THE OPEN UNIVERSITY OF SRI LANKA

CERTIFICATE IN LABORATORY TECHNOLOGY

FINAL EXAMINATION-THEORY- 2015 / 2016

PSC1222 — BASIC CHEMISTRY FOR LABORATORY PRACTICES

Date:13/12/2015(Sunday)	**Time:09.30am-11.30 am**	**Duration: Two hours**

Instructions to students

This question paper consists of six pages and six questions. <u>Answer any four questions.</u>

1. (a). The notation $^{39}_{19}K$ indicates a neutral atom of potassium.

    (i)   What is its atomic number?
    (ii)   What is its mass number?
    (iii)   How many protons does it have?
    (iv)   How many electrons does it have?
    (v)   How many neutrons does it have?   **(10 marks)**

  (b). (i)   Define the term "isotope" of an atom.

    (ii)   There are three isotopes of magnesium with mass number 24, 25 and 26. [Atomic number of magnesium is 12]. Write the atomic symbol for each of these isotopes.

    (iii)   Copper is made up of two isotopes, Cu-63 (62.9296 amu) and Cu-65 (64.9278 amu). Atomic weight of Cu is 63.546 amu, what is the percentage (%) abundance of each isotope?
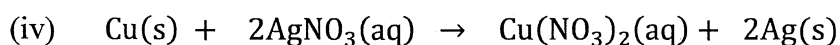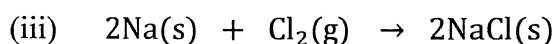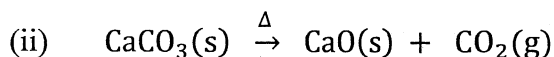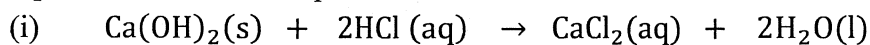
                                            (30 marks)

  (c). Write formula for each of the following compounds.

    (i)   Sodium dihydrogen phosphate
    (ii)   Carbon disulphide
    (iii)   Phosphoric acid
    (iv)   Aluminum hydroxide
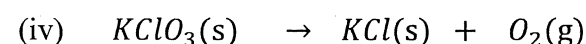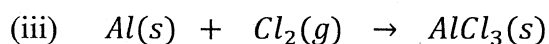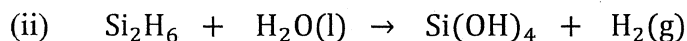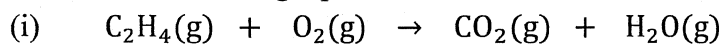   (v)   Potassium carbonate   **(10 marks)**

(d). Write the correct formula for compounds formed between the following ions

    (i) Al^{3+} and Br^- (ii) Ba^{2+} and O^{2-}

    (iii) Na^+ and S^{2-} (iv) Ca^{2+} and Cl^-

    (v) K^+ and I^- (10 marks)

(e). Classify each of the following as combination reaction, single replacement, double replacement and decomposition.

    (i) $Ca(OH)_2(s) + 2HCl\,(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$

    (ii) $CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2(g)$

    (iii) $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$

    (iv) $Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

                                                    (20 marks)

(f). Balance the following equations.

    (i) $C_2H_4(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

    (ii) $Si_2H_6 + H_2O(l) \rightarrow Si(OH)_4 + H_2(g)$

    (iii) $Al(s) + Cl_2(g) \rightarrow AlCl_3(s)$

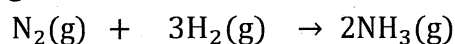   (iv) $KClO_3(s) \rightarrow KCl(s) + O_2(g)$ (20 marks)

2. (a).(i)   Determine the empirical formula of a compound with the following composition by mass; C= 60%; H=12% ; N=28%. [Relative atomic mass; C=12; H=1; N=14]

    (ii)   If this compound has a molar mass of 300 g/mol, what is its molecular formula?

                                                      (20 marks)

(b). Consider the following reaction.

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

    (i)   How many grams of NH_3 can be produced (theoretically) from the reaction of 5.0 g N_2 and 5.0 g H_2? [Molecular weight (g/ mol): N = 28; H=2]

    (ii)   What is the limiting reagent?

    (iii)   What is the theoretical yield?

