol$ (1)

$M = \frac{m}{n} = \frac{0.1245}{6.83 \times 10^{-4}} = 182.3\ g\,mol^{-1}$. (1)

$M(EF) = 182.44\ g\,mol^{-1}$

∴ M.F. is E.F. $C_6H_4Cl_3$. (1)

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END OF TEST