

**THE COLLEGE OF THE BAHAMAS  
FACULTY OF PURE AND APPLIED SCIENCES  
SCHOOL OF NATURAL SCIENCES AND  
ENVIRONMENTAL STUDIES**

NASSAU:

FREEPORT:

**DEPARTMENT OF CHEMISTRY  
FINAL EXAMINATION FOR SEMESTER 012004  
COURSE NUMBER: 115  
COURSE TITLE: INTRODUCTORY CHEMISTRY**

DATE AND TIME:

DURATION: 2 HOURS

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**INSTRUCTIONS TO CANDIDATES:** The exam paper consists of 9 pages **exclusive** of this introductory page. Section A consists of **twenty** Multiple Choice Questions. These questions are to be answered on the Multiple-Choice answer sheet provided. Section B consists of **eight** short answer questions. These questions are to be answered in the spaces provided on this question paper. You are provided with a PERIODIC TABLE overleaf.

YOU MUST RETURN THE EXAMINATION PAPER AND YOUR MULTIPLE CHOICE ANSWER SHEET AT THE END OF THE EXAMINATION .

**LECTURER'S NAME:** .....

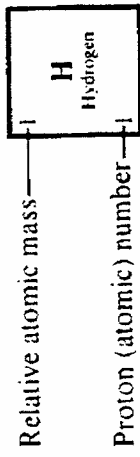
**STUDENT NAME:** .....

**STUDENT NUMBER:** .....

USEFUL INFORMATION:

- Avogadro's constant:  $6 \times 10^{23}$
- One mole of a gas at *stp* occupies  $22.4 \text{ dm}^3$

1 2 3 4 5 6 7 0



7	<b>Li</b> Lithium	9	<b>Be</b> Beryllium	11	<b>B</b> Boron	12	<b>C</b> Carbon	14	<b>N</b> Nitrogen	16	<b>O</b> Oxygen	19	<b>F</b> Fluorine	20	<b>Ne</b> Neon
3		4		5		6		7		8		9		10	
23	<b>Na</b> Sodium	24	<b>Mg</b> Magnesium	27	<b>Al</b> Aluminium	28	<b>Si</b> Silicon	31	<b>P</b> Phosphorus	32	<b>S</b> Sulphur	35.5	<b>Cl</b> Chlorine	40	<b>Ar</b> Argon
11		12		13		14		15		16		17		18	
39	<b>K</b> Potassium	40	<b>Ca</b> Calcium	59	<b>Co</b> Cobalt	63.5	<b>Cu</b> Copper	70	<b>Ga</b> Gallium	73	<b>Ge</b> Germanium	75	<b>As</b> Arsenic	79	<b>Se</b> Selenium
19		20		26		29		31		32		33		34	
85	<b>Rb</b> Rubidium	88	<b>Sr</b> Strontium	101	<b>Ru</b> Ruthenium	108	<b>Ag</b> Silver	115	<b>In</b> Indium	119	<b>Sn</b> Tin	122	<b>Sb</b> Antimony	127	<b>Te</b> Tellurium
37		38		44		47		49		50		51		52	
133	<b>Cs</b> Caesium	137	<b>Ba</b> Barium	190	<b>Os</b> Osmium	197	<b>Au</b> Gold	204	<b>Tl</b> Thallium	207	<b>Pb</b> Lead	209	<b>Bi</b> Bismuth	210	<b>Po</b> Polonium
55		56		76		79		81		82		83		84	
223	<b>Fr</b> Francium	226	<b>Ra</b> Radium	263	<b>Unh</b> Unil- hexium	263	<b>Unh</b> Unil- hexium	263	<b>Unh</b> Unil- hexium	263	<b>Unh</b> Unil- hexium	263	<b>Unh</b> Unil- hexium	263	<b>Unh</b> Unil- hexium
87		88		106		106		106		106		106		106	

