

THE COLLEGE OF THE BAHAMAS

EXAMINATION

SEMESTER 02-2004

FACULTY OF PURE AND APPLIED SCIENCES

SCHOOL OF NATURAL SCIENCES AND ENVIRONMENTAL STUDIES

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FREEPORT
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DATE AND TIME OF EXAMINATION: Monday, June 28, 2004 at 2 p.m.

DURATION: 3 HOURS

COURSE NUMBER: CHEM 115

COURSE TITLE: INTRODUCTORY CHEMISTRY

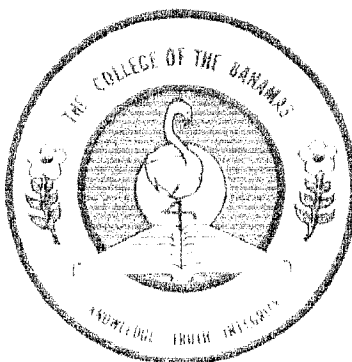
STUDENT NAME:

STUDENT NUMBER:

LECTURER'S NAME:

INSTRUCTIONS TO CANDIDATES: This paper has 9 pages and 45 questions. Please follow instructions given.

COLLEGE OF THE BAHAMAS
DIVISION OF NATURAL SCIENCES AND ENVIRONMENTAL STUDIES
FINAL EXAMINATION, SEMESTER 02-2004
CHEMISTRY 115: INTRODUCTORY CHEMISTRY
TIME: 3 HOURS
CODE: R



DATE AND TIME:

INSTRUCTIONS TO CANDIDATES

COMPLETE THE FOLLOWING CAREFULLY

YOUR LECTURER'S NAME _____

YOUR SECTION NO. _____

YOUR STUDENT NO. _____

(FOR OFFICIAL USE ONLY)

SECTION A: MULTIPLE CHOICE QUESTIONS

INSTRUCTIONS: Answer ALL questions in this section. Select the single best alternative and mark it on the ANSWER SHEET PROVIDED.

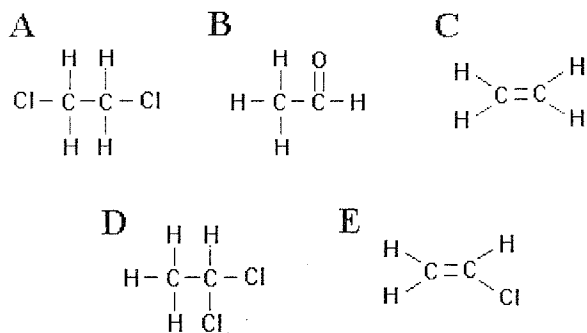
The following information may be required: RAM of H = 1, C = 12, N = 14, O = 16, Na = 23, Mg = 24, Si = 28, P = 31, S = 32, Cl = 35.5, Fe = 56 The molar volume of any gas at s.t.p. is 22.4 dm³mol⁻¹. Avogadro's number is 6 × 10²³.

ORGANIC

- 1) A gaseous hydrocarbon reacts slowly with bromine to form a mixture of bromoalkanes and hydrogen bromide. Which one of the following formulae could correctly represent the hydrocarbon?

- A C₂H₄
 B C₂H₆
 C C₂H₂
 D C₃H₆
 E C₃H₄

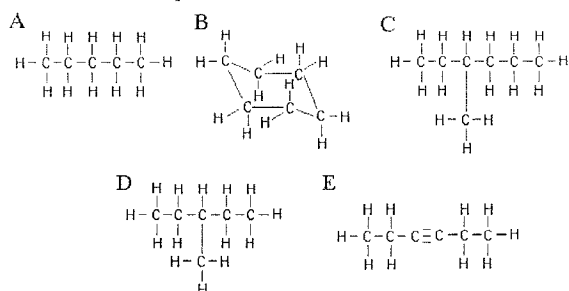
- 2) Which one of the following compounds can be made by an addition reaction of ethene?



- 3) Which one of the following statements about the homologous series of alkenes is correct?

