

STUDENT ID NUMBER

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**SIR ARTHUR LEWIS COMMUNITY COLLEGE**  
**DIVISION OF TECHNICAL EDUCATION & MANAGEMNET STUDIES**

EXAMINATION SESSION : Final Examination  
PROGRAMME TITLE : Construction Engineering, Architectural  
Technology, Quantity Surveying  
**COURSE TITLE** : **CHEMISTRY (CHM102)**  
**DATE** : **Wednesday April 29<sup>th</sup>, 2009**  
**DURATION** : 3 hours  
Instructors : Catton/ Marty  
Number of students : sixty (60)

**INSTRUCTIONS**

#C2

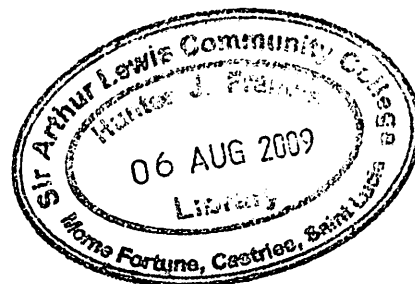
1. This is a THREE hour examination consisting of six (6) pages and a periodic table.
2. Answer all questions in the space provided. For numerical problems all working must be shown on paper provided, for full marks.
3. Use of pocket electronic calculators is permitted.  
**MEMORY CONTAINING PROGRAMABLE CALCULATORS ARE NOT PERMITTED UNLESS THE MEMORY IS DUMPED OF CHEMISTRY RELATED EQUATIONS.**
4. All cell phones must be turned off. Place cell phone on front desk if leaving the room during the examination period to go to the washroom.

Section	Number	Marks earned	Maximum Marks
Section I Multiple choice	1 - 20		20
Section II PROBLEMS	1		20
	2		20
	3		20
	4		10
	5		10
	6		10
	7 bonus		5
	<b>TOTAL</b>		/110



**SECTION I:**  
**MULTIPLE CHOICE QUESTIONS**  
Answer all questions in the booklet provided

1. Which of the following statement is/are true of atoms?
- I They contain three fundamental particles.  
II They are indivisible in chemical reactions.  
III Those of an elements are all exactly alike.  
IV They contain particles which all carry charges.
- A) I only    B) I and II only  
C) I and III only                                D) II and IV only
2. Which of the following will not conduct electricity?
- A) Solid calcium  
B) Solid calcium chloride  
C) A solution of calcium chloride in water  
D) Molten calcium chloride
3. In which of the following compounds does manganese (Mn) have an oxidation number of +7?
- A) MnO                      B) MnO<sub>2</sub>                      C) Mn<sub>2</sub>O<sub>3</sub>                      D) KMnO<sub>4</sub>
4. Which of the following would contain the same number of atoms as there are in 12 grams of carbon – 12?
- I 2 g of hydrogen gas  
II 17 g of ammonia gas  
III 23 g of sodium metal  
IV 71 g of chlorine gas
- A) III only    B) IV only  
C) I and IV only                                D) II and IV only
5. Which of the following aqueous solutions is a buffer?
- A) HF + KF                                      B) HNO<sub>3</sub> + KNO<sub>3</sub>  
C) H<sub>2</sub>SO<sub>4</sub> + NaOH                              D) NaCl + NaOH
6. In the electrolysis of concentrated copper (II) chloride solution using carbon electrodes, the substance formed at the anode is
- A) copper    B) oxygen    C) chlorine    D) carbon
7. Isotopes of the same element differ in their
- A) number of protons                              B) number of electrons  
C) physical properties                              D) chemical properties



8. An atom of hydrogen can form

- I an ionic bond losing an electron.
- II a covalent bond by sharing a pair of electrons with a metal.
- III an ionic bond by gaining an electron.
- IV a covalent bond by losing a pair of electrons.

- A) I and III only                      B) I and IV only  
C) II and III only                      D) II and IV only

9. Which two of following equations represent the reaction taking place at the electrodes when copper sulphate solution is electrolyzed using copper electrodes?

