

INTI INTERNATIONAL UNIVERSITY  
FOUNDATION 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) Calculate :
- (i) The number of molecules in 0.02 mole of water molecules. (1 mark)
  - (ii) The number of moles in  $3.01 \times 10^{22}$  copper atoms. (1 mark)
  - (iii) The mass of 0.75 mole of urea,  $\text{CO}(\text{NH}_2)_2$ . (1 mark)
- (b) Naturally occurring carbon has two isotopes :  $^{12}\text{C}$  and  $^{13}\text{C}$ . The relative atomic mass of carbon is 12.01 a.m.u. If the relative isotopic mass of  $^{12}\text{C} = 12.00$  a.m.u. and  $^{13}\text{C} = 13.00$  a.m.u., what is the relative abundance of  $^{13}\text{C}$  isotope? (2 marks)
- (c) 37.3 g of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  is dissolved in 0.40 L of solution. Calculate the molarity of the solution. (2 marks)
- (d)  $150 \text{ cm}^3$  of water are added to  $350 \text{ cm}^3$  of 4 M sulphuric acid. What is the final molarity of the solution? (2 marks)
- (e) An element X exists as a colourless gas at room condition. At a temperature of  $27^\circ\text{C}$  and a pressure of 99.7 kPa, the density of the gas is  $1.11 \text{ g dm}^{-3}$ . Suggest an element that matches the information given. (3 marks)
- (f) A sample of neon gas occupies 4.8L at temperature  $25^\circ\text{C}$ . If the temperature is raised to  $298^\circ\text{C}$ , what is the change in the volume of the neon gas at a constant pressure? (2 marks)
- (g) Write the electronic configurations of :
- (i) K (1 mark)

- (ii) Ni (1 mark)
- (iii)  $V^{4+}$  (1 mark)
- (iv)  $S^{2-}$  (1 mark)
- (h) Classify each of the following compounds as an ionic compound or a covalent compound:
- (i)  $ICl_3$  (1 mark)
- (ii)  $NH_4Cl$  (1 mark)
- (iii)  $SiO_2$  (1 mark)
- (i) Draw the Lewis structures for the following compounds and ions, and predict the geometry of the molecule by using VSEPR theory.
- (i)  $CS_2$  (2 marks)
- (ii)  $NO_2^-$  (2 marks)

**Question 2**

- (a) Use dotted lines to show hydrogen bonding in the following cases :
- Between ethanol molecules ( $C_2H_5OH$ ). (2 marks)
  - Between ethanol and water molecules. (2 marks)
- (b) X, Y and Z represent the elements with proton numbers 9, 16 and 19.
- Write the electronic configurations of X, Y and Z. (3 marks)
  - Predict the type of bonding you would expect to form between (i) X and Y, (ii) X and Z, (iii) Y and Z. (3 marks)
  - Show the Lewis structure for the compounds formed in (b) (ii). (3 marks)
- (c) An equilibrium mixture contains 2.00 moles of bromine, 1.25 moles of hydrogen and 0.50 mole of hydrogen bromide in a  $4.0 \text{ dm}^3$  container. Calculate the  $K_{eq}$  for the reaction.
- $$H_2(g) + Br_2(g) \rightleftharpoons 2HBr(g)$$
- (4 marks)
- (d) A 0.0500 M solution of a base is 7.5 % ionized. Calculate the base ionization constant,  $K_b$ . (3 marks)
- (e) Write balanced nuclear equations for the alpha decay of each of the following nuclides :
- Curium-240 (1 mark)
  - ${}^{200}_{84}Po$  (1 mark)
- (f) Determine the number of moles of substance present in each of the following quantities :
- $8.50 \times 10^{15}$  atoms S (1 mark)
  - 25.0 g Li (1 mark)
  - $3.01 \times 10^{23}$   $SO_2$  molecules (1 mark)

**Question 3**

(a) Explain these observations :

(i) The boiling point of ammonia is higher than that of phosphine,  $\text{PH}_3$ . (3 marks)

(ii) The boiling point of ammonia is lower than that of water. (3 marks)

(b) At a temperature of 298 K, dinitrogen tetroxide and nitrogen dioxide exist in chemical equilibrium according to the following equation.



(i) 3.0 g of a mixture of  $\text{N}_2\text{O}_4$  and  $\text{NO}_2$  have a volume of  $1.0 \times 10^{-3} \text{ m}^3$  at 298 K and 101 kPa. Calculate the relative molecular mass of this mixture. (3 marks)

(ii) State the effect on the equilibrium position if (i) the pressure is raised and (ii) the temperature is raised. (2 marks)

(c) Nickel metal has a density of  $8.90 \text{ g/cm}^3$ . How much does  $15 \text{ cm}^3$  of nickel metal weigh in grams? (2 marks)

(d) Write the balanced chemical equation to represent each of the following acid-base neutralization reactions.

