INTI INTERNATIONAL UNIVERSITY

FOUNDATION PROGRAMME IN SCIENCE (CFSI)
CHM1203: CHEMISTRY 1
FINAL EXAMINATION: JANUARY 2014 SESSION

Instructions: This paper consists of **FIVE (5)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Question 1

(a) Naturally occurring nitrogen contains a mixture of two isotopes, ^{14}N and ^{15}N.

(i) Explain the term of isotopes.

(2 marks)

(ii) Complete the table below for the isotopes, ^{14}N and ^{15}N.

Isotopes	Protons (p)	Neutrons (n)	Electrons (e)
^{14}N			
^{15}N			

(6 marks)

(b) Classify each of the followings as physical or chemical change.

(i) Melting of ice-cream
(ii) Burning of wood in fireplace
(iii) Cooking of raw food

(3 marks)

(c) Write the chemical formulae or chemical symbols for the following compounds.

(i) Calcium nitride

(1 mark)

(ii) Ammonium hydroxide

(1 mark)

(iii) Iron (III) chloride

(1 mark)

(d) The atomic radii of the elements Na to C*l* are shown in the table below.

Element	Na	Mg	A*l*	Si	P	S	C*l*
Atomic radius (nm)	0.154	0.145	0.130	0.118	0.110	0.102	0.099

(i) Using only the elements in this table, select

1 An element with both metallic and non-metallic properties

(1 mark)

2 An element with a giant molecular structure

(1 mark)

(ii) The atomic radii of each element decreases across the period. Explain what causes the decrease.

(3 marks)

(iii) Predict and explain whether a sodium ion is larger, smaller or the same size as the sodium atom.

(3 marks)

(e) A sample of oxygen at 24.0 °C and 745 torr was found to have a volume of 5000 mL. Calculate how many grams of O_2 were in the sample?
Given the ideal gas constant value is 62.364 L torr K^{-1} mol^{-1}.

(3 marks)

Question 2

(a) Perform the following arithmetic and round off the answers to the correct number of significant figures or express the answers in scientific notation.

(i) $\dfrac{(1.987 \text{ X } 298)}{0.0821}$

(2 marks)

(ii) $\dfrac{(4.5\ x\ 10^{28})}{(3.0\ x\ 10^{-6})}$

(2 marks)

(b) The reaction equation occurs in rock and soil are written as below:

$$4.67\ kcal + \ Ca^{2+}\ (aq) + \ 2HCO_3^-\ (aq) \rightleftharpoons \ CaCO_3(s) + \ CO_2(aq) + \ H_2O\ (l)$$

Predict the effect on the equilibrium composition for each of the following changes.

(i) The concentration of Ca^{2+} is increased by addition of some $CaCl_2$.

(2 marks)

(ii) Some solid $CaCO_3$ is removed from the mixture.

(2 marks)

(iii) The temperature of the system in increased. Assume the above reaction is in a closed environment.

(2 marks)

(iv) A catalyst is added.

(2 marks)

(c) The arrangement of electrons in a copper atom can be represented by an energy diagram.

(i) Draw the energy level diagram for a copper atom. You may draw the diagram in your answer sheet.

(2 marks)

(ii) Copper can form two stable ions, Cu^+ and Cu^{2+}. Write the electron configuration for both ions.

(4 marks)

(iii) Which is a more stable ion, Cu^+ or Cu^{2+}? Explain your reasoning.

(2 marks)

(d) Complete the following nuclear equations by writing the symbols of the missing particles.

(i)

$$^{211}_{82}Pb \longrightarrow {}^{0}_{-1}e + \_\_\_\_$$

(2 marks)

(ii)

$$^{177}_{73}Ta \xrightarrow{\text{electron capture}} \_\_\_\_$$

(2 marks)

(e) Define the term “half-life” of a matter.

(1 mark)

Question 3

(a) Limestone contains the ionic compound calcium carbonate, $CaCO_3$. Limestone decomposes when it is heated strongly, forming an ionic compound, Calcium Oxide (CaO) and covalent compound, Carbon dioxide (CO_2).

$$CaCO_3\,(s) \rightarrow CaO(s) + CO_2(g)$$

(i) State what is meant by ionic bonding.

(2 marks)

(ii) Draw the '*dot* and *cross'* diagrams to show the bonding in CaO and CO_2 compounds.

(4 marks)

(iii) Write the electronic configuration of calcium in CaO.

(2 marks)

(iv) Calcium oxide, CaO neutralises acids such as nitric acid, HNO_3. A student neutralized 1.50 g of CaO with 2.50 mol dm^{-3} of HNO_3. The equation for this reaction is as shown below:-

$$CaO\,(s) + 2HNO_3\,(aq) \rightarrow Ca(NO_3)_2\,(aq) + H_2O\,(l)$$

(i) How many moles of CaO were reacted?.

(2 marks)

(ii) Calculate the volume of 2.50 mol dm^{-3} HNO_3 needed to exactly neutralises 1.50 g of CaO.

(2 marks)

(b) Cesium-137, ^{137}Cs, one of the radioactive wastes from a nuclear power plant or an atomic bomb explosion, emits beta and gamma radiation. Write the nuclear equation for the decay of cesium-137.

(2 marks)

(c) Perform the following computations or operation rules or conversion, expressing your answers to the proper number of significant figures.

(i) Convert 25 m^3 to cm^3

(2 marks)

(ii) $\frac{[(1.0\ x\ 10^7)+ (4.0\ x\ 10^5)\ ]}{(2.0\ x\ 10^8)}$. Express your answer in scientific notation.