- I  $Cu_{(s)} \rightarrow Cu^{2+} + 2e$
- II  $SO_4^{2-}(aq) \rightarrow SO_4(aq) + 2e$
- III  $4OH^-(aq) \rightarrow 2H_2O_{(l)} + O_{2(g)} + 4e$
- IV  $Cu^{2+}(aq) + 2e \rightarrow Cu_{(s)}$

- A) I and IV                              B) I and III  
C) II and III                             D) II and IV

10. Which of the following statements are true?

- I Non-metal ions have minus charges
- II In a correct ionic formula, the total negative and positive charges balance
- III Metal ions have plus charges
- IV Sulphate and sulphide ions are really the same thing

- A) I and II                                B) II and III  
C) I and IV                                D) I, II and III

11. Aluminum is in group III of the periodic table. How many moles of product would be formed by the passage of 9650 C of electricity?

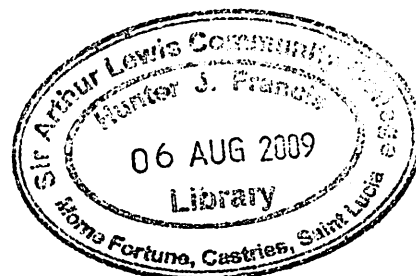
- A) 0.003                      B) 0.03                      C) 0.30                      D) 3.0

12. 6.6412 g + 12.85g + 0.046 g + 3.48 g, expressed to the correct number of significant figures is:

- A) 23 g                      B) 23.0 g                      C) 23.017 g                      D) 23.02 g

13. Which of the following is true about a strong acid?

- A) It fumes in moist air.
- B) It dissociates completely in aqueous solution.
- C) It is extremely viscous
- D) It has a high pH in aqueous solution.



14. Which of the following is (are) strong acids?

- I)  $\text{HClO}_4$
- II)  $\text{HF}$
- III)  $\text{HNO}_2$

- A) I only
- B) III only
- C) I and II only
- D) II and III only

15. The pH of a solution of sodium cyanide,  $\text{NaCN}$ , is expected to be a:

- A)  $\text{pH} > 7$
- B)  $\text{pH} < 7$
- C)  $\text{pH} = 7$
- D)  $\text{pH} = 0$
- E) none of these

16. How many chlorine atoms are in 4.0 mol of  $\text{PCl}_3$ ?

- A) 3 atoms
- B) 12 atoms
- C)  $7.2 \times 10^{+24}$
- D)  $2.4 \times 10^{+24}$
- E)  $1.8 \times 10^{+24}$

17. The formula  $\text{CaCO}_3$  means:

- A) Three atoms of every thing
- B) Three carbon atoms and three oxygen atoms
- C) One calcium atom, one carbon and three oxygen atoms
- D) One calcium atom, three carbon atoms and three oxygen atoms

18. When combining with non-metallic atoms, metallic atoms will

- A) lose electrons and form negative ions
- B) gain electrons and form negative ions
- C) lose electrons and form positive ions
- D) gain electrons and form positive ions

19. In the reaction  $\text{Cu}^{2+} + \text{Zn} \rightleftharpoons \text{Cu} + \text{Zn}^{2+}$ , the reducing agent is:

- A)  $\text{Zn}$
- B)  $\text{Zn}^{2+}$
- C)  $\text{Cu}$
- D)  $\text{Cu}^{2+}$

20. An element has two isotopes of relative mass 106.905 (51.82%) and 108.905 (48.18%). The average relative atomic mass of the element is:

- A) 106.905
- B) 107.869
- C) 108.475
- D) 108.905



## Section II

This section consists of six (6) compulsory questions.

Answer all questions in booklets provided

Show all workings for full marks

### General Equilibrium

1. (i) State Le Chatelier's principle.
- (ii) Utilizing le Chatelier's Principle, indicate the shift (if any) that would occur to  $\text{C}_2\text{H}_6(\text{g}) + \text{heat} \rightleftharpoons \text{C}_2\text{H}_4(\text{g}) + \text{H}_2(\text{g})$
- (a) If the concentration of hydrogen gas is decreased
- (b) If the temperature is lowered
- (c) If a catalyst is added
- (d) If  $\text{C}_2\text{H}_6$  is removed from the system
- (e) If the volume of the container is increased
- (iii) At 850K, 0.200 moles of  $\text{SO}_2$  and  $\text{O}_2$  were placed in a 2.00 litres/dm<sup>3</sup> vessel. At equilibrium the moles of  $\text{SO}_3$  in the vessel was 0.0400 mol.
- (a) Write the equilibrium expression for  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$
- (b) Calculate the concentration of all gases at equilibrium, by copying and filling in the table below.