- A Their general formula is C_nH_{2n}.
 B They all contain the group >C≡C<.
 C They are all gases at room temperature and pressure.
 D Each member of the series is an isomer of the next member in the series.
 E The molecules all contain at least one methyl group, CH₃.

- 4) Which one of the following structural formulae represents an isomer of hexane?



- 5) Which one of the following correctly explains why a wick is necessary in a candle?

- A A wick allows a small portion of the wax to vaporise.
 B A wick maintains the flame by burning itself.
 C A wick allows the wax to come into contact with oxygen.
 D A wick prevents the candle from breaking easily.
 E A wick prevents the flame from getting too hot.

- 6) When an alcohol reacts with a carboxylic acid in the presence of an acid catalyst

- A An alkene is formed.
 B An ester is formed.
 C An alkane is formed.
 D A hydrocarbon is formed.
 E A carbohydrate is formed.

- 7) Methane may be prepared in the laboratory by the action of

- A heat on sodium ethanoate.
 B heat and soda lime on sodium ethanoate.
 C heat on sodium methanoate.
 D heat and soda lime on sodium methanoate.
 E heat and soda lime on sodium carbonate.

- 8) Which one of the following is NOT true of a homologous series?

- A Each member differs from the next by CH₂.
 B Each member conforms to a general formula.
 C There is a gradation of chemical properties.
 D There is a gradation of physical properties.
 E Each member has the same formula.

- 9) The name 2-bromoethane is not used because

- A no such compound exists.
 B it is much less stable than 1-bromoethane.
 C it is best named bromoethane without the number.
 D bromine does not form compounds.
 E ethane does not form compounds.

THE MOLE CONCEPT

- 10) Which one of the following contains the greatest proportion of nitrogen by mass?
- | | COMPOUND | RFM |
|---|------------------------------|------|
| A | $(\text{NH}_4)_2\text{SO}_4$ | 132 |
| B | $(\text{NH}_4)_2\text{CO}_3$ | 96 |
| C | NH_4NO_3 | 80 |
| D | $(\text{NH}_4)_3\text{PO}_4$ | 149 |
| E | NH_4Cl | 53.5 |
- (RAM of N = 14)
- 11) The relative atomic mass of an element shows
- the number of electrons in an atom of the element.
 - the number of protons in an atom of the element.
 - the total number of particles in an atom of the element.
 - the mass of an atom of the element in grams.
 - the mass of an atom of the element compared with 1/12th the mass of an atom of carbon-12.
- 12) Which one of the following statements regarding the elements hydrogen and oxygen under the same conditions of temperature and pressure is true?
- One mole of each will occupy a different volume at s.t.p.
 - One mole of each will have the same mass.
 - One mole of each will occupy the same volume if they are solidified.
 - One mole of each will occupy the same volume if they are liquefied.
 - One mole of each will contain the same number of molecules.
- 13) Which one of the following masses of anhydrous sodium carbonate (Na_2CO_3 , RFM=106) contains 0.005 moles of this substance?
- 0.255g
 - 21200g
 - 5.3g
 - 0.53g
 - 106g
- 14) Which one of the following correctly expresses the number of moles in 0.085g of ammonia gas (NH_3 , RFM=17)?
- 22.4
 - 22.4×0.085
 - $0.085 \div 17$
 - $17 \div 0.085$
 - 0.085×17
- 15) Which one of the following correctly expresses the number of molecules present in 5.6 dm^3 of sulphur dioxide gas (SO_2) at s.t.p.?
- 6×10^{23}
 - $5.6 \times 6 \times 10^{23}$
 - $64 \times 6 \times 10^{23}$
 - $(5.6 \div 22.4) \times 6 \times 10^{23}$
 - $22.4 \times 6 \times 10^{23}$
- 16) 2 moles of silicon tetrachloride (SiCl_4) contain:
- 4 moles of chlorine atoms.
 - 8 *molecules* of chlorine.
 - 1 mole of silicon.
 - 1 mole of chlorine gas.
 - 8 moles of chlorine atoms.
- 17) A compound consists of 22.5% phosphorus and 77.5% chlorine. Which one of the following is the correct empirical formula of the compound? (RAM P=31, Cl=35.5)
- PCl_4
 - PCl_3
 - PCl
 - P_2Cl_3
 - P_3Cl
- 18) What mass of iron would contain the same number of atoms as 10g of silicon? (RAM Fe=56, Si=28)
- 5.0g
 - 5.6g
 - 2.8g
 - 20g
 - 10g

REACTIVITY SERIES

- 19) In which one of the following cases does **NO** change occur?
- Mg(s) added to $\text{ZnSO}_4(\text{aq})$.
 - Pb(s) added to $\text{ZnSO}_4(\text{aq})$
 - Pb(s) added to $\text{AgNO}_3(\text{aq})$
 - Fe(s) added to $\text{CuSO}_4(\text{aq})$
 - Fe(s) added to $\text{Pb}(\text{NO}_3)_2(\text{aq})$
- 20) Which one of the following metals is least affected chemically when heated in air?
- A Na B Zn C Ag D Mg E Fe**
- 21) Dilute hydrochloric acid will react readily with all of the following **EXCEPT**:
- magnesium
 - calcium carbonate
 - sodium hydroxide
 - copper
 - magnesium oxide

- 22) Which one of the following compounds does NOT decompose when heated in a bunsen flame?
 A silver carbonate
 B lead(II) carbonate
 C calcium carbonate
 D copper(II) carbonate
 E sodium carbonate
- 23) Which one of the following compounds 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
- 24) Which one of the following elements reacts with hydrogen to form a compound which dissolves in water to give a strongly acidic solution?
 A sodium
 B lithium
 C carbon
 D neon
 E chlorine
- 25) Which one of the following decreases in magnitude as you go down the group of alkali metals?
 A size of atom
 B number of electrons
 C number of protons
 D melting point
 E reactivity
- 26) Francium is at the bottom of Group I in the periodic table. Which one of the following predictions about the chemistry of this element and its compounds is LEAST likely to be correct?
 A The element will react with water to liberate hydrogen.
 B The hydroxide will be a strong alkali in aqueous solution.
 C The carbonate will decompose on heating at bunsen temperature to give carbon dioxide.
 D The nitrate will decompose on heating to give the nitrite and oxygen.
 E The element will form an ionic chloride.
- 27) Element X is in group VI of the periodic table. The oxides of element X are likely to be:
 A acidic
 B neutral
 C basic
 D amphoteric
 E non-existent
- 28) Which oxide dissolves in water to give a strongly alkaline solution?
 A carbon dioxide
 B magnesium oxide
 C sulphur dioxide
 D sodium oxide
 E copper(II) oxide
- 29) Zinc oxide dissolves in both dilute hydrochloric acid and dilute sodium hydroxide solution. Zinc oxide is therefore described as
 A amphoteric.
 B neutral.
 C acidic.
 D basic.
 E soluble in water.

PERIODIC TABLE

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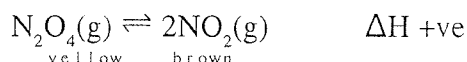
ELECTROCHEMISTRY AND REDOX

- 30) When dilute sulfuric acid is electrolysed, the reaction at the cathode can be expressed as
 A $2\text{H}^+(\text{aq}) \rightarrow \text{H}_2(\text{g}) + 2\text{e}^-$
 B $4\text{OH}^-(\text{aq}) + 4\text{e}^- \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$
 C $2\text{SO}_4^{2-}(\text{aq}) \rightarrow 2\text{SO}_3^{2-}(\text{aq}) + \text{O}_2(\text{g})$
 D $2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$
 E $2\text{SO}_4^{2-}(\text{aq}) \rightarrow \text{S}_2\text{O}_8^{2-}(\text{aq}) + 2\text{e}^-$
- 31) Which one of the following is a correct definition of an oxidising agent?
 A an electron acceptor
 B an electron donor
 C a proton donor
 D a proton acceptor
 E an oxygen acceptor
- 32) In which one of the following reactions is hydrogen acting as an oxidising agent?
 A with iodine to give hydrogen iodide
 B with lithium to give lithium hydride
 C with nitrogen to give ammonia
 D with sulphur to give hydrogen sulphide
 E with oxygen to give water
- 33) Each of the following compounds is electrolysed, first molten, and then as an aqueous solution. For which one of the following compounds would the products of electrolysis most likely be the same?
 A copper(II) iodide
 B magnesium bromide
 C potassium iodide
 D sodium hydroxide
 E sodium chloride

RATE AND EQUILIBRIUM

- 34) Which one of the following is the best explanation for the effect of an increase in temperature on the rate of a reaction?
- A It increases the number of particles with the necessary activation energy.
 B It enables the reacting particles to collide at the correct angle.
 C It lowers the activation energy for the reaction.
 D It enables the activated complex to be more easily converted to the products.
 E It prevents product molecules from changing back into reactants.

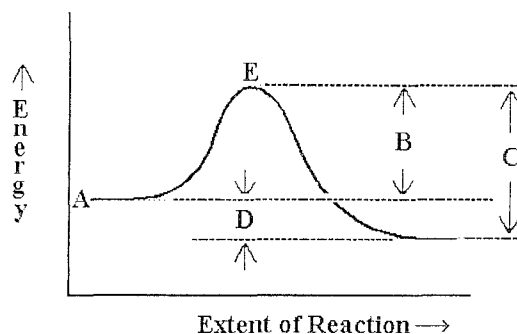
- 35) The brown gas prepared by the action of concentrated nitric acid on copper is an equilibrium mixture of dinitrogen tetroxide (pale yellow) and nitrogen dioxide (dark brown).



Which one of the following changes to a sample of the gas at equilibrium would result in a change from yellow to brown?

- A increase in pressure
 B increase in temperature
 C addition of a catalyst
 D removal of dinitrogen tetroxide by liquefaction
 E lowering of the temperature

Items 36 to 38 These involve the energy profile diagram for a reversible reaction shown below.



Select, from the diagram, the appropriate energy change A-E for each of the following items. Each letter may be used ONCE, MORE THAN ONCE, OR NOT AT ALL.

- 36) The heat change of the reaction
 37) Activation energy of the forward reaction
 38) Activation energy of the reverse reaction

MISCELLANEOUS

- 39) Before carrying out a flame test on a substance, it is first moistened with concentrated hydrochloric acid. For which one of the following reasons is this done?
- A In order to clean the substance.
 B In order to form a relatively volatile chloride of the metal.
 C In order to make the substance more flammable.
 D In order to remove water from the substance.
 E In order to remove unwanted sodium ions.
- 40) Which one of the following gases will turn moist red litmus paper blue?
- A oxygen.
 B sulphur dioxide.
 C ammonia.
 D carbon dioxide.
 E hydrogen.

SECTION II: Short answer questions

Answer each of the following questions in the space provided on your question paper. Indicate clearly how you arrive at your answers. **Underline your answers** where appropriate.

- 1) This question concerns various aspects of organic chemistry. (14)
- a) i) Write a balanced chemical equation to show the first stage of the reaction between methane and chlorine gas in the presence of light, showing the structural formula of the organic product. Name the organic product. (3)

What *type* of reaction is this? (1)

- ii) Write a balanced chemical equation to show the reaction between ethene and chlorine gas, showing the structural formula of the product. Name the product. (3)

What *type* of reaction is this? (1)

- b) Ethene is converted to ethanol by heating ethene with water in the presence of sulfuric acid. Write an equation to represent the overall reaction showing the structural formula of ethanol. (2)

- c) i) Write an equation to show what happens when ethanol is reacted with acidified potassium dichromate solution, showing the structural formula of the organic product. You may represent the acidified potassium dichromate as [O]. Name the organic product. (3)

ii) What effect would a solution of this organic product have on litmus paper? (1)

- 2) This question concerns the reactivity series of metals as applied to magnesium, copper, zinc, and silver. (13)

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

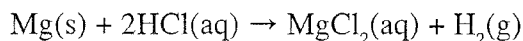
- b) State which of these metals react with dilute hydrochloric acid and give equations for the reactions which occur. (4)
-
-
-

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

- d) State which one of the above metals has a carbonate which decomposes to the metal if heated. Give an equation for this reaction. (3)

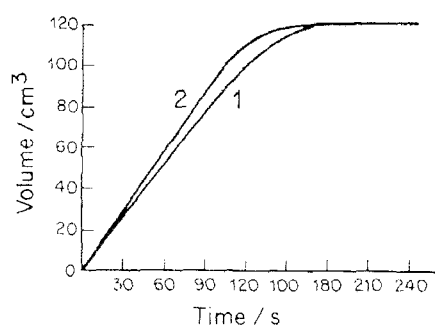
- 3) This question concerns the reaction between magnesium and dilute hydrochloric acid. Two experiments were performed to investigate the effect of the sizes of the pieces of magnesium ribbon on reaction rate. In experiment (1) a single piece of magnesium ribbon weighing 0.12g was allowed to react with 50cm³ of dilute hydrochloric acid (concentration 0.20mol dm⁻³) at room temperature in a suitable apparatus. The volume of hydrogen collected was noted at 15 second intervals. Experiment (2) was similar to the first except that the magnesium ribbon was cut into 20 pieces.

The equation for the reaction is as follows:



(The relative atomic mass of H=1 and of Mg=24. The molar volume of a gas at room temperature and pressure is 24000cm³mol⁻¹.)

The graph of the volume of gas evolved against time is plotted below. (13)



- a) Draw a fully-labelled diagram of the apparatus suitable for performing the above experiments. (4)

- b) i) What amount (in moles) of magnesium was used? (1)

- ii) What amount (in moles) of hydrochloric acid was used? (2)

- iii) What amount of hydrogen (in moles) had been produced after 180 seconds in both experiments? (2)

c) i) In which experiment was the initial reaction rate the fastest? (1)

ii) Why is there a difference in the initial reaction rates between the two experiments? (2)

iii) Why do the graphs become horizontal after 180 seconds? (1)

d) On the above graph sketch the corresponding curve (labelled 3) that you would expect to obtain if powdered magnesium were used instead of magnesium ribbon. (All other conditions are held the same.) (2)

4) This question concerns various aspects of electrolysis. (13)

a) Briefly explain what is meant by each of the following terms.
i) electrolyte (2)

ii) electrode (2)

b) When molten sodium chloride is electrolysed, what substance is liberated at
i) the cathode (1)

ii) the anode (1)

c) For the electrolysis of aqueous copper(II) sulphate solution using copper electrodes write half equations to show the process occurring at (4)

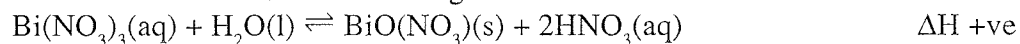
i) the cathode _____

ii) the anode: _____

The overall reaction of (c) above has an important industrial use. What is it? (1)

Mention two uses of copper. (2)

5) When bismuth nitrate is dissolved in water the following reversible reaction occurs:



a) What does the symbol \rightleftharpoons mean? (1)

b) Given that precipitate contains two types of ion, write the formulae of four of the ions present in an aqueous solution of bismuth nitrate. (2)

c) What do you observe if
i) the solution of bismuth nitrate is tested with litmus paper? (1)

ii) a piece of magnesium ribbon is added to the bismuth nitrate solution. What do you observe? (2)

d) What could be added to the bismuth nitrate solution in order to remove the precipitate? (1)

e) If the solution were warmed, what would happen to the precipitate? Explain your answer. (3)

f) The precipitate is quickly filtered off. How is the concentration of bismuth nitrate affected? (1)