(2 marks)

(d) Identify the substance that is oxidized, reduced, reducing agent and oxidizing agent for the following reaction.

$$2\ Al\ (s) + Cr_2O_3(s)\ \rightarrow 2\ Cr\ (s) +\ Al_2O_3(s)$$

(4 marks)

(e) Classify the following as homogeneous or heterogeneous mixture.

(i) Coca-cola with ice-cream
(ii) Salad
(iii) Hand lotion

(3 marks)

Question 4

(a) Gold (III) hydroxide, $Au(OH)_3$ is used for electroplating gold onto other metals. It can be made by the following reaction.

$$2\ KAuCl_4 + 3\ Na_2CO_3 + 3\ H_2O\ \rightarrow 2\ Au(OH)_3 + 6\ NaCl + 2\ KCl + 3\ CO_2$$

To prepare a fresh supply of $Au(OH)_3$, a chemist at an electroplating plant has mixed 20.00g of $KAuCl_4$ with 25.00g of Na_2CO_3. Both dissolved in an excess amount of water. What is the maximum number of grams of $Au(OH)_3$ that can form?.

(4 marks)

(b) Compounds with covalent bonding often have polar bonds. Polarity can be explained in term of electronegativity.

(i) Explain the term electronegativity.

(2 marks)

(ii) Use a suitable example to show how the presence of a polar bond can be explained in term of electronegativity. You may draw a diagram in your answer.

(2 marks)

(iii) Some polar molecules are able to form hydrogen bonding. Draw a diagram to show an example of hydrogen bonding.

(2 marks)

(c) With the aid of periodic table, write the electron configuration for each of the following atoms or ions.

(i) Cr^{3+}

(2 marks)

(ii) K

(2 marks)

(d) 2.40 g of $Fe_2(SO_4)_3$ is added to 80.0 g of water.

(i) Find the percent-by-mass, % (m/m) of this solution

(3 marks)

(ii) Write the name of this ionic compound $Fe_2(SO_4)_3$

(2 marks)

(e) Prove that the molar volume of oxygen gas at STP is 22.4 L. Given the R value is 0.08206 L(atm) / K (mol).

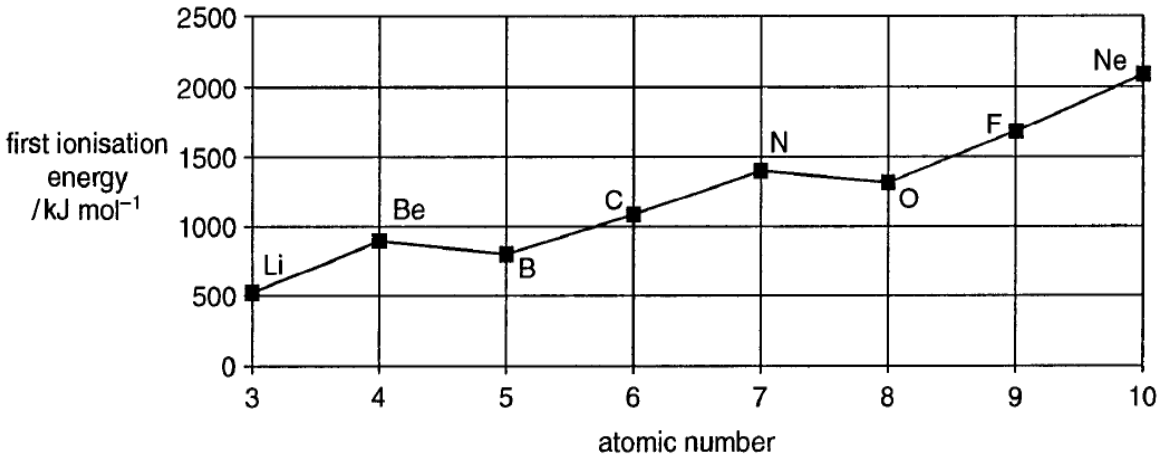
(3 marks)

(f) What is the molality of 10.0 % of aqueous NaCl?

(3 marks)

Question 5

(a) The diagram below shows the variation of ionisation energies of elements across Period 2 of the Periodic Table.



(i) Define the term ionisation energy.

(2 marks)

(ii) Explain why the ionisation energies show a general increase across Period 2.

(2 marks)

(b) Carbon is in the p-block of the periodic table. Naturally occurring carbon contains a mixture of two isotopes, ^{13}C and ^{14}C.

(i) Complete the table below for the isotopes, ^{13}C and ^{14}C.

Isotopes	Protons	Neutrons	Electrons
^{13}C			
^{14}C			

(6 marks)

(ii) Give one of the usage of carbon-isotopes.

(2 marks)

(c) Classify each of the following in term of type of chemical reactions.

(i) $2Mg\ (s) + O_2(g) \rightarrow 2MgO\ (s)$

(ii) $CaCO_3\ (s) \rightarrow CaO\ (s) + CO_2\ (g)$

(iii) $Ag(NO_3) + Na_3PO_4 \rightarrow Ag_3PO_4 + NaNO_3$

(3 marks)

(d) Write the chemical formulae for the following compounds.

(i) Ammonium sulfate

(2 marks)

(ii) Selenium dioxide

(2 marks)

(e) Draw the Lewis diagram for the following compounds.

(i) Carbon monoxide

(2 marks)

(ii) Beryllium dichloride

(2 marks)

(f) Arrange the following atoms in order of increasing electronegativity.

Cl, Ca, P, N

(2 marks)

--THE END--

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