Moles	$\text{SO}_2(\text{g})$	$\text{O}_2(\text{g})$	$\text{SO}_3(\text{g})$
START			
EQUILIBRIUM			

- (c) Calculate the numerical value of the equilibrium constant,  $K_c$ .

Total 20 marks

### Acid-Base Equilibrium

2. (i) Using Brønsted-Lowry theory, define an acid and a base.
- (ii) Identify the conjugate acid-base pairs in the following equations:
- (a)  $\text{HCl} + \text{NH}_3 \rightleftharpoons \text{NH}_4^+ + \text{Cl}^-$
- (b)  $\text{HCO}_3^- + \text{OH}^- \rightleftharpoons \text{CO}_3^{2-} + \text{H}_2\text{O}$
- (c)  $\text{HCO}_3^- + \text{H}_3\text{O}^+ \rightleftharpoons \text{H}_2\text{CO}_3 + \text{H}_2\text{O}$
- (d)  $\text{HC}_2\text{H}_3\text{O}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{C}_2\text{H}_3\text{O}_2^-$
- (e)  $\text{HC}_2\text{H}_3\text{O}_2 + \text{H}_2\text{SO}_4 \rightleftharpoons \text{H}_2\text{C}_2\text{H}_3\text{O}_2^+ + \text{HSO}_4^-$
- (iii)
- (a) What is the pH of a 0.010M NaOH solution? Assume that NaOH is 100% ionized?
- (b) What is a buffer?
- (iv) Draw a titration curve, pH versus volume of strong base, for the titration of a weak acid by a strong base. Indicate the following on the diagram:
- (a) the equivalence point
- (b) the buffer region
- (c) the point where  $\text{pH} = \text{pKa}$
- (v) (a) What is meant by 'an indicator'?



- (b) Litmus indicator changes red in acid and blue in base. State the colour change for the following (i) tartaric acid and (ii) ammonia.

Total 20 marks

### Oxidation-Reduction Reaction

3. (i)(a) Distinguish between oxidation and reduction  
 (b) Find the oxidation state of the underlined element in the following: (i)CrO<sub>4</sub><sup>2-</sup> (ii)H<sub>3</sub>PO<sub>3</sub>  
 (iii)Ca(IO<sub>3</sub>)<sub>2</sub> (iv)Mn<sub>2</sub>O<sub>7</sub> (v)VO<sub>2</sub><sup>+</sup>
- (ii) Complete and balance the following half equations, and indicate whether oxidation or reduction is involved.  
 (a) NO<sub>3</sub><sup>-</sup> =====> N<sub>2</sub>O (acidic solution)  
 (b) Cl<sup>-</sup> =====> ClO<sub>3</sub><sup>-</sup> (basic solution)
- (iii) (a) Distinguish between oxidizing and reducing agents  
 (b) What are the oxidizing and reducing agents in the following redox reactions?  
 (i) 5 SO<sub>3</sub><sup>2-</sup> + 2MnO<sub>4</sub><sup>-</sup> + 6H<sup>+</sup> =====> 5 SO<sub>4</sub><sup>2-</sup> + 2Mn<sup>2+</sup> + 3 H<sub>2</sub>O  
 (ii) 2 NO<sub>2</sub> (g) + 7 H<sub>2</sub> (g) =====> 2 NH<sub>3</sub> (g) + 4 H<sub>2</sub>O (g)  
 (iii) 2 [Fe (CN)<sub>6</sub>]<sup>4-</sup> + H<sub>2</sub>O + 2 H<sup>+</sup> =====> 2 [Fe(CN)<sub>6</sub>]<sup>3-</sup> + 2H<sub>2</sub>O
- (c) Balance the following Redox equation:  
 (i) Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup> + Cl<sub>2</sub> =====> Cr<sup>3+</sup> + ClO<sub>2</sub><sup>-</sup>(g) (acidic solution)  
 (ii) Fe<sup>2+</sup> + Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup> =====> Fe<sup>3+</sup> + Cr<sup>3+</sup> (acidic solution)  
 (iii) MnO<sub>2</sub> + ClO<sub>3</sub><sup>-</sup> =====> MnO<sub>4</sub><sup>-</sup> + Cl<sup>-</sup> (basic solution)

