INTI INTERNATIONAL UNIVERSITY

FOUNDATION IN SCIENCE (CFSI)
CHM1203: CHEMISTRY 1
FINAL EXAMINATION: MAY 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) Classify each as physical or chemical changes.

(i) Bleach removes a stain. (1 mark)

(ii) An enzyme breaks down the lactose in milk. (1 mark)

(iii) Peppercorns are ground into flakes. (1 mark)

(b) Calculate the total heat, in calories, needed to convert 15.0 g of ethanol at 25.0 ^{o}C to its boiling point at 78.0 ^{o}C (specific heat of ethanol = 2.46 J/g^{o}C).

(2 marks)

(c) Answer the following for the reaction

$$Pb(NO_3)_2\ (aq) + 2KCl(aq) \rightarrow PbCl_2(s) + 2KNO_3(aq)$$

(i) How many grams of $PbCl_2$ will be formed from 50.0 ml of 1.50 M KCl solution?

(3 marks)

(ii) How many milliliters of 2.00 M $Pb(NO_3)_2$ solution will react with 50.0 ml of 1.50 M KCl solution?

(3 marks)

(d) (i) Sketch the molecular geometry of silicon tetrachloride, $SiCl_4$ and state its shape.

(2 marks)

(ii) By the aid of diagram, show whether $SiCl_4$ 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) $_{19}K$ (2 marks)

(ii) $_{25}Mn$ (2 marks)

(f) A lead weight used in the belt of a scuba diver has a mass of 226 g. When the weight is placed in a graduated cylinder containing 200.0 ml of water, the water level rises to 220.0 ml. What is the density of the lead weight (g/ml)?

(2 marks)

(g) What is the molarity (M) of 60.0 g of NaOH in 0.250 L of solution? (2 marks)

(h) A typical antibiotic is 1.0 % (m/v) Clindamycin. How many grams of Clindamycin are in 60.0 ml of the 1.0 % (m/v) solution?

(2 marks)

Question 2

(a) Balance each of the following unbalanced equations and identify the type of reaction :

(i) $Fe_2O_3 + C \rightarrow Fe + CO$ (2 marks)

(ii) $NI_3 \rightarrow N_2 + I_2$ (2 marks)

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

(i) $1s^2 2s^2 2p^6 3s^2 3p^4$ and $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$ (1 mark)
(ii) $1s^2 2s^1$ and $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ (1 mark)

(c) Nitrogen dioxide and water react to produce nitric acid, HNO_3 and nitrogen monoxide:

$$3NO_2(g) + H_2O(l) \rightarrow 2HNO_3(aq) + NO(g)$$

(i) How many grams of H_2O are required to react with 28.0 g of NO_2? (3 marks)

(ii) How many grams of NO are obtained from 15.8 g of NO_2? (3 marks)

(iii) How many grams of HNO_3 are produced from 8.25 g of NO_2? (3 marks)

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

(i) Li_2SO_4 (1 mark)

(ii) $NaNO_3$ (1 mark)

(iii) KCl (1 mark)

(e) Uranium-238 decays in a series of nuclear changes until stable ${}^{206}_{82}Pb$ is produced. Complete the following nuclear equations that are part of the ${}^{238}_{92}U$.

(i) ${}^{238}_{92}U \rightarrow {}^{234}_{90}Th + ?$ (1 mark)

(iii) ${}^{234}_{90}Th \rightarrow ? + {}^{0}_{1-}e$ (1 mark)

(iii) $? \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He$ (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 1.00 M HCl (2 marks)

(iii) 1.45 L of 3.00 M NaCl (2 marks)

Question 3

(a) Write the electronic configurations of :

(i) P^{3-}

(1 mark)

(ii) Mn^{2+}

(1 mark)

(iii) Cr

(1 mark)

(b) (i) Define the term buffer solution. (2 marks)

(ii) Give an example of buffer solution that has a pH less than 7. (1 mark)

(iii) If the pH of a solution is 7.21, what is the $[OH^-]$ of this solution? ($K_w = 1 \times 10^{-14}$).

(2 marks)

(c) Draw the Lewis structures for the following compounds and ions, and predict the geometry of the molecule by using VSEPR theory.

(i) OF_2

(2 marks)

(ii) NH_4^+

(2 marks)

(d) Indium (In) with an atomic mas of 114.8 consists of two naturally occurring isotopes: ${}^{113}_{49}In$ and ${}^{115}_{49}In$. If 4.30% of a sample of indium is ${}^{113}_{49}In$, which has a mass of 112.90. what is the mass of the ${}^{115}_{49}In$?

(2 marks)

(e) What is the specific heat of lead if 13.6 cal are needed to raise the temperature of 35.6 g of lead by 12.5 ^oC.

(2 marks)

(f) How many moles of HCl are present in 750 ml of a 6.0 M HCl solution? (2 marks)

(g) The temperature of a room is set at 22 ^oC. If that temperature is lowered by 1 ^oC, it can save as much as 5 % in energy costs. What temperature, in Fahrenheit degrees, should be set to lower the Celsius temperature by 1 ^oC?