    (iv)   If 4.52 g of NH_3 are formed experimentally what is the percentage yield of NH_3?   (35 marks)

(c). (i)   What do you understand by the term" Molarity" of a solution.

    (ii)   A 125 ml of $Pb(ClO_3)_2$ solution was diluted with water to 250.0 ml. A 75.0 ml of sample of the diluted solution was found to contain 0.335 moles of $Pb(ClO_3)_2$. What was the concentration of $Pb(ClO_3)_2$ in the original undiluted solution?   (20 marks)

(d). (i)   What do you understand by the term "molality" of a solution?

(ii)   Concentrated nitric acid solution contains 70.4% HNO_3 by mass. The density of this solution is 1.42 g/ml. Calculate the molality of the acid.
[Atomic weight (g/mol): N= 14; H=1; O = 16]

(25 marks)

3. (a) (i) What is meant by "Hazardous chemicals".

(ii) Name three carcinogens found in the **laboratory**.

(iii) Identify the danger/risk(s) associated with the following substances.
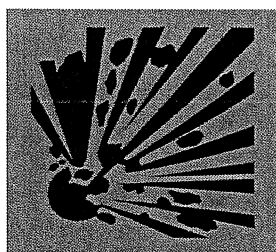
(A) Thorium-228..
(B) Acetone..
(C) Potassium permanganate..
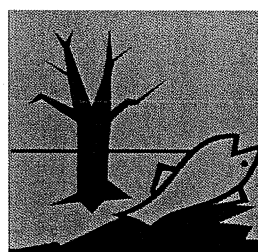
(30 marks)

(b) (i) Give a common name which can explained the following statement.

"Substances that can ignite spontaneously, even in small quantities, after coming into contact with air"

(ii) Identify the following symbols (a) and (b).

(a)   (b)

(iii) Giving one example explain how would you store a chemical which is light sensitive?   (20 marks)

(c) (i) Liquid oxygen boils at -182.96 °C at normal pressure. Express this temperature in Kelvin?   (07 marks)

(ii) The wavelength of the red light from a helium-neon laser is 632 nm. What is the wavelength in meters?   (07 marks)

(d) Two sets Q and R, each containing 25 bulb pipettes having a volume of twenty five milliliters are delivered to your laboratory. You are asked to test the accuracy and precision and select the best pack.

    (i) How would you take a random sample of five pipettes from each?

<div align="right">(06 marks)</div>

    (ii) One student pipetted out a twenty five milliliters of an acid solution using five pipettes of set Q and the actual volumes (in ml) he had measured were as follows. 25.05, 25.01, 25.05, 25.00, 25.02

        (a) Calculate the mean volume of the pipettes.

        (b) Calculate the absolute error of the mean volume.

        (c) Precision of the two sets of pipettes was the same. If the absolute error of the mean of the set R is -0.05 ml, which set will you select? Why?

<div align="right">(18 marks)</div>

    (iii) Explain the following observation.

HCl gas and solid NaCl were dissolved in a sealed tube containing 100 ml of distilled water until a small amount of NaCl remained undissolved. When the temperature of this solution was increased the undissolved NaCl disappeared in the solution increasing the NaCl concentration but decreasing the HCl concentration.

<div align="right">(12 marks)</div>

(4) A 5.0 ml of 0.1 M HCl was diluted to 20.0 ml with distilled water and was neutralized by adding 40.0 ml of 0.025 NH_4OH.

    (i)   HCl is a strong acid but NH_4OH is a weak base. What do you understand by the words "weak" and "strong" here? (20 marks)

    (ii)   Name a weak acid and a strong base that you find in the laboratory.

<div align="right">(10 marks)</div>

    (iii)   Calculate the pH of the diluted HCl solution before adding NH_4OH.

<div align="right">(20 marks)</div>

    (iv)   Calculate the concentration of NH_4OH showing all the steps involved in the calculation. (20 marks)

(v)   Do you agree with the following statements? Give reasons for your answer.

     i. The lime water in the laboratory was not suitable to test for carbon dioxide gas since it was already turbid.

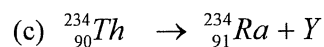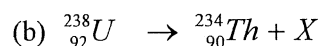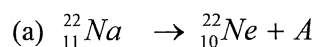   ii. Phenolphthalein can be used as the indicator for all acid-base titrations.