(i)  $\text{H}_2\text{SO}_4$  and  $\text{LiOH}$  (2 marks)

(ii)  $\text{KOH}$  and  $\text{HCl}$  (2 marks)

(e) Write balanced nuclear equations for beta decay of each of the following nuclides :

(i) Sodium-25 (1 mark)

(ii)  ${}_{9}^{21}\text{F}$  (1 mark)

(f) 0.112 g of an organic liquid was completely vaporized in a gas syringe at  $127^\circ\text{C}$  and a pressure of  $101 \text{ kNm}^{-2}$ . The vapour produced occupied a volume of  $81.8 \text{ cm}^3$ . Calculate the relative molecular mass of the organic liquid. (4 marks)

(g) The half-life of sodium-24 is 15.0 hr. How many grams of this nuclide in a 4.00 g sample will remain after 60.0 hr? (2 marks)

**Question 4**

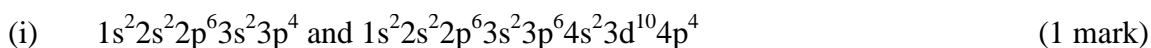
- (a) Classify each as physical or chemical changes.
- (i) Evaporation of water from a lake. (1 mark)
  - (ii) A copper object turns green over time. (1 mark)
  - (iii) Melting of some candle wax (1 mark)
- (b) How many calories of heat energy are required to raise the temperature of 30.0 g of ethyl alcohol ( $c = 0.58 \text{ cal/g}^\circ\text{C}$ ) from  $25^\circ\text{C}$  to  $45^\circ\text{C}$ ? (2 marks)
- (c) In a nitric acid ( $\text{HNO}_3$ ) –potassium hydroxide ( $\text{KOH}$ ) acid-base titration, 32.4 mL of 0.352 M  $\text{KOH}$  is required to neutralize 50.0 mL of  $\text{HNO}_3$  of unknown concentration. Find the molarity of the  $\text{HNO}_3$  solution, given that the neutralization reaction that occurs is
- $$\text{HNO}_3(aq) + \text{KOH}(aq) \rightarrow \text{KNO}_3(aq) + \text{H}_2\text{O}(l)$$
- (2 marks)
- (d) (i) Sketch the molecular geometry of phosphine,  $\text{PH}_3$  and state its shape. (3 marks)
- (ii) By the aid of diagram, show whether  $\text{PH}_3$  is polar or non-polar. (2 marks)
- (e) How many unpaired electrons are present in the orbital diagram for each of the following elements?
- (i)  ${}_{12}\text{Mg}$  (2 marks)
  - (ii)  ${}_{25}\text{Mn}$  (2 marks)
- (f) Silver metal has a density of  $10.40 \text{ g/cm}^3$ . What is the volume, in cubic centimeters, of a 100.0 g bar of silver metal? (3 marks)
- (g) Calculate the mass, in grams, of  $\text{K}_2\text{SO}_4$  needed to prepare 32.00 g of 2.000 % (m/m)  $\text{K}_2\text{SO}_4$  solution? (3 marks)
- (h) How many grams of  $\text{NaCl}$  are present in 50.0 mL of a 7.50 % (m/v)  $\text{NaCl}$  solution? (3 marks)

**Question 5**

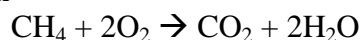
- (a) Classify each of the following chemical reactions as a combination, decomposition, single-replacement, double-replacement or combustion reaction.



- (b) Indicate whether the elements by the given pairs of electron configurations have similar chemical properties.



- (iii) The principle constituent of natural gas is methane, which burns in air according to the reaction



How many grams of  $\text{O}_2$  are needed to produce 3.50 g of  $\text{CO}_2$ ? (3 marks)

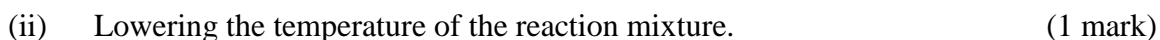
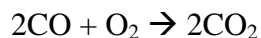
- (c) Write a balanced chemical equation for the preparation of each of the following salts, using an acid-base neutralization reaction.



- (d) Supply the missing symbol in each of the following nuclear equations.



- (e) Will each of the changes listed increase or decrease the rate of the following chemical reaction?



- (iii) Adding a catalyst to the reaction mixture. (1 mark)
- (f) For each of the following solutions, how many milliliters of water should be added to yield a solution that has a concentration of 0.100 M?
- (i) 50.0 mL of 3.00 M HCl (2 marks)
- (iii) 1.45 L of 6.00 M NaCl (2 marks)

**--THE END--**

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