TRANSITION ELEMENTS

140	<b>Ce</b> Cerium	141	<b>Pr</b> Praseo- dymium	144	<b>Nd</b> Neodymium	147	<b>Pm</b> Promethium	150	<b>Sm</b> Samarium	152	<b>Eu</b> Europium	157	<b>Gd</b> Gadolinium	159	<b>Tb</b> Terbium	162	<b>Dy</b> Dysprosium	165	<b>Ho</b> Holmium	167	<b>Er</b> Erbium	169	<b>Tm</b> Thulium	173	<b>Yb</b> Ytterbium	175	<b>Lu</b> Lutetium
58		59		60		61		62		63		64		65		66		67		68		69		70		71	
232	<b>Th</b> Thorium	231	<b>Pa</b> Protactinium	238	<b>U</b> Uranium	237	<b>Np</b> Neptunium	242	<b>Pu</b> Plutonium	243	<b>Am</b> Americium	247	<b>Cm</b> Curium	245	<b>Bk</b> Berkelium	251	<b>Cf</b> Californium	254	<b>Es</b> Einsteinium	253	<b>Fm</b> Fermium	256	<b>Md</b> Mendelevium	254	<b>No</b> Nobelium	257	<b>Lr</b> Lawrencium
90		91		92		93		94		95		96		97		98		99		100		101		102		103	

\*58-71 Lanthanum series

\*90-103 Actinium series

**SECTION A: MULTIPLE CHOICE QUESTIONS**

Five possible answers **A, B, C, D, E** are given for each of the twenty questions in this section. Choose the one you consider to be correct and mark your response on the multiple choice answer sheet provided. Each question in this section is worth one mark, for a total of 20 marks.

**ORGANIC**

- 1 Alkenes typically undergo
- A substitution reactions
  - B addition reactions
  - C dehydration reactions
  - D esterification reactions
  - E neutralization reactions
- 2 Which one of the following statements about the homologous series of alkanes is correct?
- A The general formula of the alkanes is  $C_nH_{2n}$ .
  - B They are all gases at room temperature and pressure.
  - C Each member of the series is an isomer of the next member in the series.
  - D Each member of the series differs from the next member in the series by  $CH_2$ .
  - E They are all soluble in water.
- 3 The process known as 'cracking' involves
- A separating crude oil into fractions.
  - B removing water from ethanol molecules.
  - C removing hydrogen from an alkane molecule.
  - D breaking alkane molecules into smaller alkane and alkene molecules.
  - E breaking a polymer into its monomer.

**THE MOLE CONCEPT**

- 4 If the relative molecular mass of a compound is 95, then
- A One mole of the compound has a mass of 95g.
  - B One molecule of the compound has a mass of 95g.
  - C One mole of the compound has  $95 \times 6 \times 10^{23}$  molecules.
  - D The empirical formula of this compound is the same as the molecular formula.
  - E One mole of the compound has a mass that is 95 times the mass of the  $^{12}_6C$  isotope of carbon.
- 5 2.0 moles of ammonium carbonate,  $(NH_4)_2CO_3$  contains
- A 8 mol of hydrogen atoms.
  - B 2.0 mol of oxygen molecules.
  - C  $16 \times 6 \times 10^{23}$  mol of nitrogen atoms.
  - D 2.0 mol of carbon atoms.
  - E 6.0 mol of carbonate ions.
- 6 What is the molarity of a solution containing 4.0 g of sodium hydroxide (RFM=40) in 100  $cm^3$  of solution?
- A 1.0 M
  - B 0.10 M
  - C 0.04 M
  - D 0.40 M
  - E 4000 M
- 7 The number of molecules of oxygen gas,  $O_2$ , in 5.6  $dm^3$  at *stp* is
- A  $1.5 \times 10^{23}$
  - B  $5.6 \times 10^{23}$
  - C  $6 \times 10^{23}$
  - D  $2.4 \times 10^{24}$
  - E  $3.6 \times 10^{24}$

