THE COLLEGE OF THE BAHAMAS

EXAMINATION

SEMESTER 04-2006

FACULTY OF PURE AND APPLIED SCIENCES

SCHOOL OF SCIENCES AND TECHNOLOGY

X NASSAU
FREEPORT
EXUMA
ELEUTHERA

DATE AND TIME OF EXAMINATION: Monday, December 4, 2006 at 9 am
DURATION: 2 ½ HOURS

COURSE NUMBER: CHEM 115

COURSE TITLE: INTRODUCTORY CHEMISTRY

STUDENT NAME:

STUDENT NUMBER:

LECTURER'S NAME

INSTRUCTIONS TO CANDIDATES: This paper has 8 page and 38 questions. Please follow instructions given.

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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}
Avogadro's number = 6.02 x 10^{23}
Relative atomic masses: H = 1.0, C =12, N = 14, O = 16, Na = 23, Mg = 24, Al = 27, S = 32, Cl = 35.5, K = 39, Ca = 40, Mn = 55, Cu =64, Zn = 65.

Section A: Multiple Choice. Answer **all** questions. Each question is worth 1 mark.[30]

For each question, select the most suitable answer and shade the letter corresponding to this answer on the answer sheet provided.

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

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

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

4. Which non-metal is a liquid at room temperature and pressure?
   A Oxygen
   B Chlorine
   C Sulphur
   D Iodine
   E Bromine

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

6. X is an alkali metal in Period 3 of the Periodic Table.
   Which statement is true?
   A X typically forms cations with a +2 charge.
   B The electronic configuration of X is 2,1
   C The electronic configuration of X is 2,8,1.
   D The electronic configuration of X is 2,8,2.
   E X typically forms anions.

7. Which carbonate does **not** decompose on heating?
   A Calcium carbonate
   B Lead (II) carbonate
   C Magnesium carbonate
   D Sodium carbonate
   E Zinc carbonate

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8. A compound, Y, is a metal oxide which gives a lilac flame test. Which statement is **not** true?
   A Y is potassium oxide.
   B Y is soluble in water.
   C Y is an alkali.
   D Y reacts with hydrochloric acid to form a potassium chloride and water.
   E Y is an insoluble base.

9. The oxide of which element is amphoteric?
   A Sodium
   B Magnesium
   C Aluminium
   D Phosphorus
   E Sulphur

10. A substance which absorbs water from the atmosphere and dissolves in it is described as
   A hygroscopic.
   B deliquescent.
   C amphoteric.
   D volatile.
   E thermally stable.

11. Which metal nitrate does **not** liberate nitrogen dioxide when it is thermally decomposed?
   A $AgNO_3$
   B $NaNO_3$
   C $Cu(NO_3)_2$
   D $Zn(NO_3)_2$
   E $Fe(NO_3)_2$

12. Which metal nitrate decomposes on heating to form the corresponding nitrite?
   A $AgNO_3$
   B $NaNO_3$
   C $Cu(NO_3)_2$
   D $Zn(NO_3)_2$
   E $Fe(NO_3)_2$

13. Which metal nitrate decomposes on heating to form the corresponding metal?
   A $AgNO_3$
   B $NaNO_3$
   C $Cu(NO_3)_2$
   D $Zn(NO_3)_2$
   E $Fe(NO_3)_2$

14. When heated, the carbonate of a metal, X, decomposes more readily than zinc carbonate. The metal, X, will displace copper from a solution of copper(II) sulphate. X may be
   A silver
   B mercury
   C zinc
   D iron
   E magnesium

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15. Which reaction will **not** take place?

A $Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$
B $ZnCO_3(s) \rightarrow ZnO(s) + CO_2(g)$
C $Cu(s) + 2\,HCl(aq) \rightarrow CuCl_2(aq) + H_2(g)$
D $Cu(OH)_2(s) \rightarrow CuO(s) + H_2O$
E $Cl_2(l) + 2\,NaBr(aq) \rightarrow Br_2(g) + 2\,NaCl(aq)$

16. The relative atomic mass of oxygen is 16. This means that

A an atom of oxygen is 16 times as heavy as a carbon-12 atom.
B a carbon-12 atom is 16 times as heavy as an oxygen atom.
C an oxygen atom is 16 times as heavy as 1/12 the mass of a carbon-12 atom.
D a carbon-12 atom is 16 times as heavy as 1/12 the mass of an oxygen atom.
E an atom of oxygen contains 16 protons.