Total 20 marks

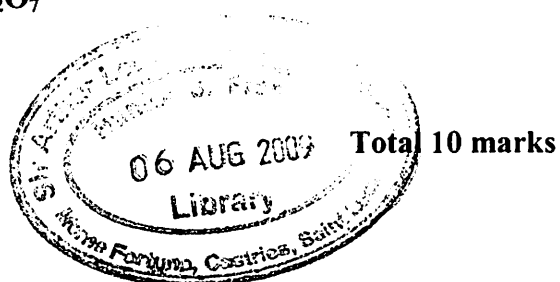
### Electrolysis

4. (i) Potassium hydride (KH) is an ionic compound. Molten potassium hydride (KH) was electrolysed using a current of 220 amperes for 10 minutes.  
 (a) What are the products of this electrolysis?  
 (b) Write ionic equations for the cathode and anode reactions  
 (c) What mass of product is liberated at the cathode? Show all steps in the reaction
- (ii) Given the following reduction potentials:  
 E° (Ni<sup>2+</sup>/Ni) = -0.236 volts      E° (Cu<sup>2+</sup>/Cu) = +0.339 volts  
 E° (Ag<sup>+</sup>/Ag) = +0.799 volts      E° (Cl<sub>2</sub>/Cl<sup>-</sup>) = +1.396 volts  
 E° (Zn<sup>2+</sup>/Zn) = -0.762 volts      E° (Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup>/Cr<sup>3+</sup>) = +1.360 volts

Using the above reduction potential, predict which of the following reactions are spontaneous. [Show calculated cell potentials]

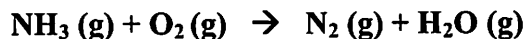
- (a) Ni<sup>2+</sup> + Ag ⇌ Ni + Ag<sup>+</sup>  
 (b) 3 Cl<sub>2</sub> + 2 Cr<sup>3+</sup> + 7H<sub>2</sub>O ⇌ 14H<sup>+</sup> + 6 Cl<sup>-</sup> + Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup>  
 (c) Cu<sup>2+</sup> + Zn ⇌ Cu + Zn<sup>2+</sup>

1 Faraday = 96,500 Coulombs.



## Stoichiometry & Shapes of molecules

5. (i) If 12.5g each of  $\text{NH}_3$  and  $\text{O}_2$  are allowed to react with heating according to the following reaction.



- a) Balance the equation above.  
b) What is the limiting reagent in this reaction is?  
c) What mass of  $\text{N}_2$  (g) will be formed?  
d) If the experimental yield of  $\text{N}_2$  is 2.45g, what is the percent yield of  $\text{N}_2$ ?  
e) What is the volume of nitrogen,  $\text{N}_2$  (g), produced at s.t.p. from this reaction?  
[s.t.p. =  $22.4 \text{ dm}^3$  or 22.4 litres]
- (ii) Draw the Lewis structures for the following using THE OCTET RULE:  
[Indicate TOTAL VALENCE ELECTRONS for each of the species and GEOMETRY OF THE CENTRAL ATOM and the SHAPE OF THE SPECIES]]
- (a)  $\underline{\text{CS}}_2$   
(b)  $\underline{\text{CH}}_4$   
(c)  $\underline{\text{NO}}_3^-$

Total 10 marks

## Nomenclature of Inorganic Compounds

6. (i) What are the symbols/formula for the following:
- (a) Ammonia  
(b) Phosphorous  
(c) Dinitrogen trioxide  
(d) Calcium Hydroxide
- (ii) Give the names of the following:
- (a)  $\text{MgS}$   
(b)  $\text{P}_2\text{O}_5$   
(c)  $\text{SCl}_2$   
(d)  $\text{Al}_2\text{O}_3$
- (iii) Name the following acids
- (a)  $\text{HNO}_2$   
(b)  $\text{H}_2\text{SO}_4$   
(c)  $\text{H}_3\text{PO}_4$   
(d)  $\text{HClO}$

Total 10 marks

7. BONUS: What is the pH of a 0.20M solution of potassium fluoride, KF.  
The  $K_a$  of hydrofluoric acid, HF, is  $4.6 \times 10^{-4}$ .

5 marks