(2 marks)

(h) A 124 ml bubble of hot gases at 212 ^{o}C and 1.80 atm escapes from an active volcano. What is the temperature, in ^{o}C, of the gas in the bubble outside the volcano if the new volume of the bubble is 138 ml and the pressure is 0.800 atm?

(2 marks)

(i) Indicate the major type of attractive forces (dipole-dipole forces, hydrogen bonds or van der waals forces) that occurs between the particles :

(i) NH_3 (1 mark)

(ii) H_2O (1 mark)

(iii) $CHCl_3$ (1 mark)

Question 4

(a) For the reaction

$$C(s) + CO_2(g) \rightleftharpoons 2CO(g)$$

The equilibrium mixture contains solid carbon, [CO] = 0.030 M and [CO_2] = 0.060 M.

(i) What is the value of K_{eq} for the reaction at this temperature? (2 marks)

(ii) What is the effect of adding more CO_2 to the equilibrium mixture? (1 mark)

(iii) What is the effect of decreasing the volume of the container? (1 mark)

(b) Write a balanced chemical equation for the reaction of HCl(aq) with each of the following:

(i) $K_2CO_3(s)$ (2 marks)

(ii) $Mg(OH)_2(s)$ (2 marks)

(c) When heated, calcium carbonate decomposes to give calcium oxide and carbon dioxide gas:

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

If 2.00 moles of $CaCO_3$ react, how many liters of CO_2 gas are produced at STP? (2 marks)

(d) A 120 mg sample of technetium-99 is used for a diagnostic test. If technetium-99 has a half-life of 6.0 h, how much of the technetium-99 sample remains after 24 h after the test? (2 marks)

(e) Write a balanced nuclear equation for each of the following:

(i) Th-225 (α decay) (1 mark)

(ii) Cesium-137 (β decay) (1 mark)

(f) A gas mixture contains oxygen and argon at partial pressures of 0.60 atm and 425 mmHg. If nitrogen gas added to the sample increases the total pressure to 1250 torr, what is the partial pressure in torr, of the nitrogen added? (3 marks)

(g) A large bottle of water (883 g) at $4^{o}C$ is removed from the refrigerator. How many kilojoules (kJ) are absorbed to warm the water to a room temperature of 27 ^{o}C? (specific heat of water = 1 cal /$g^{o}C$)

(3 marks)

(h) Draw Lewis structure of each of the following compound:

(i) $NaNO_3$ (1 mark)

(ii) OH^- (1 mark)

(i) Write the correct formula for the following compounds:

(i) Iron(III)carbonate (1 mark)

(ii) Sodium sulfate (1 mark)

(iii) Aluminium chlorate (1 mark)

Question 5

(a) During heavy exercise and workouts, lactic acid, $C_3H_6O_3$, accumulates in the muscles, where it can cause pain and soreness.

(i) What is the molar mass of lactic acid? (1 mark)

(ii) How many molecules are in 0.500 mole of lactic acid? (1 mark)

(iii) How many C atoms are in 1.50 moles of lactic acid? (1 mark)

(b) Use dotted lines to show hydrogen bonding in the following cases :

(i) Between propanoic acid molecules (C_2H_5COOH). (2 marks)

(ii) Between propanoic acid and water molecules. (2 marks)

(c) The equilibrium constant, K_{eq}, for the equilibrium

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

is 54 at 425 ^oC. If the equilibrium mixture contains 0.030 M HI and 0.015 M I_2, what is the equilibrium concentration of H_2?

(2 marks)

(d) How would each of the following change the rate of the reaction shown here?

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

(i) Adding SO_2 (1 mark)

(ii) Raising the temperature (1 mark)

(iii) Adding a catalyst (1 mark)

(iv) Removing some SO_2 (1 mark)

(e) A solution of 0.205 M NaOH is used to neutralize 20.0 ml of H_2SO_4. If 45.6 ml of NaOH is required to reach the endpoint, what is the molarity of the H_2SO_4 solution?

(2 marks)

(f) Calculate the mass percent (m/m) of a solution containing 15.5 g of Na_2SO_4 and 75.7 g of H_2O.

(2 marks)

(g) A 2.00 L container is filled with methane gas (CH_4) at a pressure of 2500 mmHg and a temperature of 18 ^oC. How many grams of methane are in the container?

(3 marks)

(h) By using the solubility rules, predict whether each of the following ionic compounds is soluble (S) or insoluble (I) in water:

(i) $PbCl_2$ (1 mark)

(ii) Ag_2SO_4 (1 mark)

(iii) $Ca_3(PO_4)_2$ (1 mark)

(i) If the amount of radioactive phosphorus-32 in a sample decreases from 1.2 g to 0.30 g in 28 d, what is the half-life of phosphorus-32?

(2 marks)

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