17. The relative molecular mass of sulphur dioxide(SO_2) gas is 64. Which statement is **not** true?

A One mole of sulphur dioxide weighs 64 g.
B One mole of sulpur dioxide occupies a volume of 22.4 dm^3 at STP.
C One mole of sulphur dioxide contains 6.02×10^{23} molecules of sulphur dioxide.
D One mole of sulphur dioxide contains $2 \times 6.02 \times 10^{23}$ atoms of oxygen.
E One mole of sulphur dioxide contains $64 \times 6.02 \times 10^{23}$ molecules.

18. 0.5 mol of K_2CO_3 contains

A 3 mol oxygen atoms.
B 0.5 mol oxygen atoms.
C 1.5 mol oxygen atoms.
D 6.02×10^{23} oxygen atoms.
E 6.02×10^{23} mol oxygen atoms.

19. The percent by mass of sodium in sodium sulphate(Na_2SO_4) is

A 23.0 %
B 32.4 %
C 46.0 %
D 142 %
E dependent on the mass of sodium sulphate.

20. 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 0.060 mol
D 0.14 mol
E 2.0 mol

21. Every molecule of the compound, ethanoic acid, contains 2 carbon atoms and 4 hydrogen atoms and 2 oxygen atoms. Which statement is **incorrect**?

A The molecular formula of ethanoic acid $C_2H_4O_2$.
B The empirical formula of ethanoic acid CH_2O.
C Ethanoic acid is polyatomic.
D Each ethanoic acid molecule weighs 60 g.
E The relative molecular mass of ethanoic acid is 60.

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22. A catalyst increases the rate of a reaction by

A increasing the kinetic energy of the reactant molecules.
B decreasing the enthalpy change (ΔH) of the reaction.
C increasing the total amount of product formed at the end of the reaction.
D increasing the collision frequency of the reactant molecules.
E decreasing the energy of activation for the reaction.

23. A chemical system in dynamic equilibrium is best described as

A a reversible system in which reaction has stopped.
B a reversible system in which the rate of the forward reaction is equal to the rate of the reverse reaction.
C a reversible system in which the forward reaction is the same as the reverse reaction.
D a reversible system in which only products are formed.
E a reversible system in which only reactants are formed.

24. Consider the reaction: $N_2(g) + 3\ H_2\ (g) \rightleftharpoons 2\ NH_3(g)$ Δ H is *-ve*
Which change can cause equilibrium to shift in the forward direction?

A Addition of some ammonia .
B Removal of some nitrogen.
C Increase in temperature of the reaction mixture.
D Increase in pressure by reducing the volume of the reaction mixture.
E The use of a suitable catalyst.

25. Which can be an electrolyte?

A A liquid covalent compound such as ethanol.
B A graphite rod.
C Solid sodium chloride.
D Molten sodium chloride.
E None of the above.

26. In electrolysis, the cathode

A is the positive electrode.
B is not necessary.
C does not conduct electricity.
D is the electrode where oxidation occurs.
E is the electrode where reduction occurs.

Questions 27 to 30 concern the following gases:

A. Ammonia
B. Carbon dioxide
C. Hydrogen
D. Water vapour
E. Oxygen

Select, from A to E, the gas which

27. relights a glowing splint.

28. turns lime water milky.

29. burns with a pop.

30. turns moistened red litmus paper blue.

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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:
The molar volume of a gas at s.t.p is 22,400 cm^3 mol^{-1} = 22.4 dm^3 mol^{-1} = 22.4 L mol^{-1}
Avogadro's number = 6.02×10^{23}
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1. Complete the table. [3]

Name of compound	Formula		Name of compound	Formula
Aluminium oxide				$Pb(OH)_2$
Iron(III) chloride				$(NH_4)_2SO_4$
Nitric acid				NO_2

2. a) Write a word equation followed by a balanced chemical equation for the thermal decomposition of copper(II) nitrate. [3]

b) Describe **three** things you expect to **observe** as copper(II) nitrate decomposes on heating. [3]

i).....

ii).....

iii).....

3. Derive a net ionic equation for the reaction:
$Pb(NO_3)_2$ (aq + 2 NaCl (aq) $\rightarrow$ $PbCl_2$ (s) + 2 $NaNO_3$ (aq) [2]

4. Calcium and magnesium belong to the same group of the Periodic Table, yet calcium reacts readily with water at room temperature whereas magnesium does not.

a) Write a word equation followed by a balanced chemical equation for the reaction of calcium with water. [3]

b) Explain the difference in the reactivity of these two metals with water. [2]

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5. a) Define the term "relative molecular mass of a compound" [2]

b) A certain compound is composed of 47.1% carbon, 7.8 % hydrogen, 13.7% nitrogen and 31.4 % oxygen. The molar mass of the compound is 102 g mol^{-1}. Find the molecular formula of the compound.. [4]