(20 marks)

(vi)   Arrange the following in the order of increasing pH.

Boric acid (Ka = 5.8 x 10^{-10} mol dm^{-3}), Carbonic acid (Ka= 4.3 x 10^{-7} mol dm^{-3}), H_2SO_4, HNO_3. (10 marks)

(5) (a) (i) Name or write the symbol of the particles A, X and Y in the following nuclear reactions.

(a) $^{22}_{11}Na \rightarrow ^{22}_{10}Ne + A$

(b) $^{238}_{92}U \rightarrow ^{234}_{90}Th + X$

(c) $^{234}_{90}Th \rightarrow ^{234}_{91}Ra + Y$

(18 marks)

(ii) $^{131}_{53}I$ is radioactive and the half life is eight days. Calculate the weight remaining after 32 days of 0.800 g of this isotope.

(12 marks)

(iv)   State two general safety practices that should be followed by a person who is exposed to radiation unexpectedly. (10 marks)

(v)   State how you would protect yourself from alpha particles and gamma particles.

(10 marks)

(b) (i) Determine the oxidation number of each element in the following compounds.
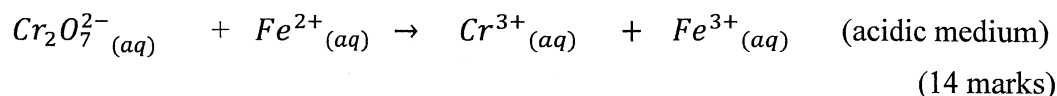
(a) CO (b) PCl_3 (c) MnO_4^- (06 marks)

(ii) "When a piece of Zn wire is placed in an aqueous solution of $CuSO_4$ an oxidation-reduction reaction takes place". Write down the net reaction occur in the above statement.

(10 marks)

5

(c) (i) Balance the following redox equation using the "half-reaction" method.

$$Cr_2O_7^{2-}{}_{(aq)} \quad + \quad Fe^{2+}{}_{(aq)} \quad \rightarrow \quad Cr^{3+}{}_{(aq)} \quad + \quad Fe^{3+}{}_{(aq)} \quad \text{(acidic medium)}$$

(14 marks)

(ii) Identify the oxidizing and reducing agent in the above reaction (c) (i).

(10 marks)

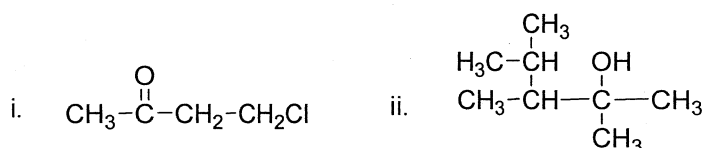(iii) Write down separately the two cathodic reactions takes place when rusting of iron under following conditions,
        (a) In the presence of oxygen and water
        (b) at low pH values

(10 marks)

(6) (a) A compound has a molecular formula $C_5H_{10}O$.
    i.   Draw two possible structures with <u>linear or branched</u> carbon skeleton for this molecular formula.
    ii.   Draw two possible structures with <u>cyclic</u> carbon skeleton for this molecular formula.

(20 marks)

(b) Name the following compounds systematically according to the IUPAC nomenclature.

i.
$$CH_3\!-\!\overset{\overset{\textstyle O}{\|}}{C}\!-\!CH_2\!-\!CH_2Cl$$

ii.
$$\begin{array}{c} CH_3 \\ | \\ H_3C\!-\!CH \quad OH \\ | \qquad | \\ CH_3\!-\!CH\!\!-\!\!\overset{\displaystyle |}{\underset{\displaystyle |}{C}}\!\!-\!\!CH_3 \\ CH_3 \end{array}$$

(20 marks)

(c) Give the structures of the following compounds.
    i.   3-ethylpentan-2,4-dione
    ii.   2-chloro-4-nitrobenzoic acid

(10 marks)

(d) Give reasons for the following observations.
    i.   A purple coloured fabric dye dissolved in water was shaken with a colourless solvent in a separatory funnel. After sometime it separated out into <u>two coloured</u> layers.
    ii.   A nail polish container was not closed properly and the liquid was found to be hardened.

(30 marks)

(e) A reaction is performed in the laboratory at room temperature. Give four possible signs to tell that a chemical reaction had occurred.

(20 marks)

****