

# THE COLLEGE OF THE BAHAMAS

## EXAMINATION

SEMESTER 04-2005

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**FACULTY OF PURE AND APPLIED SCIENCES**

SCHOOL OF SCIENCES AND TECHNOLOGY

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X NASSAU  
FREEPORT  
EXUMA  
ELEUTHERA

**DATE AND TIME OF EXAMINATION:** Monday, December 5, 2005 at 2 pm  
**DURATION:** 2 ½ HOURS

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COURSE NUMBER: CHEM 115

COURSE TITLE: INTRODUCTION TO CHEMISTRY

STUDENT NAME:

STUDENT NUMBER:

LECTURER'S NAME

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**INSTRUCTIONS TO CANDIDATES:** This paper has 8 pages and 36 questions. Please follow instructions given.

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You may use the following information wherever necessary:

The molar volume of a gas at s.t.p is  $22,400 \text{ cm}^3 \text{ mol}^{-1} = 22.4 \text{ dm}^3 \text{ mol}^{-1}$ .

Avogadro's number =  $6.02 \times 10^{23}$

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, 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.

**Questions 1 to 7** concern the following gases:

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

Select, from A to E, the gas which

1. relights a glowing splint.
2. turns lime water milky.
3. turns blue cobalt chloride paper pink.
4. burns with a pop.
5. turns moistened red litmus paper blue.
6. is liberated when copper(II) hydroxide decomposes on heating.
7. is produced when copper(II) nitrate decomposes on heating.

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8. X is an alkaline earth metal in Period 3 of the Periodic Table.

Which statement is true?

- A Compounds of X are covalent.
- B The electronic configuration of X is 2,8,1
- C The electronic configuration of X is 2,8,2
- D The electronic configuration of X is 2,8,8,2.
- E X typically forms negative ions.

9. Which substance is thermally stable?

- A Calcium carbonate
- B Copper (II) carbonate
- C Magnesium carbonate
- D Potassium carbonate
- E Zinc carbonate

10. A compound, Y, is a metal chloride which gives a lilac flame test. Which statement is **not** true?

- A Y is potassium chloride.
- B Y is soluble in water.
- C Y is a covalent compound.
- D Y is a good electrolyte.
- E Y is not hydrolyzed in water.

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11. Three elements, X, Y and Z belong to the same period of the Periodic Table. X forms an amphoteric oxide, Y forms a basic oxide, whilst Z forms an acidic oxide. The order of increasing atomic number of the elements is
- A XYZ
  - B ZYX
  - C YXZ
  - D XZY
  - E YZX
12. Which metal nitrate does **not** liberate nitrogen dioxide when it is thermally decomposed?
- A  $\text{AgNO}_3$
  - B  $\text{KNO}_3$
  - C  $\text{Cu}(\text{NO}_3)_2$
  - D  $\text{Zn}(\text{NO}_3)_2$
  - E  $\text{Pb}(\text{NO}_3)_2$
13. Which metal nitrate decomposes on heating to form the corresponding nitrite?
- A  $\text{AgNO}_3$
  - B  $\text{KNO}_3$
  - C  $\text{Cu}(\text{NO}_3)_2$
  - D  $\text{Zn}(\text{NO}_3)_2$
  - E  $\text{Pb}(\text{NO}_3)_2$
14. Which metal nitrate decomposes on heating to form the corresponding metal?
- A  $\text{AgNO}_3$
  - B  $\text{KNO}_3$
  - C  $\text{Cu}(\text{NO}_3)_2$
  - D  $\text{Zn}(\text{NO}_3)_2$
  - E  $\text{Pb}(\text{NO}_3)_2$
15. 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
16. Which atom has the smallest atomic radius?
- A H
  - B He
  - C Li
  - D Be
  - E B
17. Which atom has the lowest first ionization energy?
- A Na
  - B Mg
  - C Al
  - D Si
  - E P