6. Consider the reaction: MnO_2 (s) + 4 HCl (aq) → $MnCl_2$ (aq) + 2 H_2O (l) + Cl_2 (g)

a) How many dm^3 of chlorine gas, at STP, can be obtained by the complete reaction of 6.0 mol HCl with excess MnO_2? [2]

b) What mass of MnO_2 is required to exactly react with 300 cm^3 of 2.0 M HCl ? [4]

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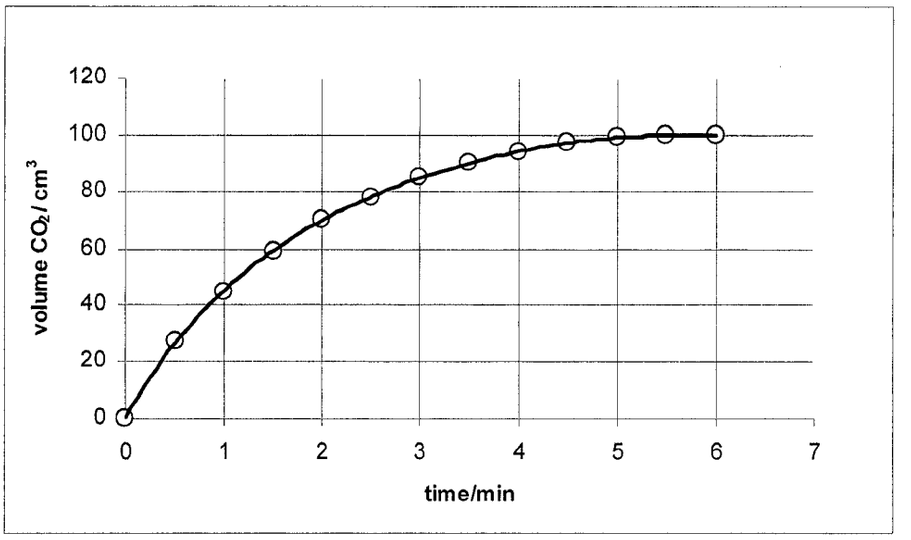
c) How many cm^3 of 2.0 M HCl are required to react with excess MnO_2 to produce 5,600 cm^3 of carbon dioxide gas at STP? [3]

7. 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)

Marble chips are composed of $CaCO_3$.
Some marble chips were added to a solution of dilute hydrochloric acid, containing excess of the acid. The volume of carbon dioxide released, at 25°C , over a period of time, was measured. The results are shown in the graph given.



a) From the graph, determine

i) the volume of carbon dioxide formed in the first minute. [1]

ii) the average rate of the reaction between the second and fourth minutes of the reaction. [2]

iii) the maximum volume of carbon dioxide liberated. [1]

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

c) If the same mass of powdered calcium carbonate were used instead of marble chips, how would this affect

i) the maximum volume of carbon dioxide produced? [1]

ii) the rate of the reaction? [1]

d) The rate of this reaction would be faster if the reaction were carried out at 40°C instead of 25°C. Explain why reaction rate increases when the temperature of the reaction mixture increases. [3]

8. a) State Le Chatelier's Principle. [2]

a) Consider the reaction:

$[Co(H_2O)_6]^{2+}$ (aq) + $4Cl^-$ (aq) $\rightleftharpoons$ $[CoCl_4]^{2-}$ (aq) + $6H_2O$ (l)

pink *colourless* *blue* *colourless*

When an equilibrium mixture, containing all four species in the equation, is heated, the colour changes from pink to blue. Is the forward reaction exothermic or endothermic? Show your reasoning. [2]

END OF EXAMINATION

PERIODIC TABLE OF THE ELEMENTS

I	II											III	IV	V	VI	VII	0
1 H hydrogen 1·0																	2 He helium 4·0
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
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
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 galium 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
37 Rb rubidium 85·5	38 Sr srontium 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
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 pollonium	85 At astatine	86 Rn radon
87 Fr francium	88 Ra radium	89 Ac actinium															

	58 Ce cerium	59 Pr praseodymium	60 Nd neodymium	61 Pm promethium	62 Sm samarium	63 Eu europium	64 Gd gadolinium	65 Tb terbium	66 Dy dysprosium	67 Ho holmium	68 Er erbium	69 Tm thulium	70 Yb ytterbium	71 Lu lutetium
	90 Th thorium	91 Pa protoactinium	92 U uranium	93 Np neptunium	94 Pu plutonium	95 Am americium	06 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium