THE COLLEGE OF THE BAHAMAS

EXAMINATION

SEMESTER 01-2007

FACULTY OF PURE AND APPLIED SCIENCES

SCHOOL OF SCIENCES AND TECHNOLOGY

X NASSAU
FREEPORT
EXUMA
ELEUTHERA

DATE AND TIME OF EXAMINATION: Tuesday, April 17, 2007 at 2 pm
DURATION: 3 HOURS

COURSE NUMBER: CHEM 115

COURSE TITLE: INTRODUCTORY CHEMISTRY

STUDENT NAME:

STUDENT NUMBER:

LECTURER'S NAME

INSTRUCTIONS TO CANDIDATES: This paper has 8 pages and 26 questions. Please follow instructions given.

Student Name .....Student Number .....

You may use the following information wherever necessary:
The molar volume of a gas at STP is 22,400 cm^3 mol^{-1} = 22.4 dm^3 mol^{-1} = 22.4 L mol^{-1}
1 dm^3 = 1 L = 1000 cm^3
Avogadro's number = 6.02×10^{23}
Relative atomic masses: H = 1.0, C =12, N = 14, O = 16, Ca = 40.

SECTION A: MULTIPLE CHOICE

For each question, select the best answer and shade the letter corresponding to the correct answer on the answer sheet provided.

1. An atom becomes an anion by
   - A losing electrons to another atom.
   - B gaining electrons from another atom.
   - C losing protons to another atom.
   - D gaining protons from another atom.
   - E sharing electrons with another atom.

2. The ion $^{25}Mg^{2+}$ contains
   - A 12 protons, 12 neutrons, 12 electrons.
   - B 12 protons, 13 neutrons, 12 electrons.
   - C 13 protons, 12 neutrons, 12 electrons.
   - D 12 protons, 13 neutrons, 10 electrons.
   - E 13 protons, 12 neutrons, 10 electrons.

3. Which statement about a pure compound is **false**?
   - A It has a fixed set of physical properties.
   - B It has a fixed set of chemical properties.
   - C Its component elements are chemically combined.
   - D It has a fixed composition by mass.
   - E It can be easily separated into its components by physical means.

4. The correct name for the compound Fe_2O_3 is
   - A iron oxide
   - B di-iron trioxide
   - C iron(II) oxide
   - D iron(III) oxide
   - E iron oxygen

5. How does a mixture of iron and sulphur differ from a compound of iron and sulphur?

   - A In the mixture, iron and sulphur are in physical contact whereas in the compound they are chemically combined.
   - B In the mixture, iron and sulphur can be present in any proportion by mass whereas in the compound they are present in a fixed proportion by mass.
   - C Iron and sulphur retain their individual properties in the mixture, whereas the compound has different properties from iron and sulphur.
   - D All of the above are correct.
   - E None of the above is correct.

6. Which statement is **not** true?

   - A All matter is composed of atoms.
   - B All atoms of an element are exactly alike.
   - C Atoms combine in whole numbers to form molecules.
   - D Atoms are neither created nor destroyed in the course of a chemical reaction.
   - E Atoms of one element cannot be changed into atoms of another element during a chemical change.

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7. Which atom has the smallest atomic radius?
   A H
   B He
   C Li
   D Be
   E B

8. Which atom has the lowest first ionization energy?
   A Na
   B Mg
   C Al
   D Si
   E P

9. Which property of Group 1 elements **decreases** down the group?
   A Atomic size
   B Metallic character
   C Number of valence electrons
   D Reactivity
   E First ionization energy

10. Which metal is a liquid at room temperature and pressure?
   A Gold
   B Potassium
   C Mercury
   D Silver
   E Aluminium

11. Which non-metal is a liquid at room temperature and pressure?
   A Fluorine
   B Chlorine
   C Bromine
   D Sulphur
   E Nitrogen

12. How many moles of $Ca_3(PO_4)_2$ (RFM = 310) are there in 18.6 g of the compound?
   A 310
   B 1.00
   C 0.06
   D 0.78
   E 18.6

13. What is the volume of 1.2 mol of carbon dioxide gas at STP?
   A 26.88 dm^3
   B 26.88 cm^3
   C 18.7 dm^3
   D 18.7 cm^3
   E 22,400 cm^3

14. What volume of 2.0 M NaCl contains 1.2 mol of the salt?
   A 1.0 dm^3
   B 2.0 dm^3
   C 600 cm^3
   D 0.60 cm^3
   E 1.2 dm^3

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15. The formula for the gas, ammonia, is NH_3. Which statement is **not** true?
A one molecule of NH_3 weighs 17 g.
B the relative molecular mass of NH_3 is 17.
C one mol of NH_3 has 6.02×10^{23} molecules.
D one mol of NH_3 occupies a volume of 22.4 dm^3 at STP.
E a molecule of NH_3 is 17 times as heavy as 1/12 the mass of a carbon -12 atom.

16. A molecule of butane contains four carbon atoms and ten hydrogen atoms. Which statement is **not** true?
A The molecular formula of butane is C_4H_{10}.
B The empirical formula of butane is C_2H_5.
C The mass of 1.0 mol butane is 58 g.
D Butane contains 82.8 % by mass of carbon.
E Butane is an ionic compound

17. The equation represents the reaction of oxalic acid($H_2C_2O_4$) with potassium permanganate($KMnO_4$) in the presence of sulphuric acid:

$$5\ H_2C_2O_4 + 2\ KMnO_4 + 3\ H_2SO_4 \rightarrow 2\ MnSO_4 + K_2SO_4 + 10\ CO_2 + 8\ H_2O$$

How many moles of $KMnO_4$ will exactly react with 0.020 mol $H_2C_2O_4$?
A 0.008 mol
B 0.050 mol
C 0.10 mol
D 2.0 mol
E 5.0 mol

18. A reversible system is said to be in a state of dynamic equilibrium when

A reaction has stopped.
B the rate of the forward reaction is faster than the rate of the reverse reaction.
C the rate of the reverse reaction is faster than the rate of he forward reaction.
D the rate of the forward reaction is equal to the rate of the reverse reaction.
E all the reactants have been used up.

19. Which statement is **not** true of a system in dynamic equilibrium?

A The concentration of each species in the system remains constant.
B Reactants are produced as fast as they are used up.
C There is no net reaction taking place.
D There is a mixture of all reactants and products in the equilibrium mixture.
E All reactants have been converted to products.

20. Which is a statement of Le Chatelier's principle?

A If a stress is applied to a reversible system, the system reacts so as to relieve the stress.
B If a stress is applied to a reversible system at equilibrium, the system reacts so as to relieve the stress.
C If a stress is applied to an irreversible system, the system reacts so as to relieve the stress.
D A stress which can be applied to a reversible system at equilibrium is a change in temperature.
E If the concentration of a reactant is reduced in an equilibrium system, equilibrium shifts to the right.

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SECTION B: Answer **all** questions in the spaces provided on the question paper.

You may use the following information wherever necessary:
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1 dm^3 = 1 L = 1000 cm^3
Avogadro's number = 6.02×10^{23}
Relative atomic masses: H = 1.0, C =12, N = 14, O = 16, Ca = 40.

1. Give the name or symbol of

a) the element in period 3 with the smallest atomic radius._____

b) the halogen with the largest atomic radius. _____

c) the alkali metal with the highest first ionization energy._____

d) the most reactive halogen. _____

e) the element in group 4 with the most metallic character._____

f) the most electronegative element in the periodic table. _____

g) an element in period 3 which forms a basic oxide. _____

h) an element in period 3 which forms an acidic oxide. _____ [8]

2. This question concerns the following metals: zinc, aluminium, potassium, silver, magnesium, copper.

a) Name the metals in order of **decreasing** reactivity. [1]

b) i) Name one metal, from the list, which reacts explosively with water. [1]

ii) Write a balanced equation for the reaction. [2]

c) i) Write a **net ionic** equation for the reaction of magnesium with dilute hydrochloric acid.. [2]

ii) Name one metal, from the list, which does **not** liberate hydrogen from dilute acids. [1]

d) i) Which metal, from the list, forms an amphoteric oxide? [1]

ii) What is an *amphoteric* substance? [1]

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e) Which metal, from the list, forms a hydroxide which is thermally stable? [1]

f) i) Write an equation for the thermal decomposition of copper(II) hydroxide. [2]

ii) What colour **change** is observed when copper(II) hydroxide is heated? [1]

iii) How can the gas or vapour evolved on heating copper(II) hydroxide be identified? [1]

g) Which metal, from the list, forms a carbonate which does **not** decompose on heating? [1]

h) i) Write an equation for the thermal decomposition of magnesium carbonate. [2]

ii) How can the gas evolved from the thermal decomposition of magnesium carbonate be identified? [1]

i) Select, from the list, a metal whose nitrate thermally decomposes to the corresponding metal nitrite and write a balanced equation for the reaction. [2]

j) Select, from the list, a metal whose nitrate thermally decomposes to the corresponding metal oxide and write a balanced equation for the reaction. [2]

k) Select, from the list, a metal whose nitrate thermally decomposes to the corresponding metal and write a balanced equation for the reaction. [2]

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3. Carbon dioxide gas can be produced by the reaction of dilute hydrochloric acid on calcium carbonate:

$CaCO_3$ (s) + 2 HCl (aq) → $CaCl_2$(aq) + CO_2 (g) + H_2O (l)

a) What is the maximum volume of carbon dioxide gas, at STP, that can be obtained by the complete reaction of 3.0 mol HCl with excess $CaCO_3$? [2]

b) What mass of $CaCO_3$ is required to **exactly** react with 150 cm^3 of 2.0 M HCl ? [3]

c) How many cm^3 of 1.5 M HCl are required to react with excess $CaCO_3$ to produce 5.6 dm^3 of carbon dioxide gas at STP? [4]

4. a) Define the term "relative molecular mass". [2]

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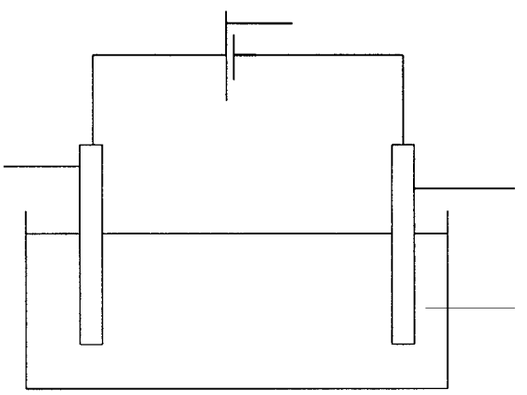
b) Ethyl butanoate is a flavoring agent which imparts a flavor of pineapple to food items such as ice cream. Ethyl butanoate consists of 62.1% carbon, 10.3% hydrogen and 27.6% oxygen. The molar mass of ethyl butanoate is 116 g mol^{-1}. Find its molecular formula. [4]

5. The diagram represents a cell used for the electrolysis of molten sodium chloride.



a) Insert the labels in the diagram and show the direction of flow of electrons, and the direction of flow of cations and anions. Show, also, the polarity of each electrode. [4]

b) Write an **ionic** equation for the reaction occurring at the

i) anode. .[2]

ii) cathode. [2]

c) Explain why **solid** sodium chloride cannot be electrolyzed. [2]

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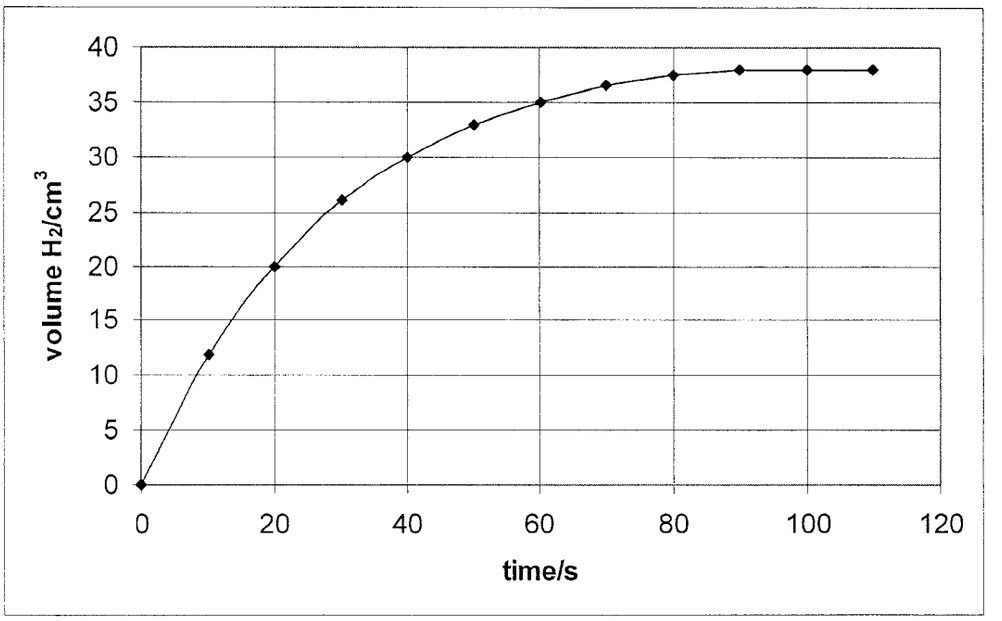
6. Magnesium metal reacts with hydrochloric acid to produce hydrogen gas:
$Mg(s) + 2\ HCl(aq) \rightarrow MgCl_2(aq) + H_2\ (g)$

A piece of magnesium ribbon was added to a solution of dilute hydrochloric acid at room temperature The volume of hydrogen released over a period of time was measured. The results are shown in the graph given.



a) From the graph, determine

i) the volume of hydrogen formed in the first 15 seconds of the reaction. [1]

ii) the average rate of the reaction between the 20th and 60th second of the reaction. [2]

iii) the time taken for the volume of hydrogen to increase from 15 cm^3 to 30 cm^3 . [2]

v) the maximum volume of hydrogen liberated. [1]

b) Explain why the maximum volume of hydrogen could not increase any further.[1]

c) The rate of this reaction can be increased by using a suitable catalyst.

i) Explain how a catalyst increases the rate of a reaction. [2]

ii) State **two** other changes that can be made in order to increase the rate of this reaction. [2]

END OF EXAMINATION

PERIODIC TABLE OF THE ELEMENTS

←Periods→	I	II	← Groups →										III	IV	V	VI	VII	0
1	1 H hydrogen 1·0																	2 He helium 4·0
2	3 Li lithium 6·9	4 Be beryllium 9·0											5 B boron 10·8	6 C carbon 12·0	7 N nitrogen 14·0	8 O oxygen 16·0	9 F fluorine 19·0	10 Ne neon 20·2
3	11 Na sodium 23·0	12 Mg magnesium 24·3											13 Al aluminium 27·0	14 Si silicon 28·1	15 P phosphorus 31·0	16 S sulfur 32·1	17 Cl chlorine 35·5	18 Ar argon 39·9
4	19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45·0	22 Ti titanium 47·9	23 V vanadium 50·9	24 Cr chromium 52·0	25 Mn manganese 54·9	26 Fe iron 55·8	27 Co cobalt 58·9	28 Ni nickel 58·7	29 Cu copper 63·5	30 Zn zinc 65·4	31 Ga gallium 69·7	32 Ge germanium 72·6	33 As arsenic 74·9	34 Se selenium 79·0	35 Br bromine 79·9	36 Kr krypton 83·8
5	37 Rb rubidium 85·5	38 Sr strontium 87·6	39 Y yttrium 88·9	40 Zr zirconium 91·2	41 Nb niobium 92·9	42 Mo molybdenum 95·9	43 Tc technetium 98·9	44 Ru ruthenium 101·1	45 Rh rhodium 102·9	46 Pd paladium 106·4	47 Ag silver 107·9	48 Cd cadmium 112·4	49 In indium 114·8	50 Sn tin 118·7	51 Sb antimony 121·8	52 Te tellurium 127·6	53 I iodine 126·9	54 Xe xenon 131·3
6	55 Cs cesium 132·9	56 Ba barium 137·3	57 La lanthanum 138·9	72 Hf hafnium 178·5	73 Ta tantalum 180·9	74 W tungsten 183·85	75 Re rhenium 186·2	76 Os osmium 190·2	77 Ir iridium 192·2	78 Pt platinum 195·1	79 Au gold 197·0	80 Hg mercury 200·6	81 Tl thallium 204·4	82 Pb lead 207·2	83 Bi bismuth 209·0	84 Po polonium	85 At astatine	86 Rn radon
7	87 Fr francium	88 Ra radium	89 Ac actinium															

Key: 19 ← proton number; K ← symbol of element; potassium ← name of element; 39.1 ← relative atomic mass

Lanthanides:

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
cerium	praseodymium	neodymium	promethium	samarium	europium	gadolinium	terbium	dysprosium	holmium	erbium	thulium	ytterbium	lutetium
140.1	140.9	144.2		150.4	152.0	157.3	158.9	162.5	164.9	167.3	168.9	173.0	175.0

Actinides:

90	91	92	93	94	95	06	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
thorium	protoactinium	uranium	neptunium	plutonium	americium	curium	berkelium	californium	einsteinium	fermium	mendelevium	nobelium	lawrencium
232.0	231.0	238.0	237.0										

Note: relative atomic masses are omitted for highly unstable elements.