**THE REACTIVITY SERIES**

- 8 When dilute hydrochloric acid was mixed with a sample of solid **Q**, a colorless gas was produced. This gas turned lime-water cloudy. When a flame test was conducted on sample **Q** a lilac flame was obtained. The most likely identity of **Q** is
- A sodium carbonate
  - B calcium oxide
  - C potassium carbonate
  - D sodium hydrogencarbonate
  - E potassium hydroxide
- 9 Which compound gives *only oxygen as a gaseous product* on heating?
- A lead(II) nitrate
  - B copper(II) nitrate
  - C calcium nitrate
  - D potassium nitrate
  - E silver nitrate
- 10 When heated, the carbonate of a metal **X** decomposes more rapidly than zinc carbonate, but the metal **X** will displace copper from a solution containing  $\text{Cu}^{2+}$  ions. The metal **X** could be
- A silver
  - B magnesium
  - C mercury
  - D zinc
  - E lead
- 12 Element **W** is an alkaline earth metal in period 3. What would the electron configuration of this element be?
- A 2, 8, 1
  - B 2, 8, 2
  - C 2, 8, 8, 2
  - D 2, 8, 3
  - E 2, 8, 8
- 13 An element **X** in group **I**, forms a compound with an element **Y** in group **VI**. The most likely formula for this compound is
- A XY
  - B  $\text{XY}_6$
  - C  $\text{X}_2\text{Y}$
  - D  $\text{XY}_2$
  - E  $\text{X}_6\text{Y}$
- 14 The atom with the largest first ionization energy is
- A Li
  - B Na
  - C K
  - D Rb
  - E Cs

**THE PERIODIC TABLE**

- 11 The collective term for the elements on the far right side of the periodic table is
- A alkali metals
  - B halogens
  - C alkaline earth metals
  - D inert gases
  - E transition metals
- 15 The atom with the smallest atomic radius is
- A Na
  - B Mg
  - C Al
  - D Si
  - E P

**ELECTROCHEMISTRY**

16 Each of the following substances was electrolysed. In which case would the products at BOTH electrodes be gaseous at r.t.p.?

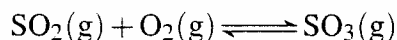
- A molten sodium chloride
- B aqueous copper(II) sulphate
- C molten copper(II) bromide
- D dilute hydrochloric acid
- E aqueous silver nitrate

17 During electrolysis of molten potassium bromide,

- A potassium ions are oxidized at the cathode.
- B potassium ions are reduced at the cathode.
- C bromide ions are oxidized at the cathode.
- D bromide ions are reduced at the anode.
- E potassium ions are oxidized at the anode.

**RATE AND EQUILIBRIUM**

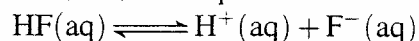
18 In the equilibrium system below, which of the following actions will cause the equilibrium position to shift to the right?



- A the addition of a suitable catalyst.

- B addition of sulfur trioxide gas.
- C removal of oxygen gas.
- D an increase in the pressure.
- E an increase of the container volume.

19 An aqueous solution of hydrofluoric acid, HF, is at equilibrium.



When the pH of the solution is increased the equilibrium shifts to the right. Which compound could have caused these changes when added to the solution of hydrofluoric acid?

- A HCl
- B NaCl
- C NaOH
- D NaF
- E Au(s)

20 For a chemical reaction which has reached equilibrium which statement is true?

- A the reaction has stopped.
- B the rate of the forward reaction is decreasing.
- C the rate of the forward and reverse reactions are equal.
- D there is always more products than reactants.
- E the reactants always have more potential energy than the products.

**SECTION B: SHORT ANSWER QUESTIONS**

Answer **ALL OF THE FOLLOWING EIGHT QUESTIONS** in the space provided on your question paper. Indicate clearly how you arrive at your answers. This section is worth 75 marks.

- 1 A sulphur-oxygen compound is 50.1% sulphur and 49.9% oxygen by mass, and has a molar mass of  $64 \text{ g mol}^{-1}$ .

(a) Calculate the empirical formula of the compound. (3 marks)

(b) Determine its molecular formula. (3 marks)

(c) Would you expect this oxide of sulphur to be ionic or covalently bonded?(1 mark)

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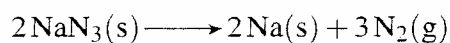
(d) i.) Write a balanced equation for the hydrolysis of this compound in water.  
(2 marks)

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ii.) How would you expect the resulting solution to affect litmus paper? (1 mark)

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- 2 "Air" bags for automobiles, are inflated during a collision by the explosion of sodium azide,  $\text{NaN}_3$ . The equation for the decomposition is,



- (a) Is it air that inflates an "Air" bag? Explain. (3 marks)

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- (b) If 57 g of sodium azide are decomposed during a collision,

- i.) how many moles of nitrogen gas are produced? (3 marks)

- ii.) If one mole of an ideal gas occupies  $18.8 \text{ dm}^3$  at 1.3 atm pressure and 298 K, what volume of nitrogen gas will be produced during the collision at this temperature and pressure? (2 marks)

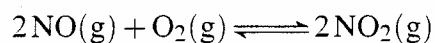
- (c) "Air" bags also contain the compounds  $\text{KNO}_3$  and  $\text{SiO}_2$  as well as sodium azide. Suggest a purpose for the presence of these compounds in the "air" bag. (Hint: look at the equation for the decomposition of sodium azide). (2 marks)

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- 3 (a) Calculate the molarity of caffeine in a 12 ounce (1 ounce = 29.6 cm<sup>3</sup>) cola drink containing 0.050 g caffeine, C<sub>8</sub>H<sub>10</sub>N<sub>4</sub>O<sub>2</sub>. (4 marks)
- (b) What is the molarity of the cola drink in part a) if it is diluted with 25.0 cm<sup>3</sup> of water? (3 marks)
- (c) Cola drinks are usually 5.06 × 10<sup>-3</sup> M in phosphoric acid, H<sub>3</sub>PO<sub>4</sub>. What mass of this acid is present in a 250 cm<sup>3</sup> drink? (3 marks)

- 4 The reaction between nitrogen oxide and oxygen gas is exothermic,



Will the concentration of NO<sub>2</sub> at equilibrium decrease, increase or remain the same if (5 marks)

- (a) additional oxygen is introduced to the container? .....
- (b) additional NO is introduced? .....
- (c) the total pressure is decreased? .....
- (d) a catalyst is added? .....
- (e) the temperature is increased? .....



5 Write a balanced chemical equation for the reaction that occurs when the following compounds are heated with a bunsen flame. (10 marks)

- (a) copper(II) nitrate crystals .....
- (b) potassium nitrate crystals .....
- (c) zinc carbonate powder .....
- (d) hydrated copper(II) sulphate crystals .....
- (e) anhydrous sodium hydrogencarbonate .....

6 This question concerns the reactivity of the metals magnesium, copper, zinc and silver.

- (a) Place the four metals in order of reactivity, putting the most reactive metal first. (2 marks)

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- (b) State which of these metals react with dilute hydrochloric acid and give equations for the reactions which occur. (4 marks)

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- (c) Describe what you would see when a strip of copper is placed in a solution of silver nitrate. Give the net ionic equation for the reaction occurring. (4 marks)

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7 (a) Consider the hydrocarbon  $C_4H_8$ .

i.) What is the name of this hydrocarbon? (1 mark)

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ii.) Is this hydrocarbon saturated or unsaturated? (1 mark)

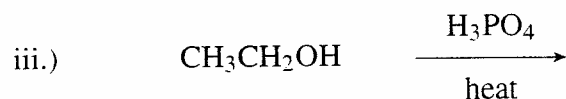
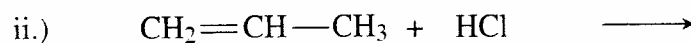
.....

iii.) Write a balanced chemical equation for the complete combustion of the hydrocarbon. (2 marks)

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iv.) Write down condensed structural formula for three isomers of  $C_4H_8$ . (3 marks)

(b) Write the structure of the *organic product* formed in each of the following reactions. (3 marks)



8 A 10 g block of calcium carbonate was placed in a conical flask with excess dilute hydrochloric acid at room temperature. The calcium carbonate reacted with the acid and produced much effervescence.

(a) Write a balanced equation for this reaction. (2 marks)

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(b) What causes the effervescence observed? (1 mark)

.....

(c) What effect would increasing the temperature of the acid have on the reaction rate? (1 mark)

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(d) Explain, with reference to collision theory, why increasing the temperature has this effect on reaction rate. (2 marks)

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(e) If you used 10 g of powdered calcium carbonate instead of the block,

i.) the effect this change would have on the initial rate of the reaction, (1 mark)

.....

ii.) the effect this change would have on the total amount of gas formed. (1 mark)

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iii.) Give a reason for your answer to part ii). (2 marks)

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