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18. 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
19. Which metal is a liquid at room temperature and pressure?
- A Mercury
  - B Potassium
  - C Gold
  - D Silver
  - E Aluminium
20. Which gas has a dark brown colour?
- A Oxygen
  - B Hydrogen
  - C Nitrogen dioxide
  - D Water vapour
  - E Carbon dioxide
21. Which reaction will **not** take place?
- A  $2 \text{Na(s)} + 2 \text{H}_2\text{O(l)} \rightarrow 2 \text{NaOH(aq)} + \text{H}_2\text{(g)}$
  - B  $\text{ZnCO}_3 \text{(s)} \rightarrow \text{ZnO (s)} + \text{CO}_2 \text{(g)}$
  - C  $\text{Fe(s)} + \text{H}_2\text{SO}_4 \text{(aq)} \rightarrow \text{FeSO}_4 \text{(aq)} + \text{H}_2 \text{(g)}$
  - D  $\text{Mg(OH)}_2 \text{(s)} \rightarrow \text{MgO(s)} + \text{H}_2\text{O}$
  - E  $\text{Br}_2 \text{(l)} + 2 \text{KCl (aq)} \rightarrow \text{Cl}_2 \text{(g)} + 2 \text{KBr (aq)}$
22. The relative atomic mass of nitrogen is 14. This means that
- A a nitrogen atom is 14 times as heavy as a carbon-12 atom.
  - B a carbon-12 atom is 14 times as heavy as a nitrogen atom.
  - C a nitrogen atom is 14 times as heavy as 1/12 the mass of a carbon-12 atom.
  - D a carbon-12 atom is 14 times as heavy as 1/12 the mass of a nitrogen atom.
  - E an atom of nitrogen contains 14 electrons.
23. The relative molecular mass of carbon dioxide( $\text{CO}_2$ ) gas is 44. Which statement is **not** true?
- A One mole of carbon dioxide weighs 44 g.
  - B One mole of carbon dioxide occupies a volume of  $22.4 \text{ dm}^3$  at s.t.p.
  - C One mole of carbon dioxide contains  $6.02 \times 10^{23}$  molecules of carbon dioxide.
  - D One mole of carbon dioxide contains  $2 \times 6.02 \times 10^{23}$  atoms of oxygen.
  - E One mole of carbon dioxide contains  $44 \times 6.02 \times 10^{23}$  molecules.
24. The equation represents the reaction of oxalic acid( $\text{H}_2\text{C}_2\text{O}_4$ ) with potassium permanganate( $\text{KMnO}_4$ ) in the presence of sulphuric acid:
- $$5 \text{H}_2\text{C}_2\text{O}_4 + 2 \text{KMnO}_4 + 3 \text{H}_2\text{SO}_4 \rightarrow 2 \text{MnSO}_4 + \text{K}_2\text{SO}_4 + 10 \text{CO}_2 + 8 \text{H}_2\text{O}$$
- How many moles of  $\text{H}_2\text{C}_2\text{O}_4$  will exactly react with 0.020 mol  $\text{KMnO}_4$ ?
- A 0.008 mol
  - B 0.050 mol
  - C 0.060 mol
  - D 0.14 mol
  - E 2.0 mol

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25. Which compound contains closest to 50%, by mass, of oxygen?
- A CO<sub>2</sub>
  - B H<sub>2</sub>O
  - C CO
  - D NO<sub>2</sub>
  - E SO<sub>2</sub>
26. Every molecule of the compound, benzene, contains 6 carbon atoms and 6 hydrogen atoms. Which statement is **incorrect**?
- A The molecular formula of benzene is C<sub>6</sub>H<sub>6</sub>.
  - B The empirical formula of benzene is CH
  - C Benzene is polyatomic.
  - D Each benzene molecule weighs 78 amu.
  - E The relative molecular mass of benzene is 78 g mol<sup>-1</sup>.
27. Which is the best description of a chemical system in dynamic equilibrium?
- 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.
28. Consider the reaction:  $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g})$        $\Delta H$  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 the temperature.
  - D Increase the pressure by reducing the volume of the mixture.
  - E The use of a suitable catalyst.
29. Which of the following can be an electrolyte?
- A A liquid covalent compound.
  - B A graphite rod.
  - C Solid sodium chloride.
  - D Molten sodium chloride.
  - E None of the above.
30. 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.

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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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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, Cu = 64, , Zn = 65.

1. Complete the table. [3]

Name of compound	Formula	Name of compound	Formula
Magnesium oxide			$\text{Fe}(\text{OH})_3$
Copper (II) nitrate			$(\text{NH}_4)_2\text{Cl}$
Nitric acid			$\text{NO}_2$

2. This question concerns the reactivity of the metals calcium, copper, magnesium, silver, sodium, zinc.

- List these six metals in order of **decreasing** reactivity. [1]
- Which of these metals would **not** liberate hydrogen from dilute hydrochloric acid? [2]
- Which of these metals forms a hydroxide which would **not** decompose on heating? [1]
- Write a word equation followed by a balanced chemical equation for the thermal decomposition of copper(II) carbonate. [2]
  - Describe two things you expect to **observe** as copper(II) carbonate decomposes on heating. [2]
- 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.

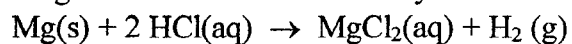
  - Write a word equation followed by a balanced chemical equation for the reaction of calcium with water. [2]
  - Explain the difference in the chemical behaviour of these two metals with water. [2]

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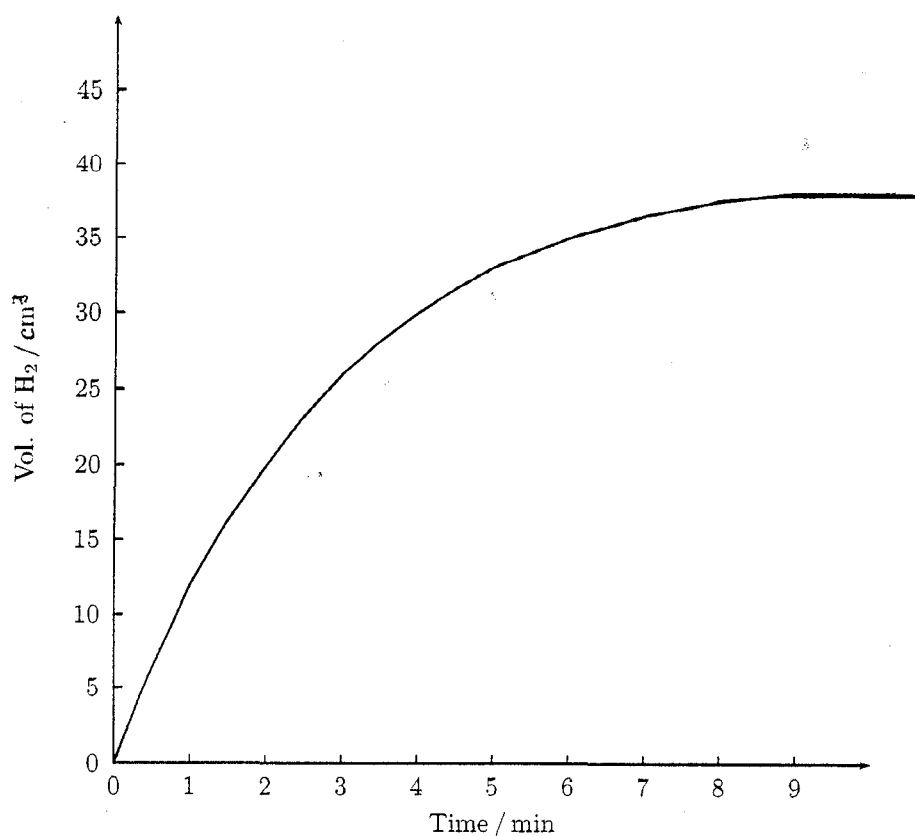
3. a) Define the term "relative molecular mass" [2]
- b) A certain birth control pill contains the hormone progesterone. The molar mass of progesterone is  $134 \text{ g mol}^{-1}$  and it is composed of 53.7 % carbon, 22.4% hydrogen and 23.9 % oxygen. Find the molecular formula of progesterone. [3]
4. Carbon dioxide gas can be produced by the reaction of dilute hydrochloric acid on calcium carbonate:  $\text{CaCO}_3 (\text{s}) + 2 \text{HCl} (\text{aq}) \rightarrow \text{CaCl}_2 (\text{aq}) + \text{CO}_2 (\text{g}) + \text{H}_2\text{O} (\text{l})$
- a) How many  $\text{cm}^3$  of carbon dioxide gas, at s.t.p, can be obtained by the complete reaction of 3.0 mol HCl with excess  $\text{CaCO}_3$ ? [2]
- b) What mass of  $\text{CaCO}_3$  is required to exactly react with  $200 \text{ cm}^3$  of 2.0 M HCl ? [2]
- c) How many  $\text{cm}^3$  of 1.5 M HCl are required to react with excess  $\text{CaCO}_3$  to produce  $5.6 \text{ dm}^3$  of carbon dioxide gas at s.t.p.? [2]

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5. Magnesium metal reacts with hydrochloric acid to produce hydrogen gas:



A piece of magnesium ribbon was added to a solution of dilute hydrochloric acid. The volume of hydrogen released, at 25°C, over a period of time, was measured. The results are shown in the graph given.



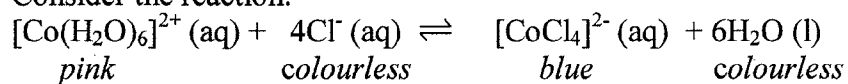
- a) From the graph, determine
- the volume of hydrogen formed in the first 3 minutes.[1]
  - the average rate of the reaction between the first and sixth minutes of the reaction.[2]
  - the maximum volume of hydrogen liberated.[1]
- b) Explain why the maximum volume of hydrogen could not increase any further.[1]
- c) On the graph sketch how the curve would look if powdered magnesium were used instead of magnesium ribbon.[2]
- d) The rate of this reaction would be faster if the reaction was carried out at 40°C instead of 25°C. Explain, in terms of the kinetic theory and collision theory, why reaction rate increases when the temperature of the reaction mixture increases.[3]



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

- a) Consider the reaction:



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

