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

NASSAU: [X] FREEPORT:

DEPARTMENT OF CHEMISTRY
FINAL EXAMINATION FOR SEMESTER 042003, 2003
COURSE NUMBER: 115
COURSE TITLE: INTRODUCTORY CHEMISTRY

DATE AND TIME: DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES: The exam paper consists of 7 pages **exclusive** of this introductory page. Section A consists of **thirty-five** Multiple Choice Questions. These questions are to be answered on the Multiple-Choice answer sheet provided. Section B consists of **six** 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: 6×10^{23}
- One mole of a gas at *stp* occupies $22.4\,\mathrm{dm}^3$

Chemistry Department
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SECTION A: MULTIPLE CHOICE QUESTIONS

Five possible answers **A, B, C, D, E** are given for each of the thirty-five 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 35 marks.

ORGANIC

1 Which compound is an alkane?

A C_2H_4
B C_3H_6
C C_6H_6
D C_4H_6
E C_4H_{10}

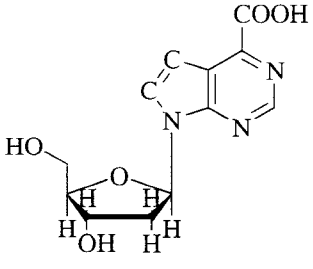
2 Alkenes typically undergo

A substitution reactions
B addition reactions
C dehydration reactions
D esterfication reactions
E neutralization reactions

3 The name of the ester obtained by reaction of $CH_3CH_2CH_2CH_2OH$ with CH_3COOH in the presence of an acid catalyst is

A ethyl butanoate
B butyl ethanoate
C propyl ethanoate
D butyl propanoate
E ethyl ethanoate

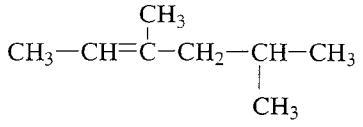
4 Three functional groups contained in this molecule



are

A halogen, alcohol, carboxylic acid
B alkene, alcohol, alkyne
C alkene, alcohol, carboxylic acid
D alkyne, ester, carboxylic acid
E halogen, alkene, alkyne

5 The correct systematic name for



is

A 2,4-dimethyl-4-butene
B 2,4-dimethyl-4-hexene
C 3,5,5-trimethyl-2-pentene
D 3,5-dimethyl-2-hexene
E 2,4-dimethyl-2-hexane

6 The major organic product prepared from heating ethanol in the presence of sulfuric acid is

A ethoxyethane
B ethyl hydrogensulphate
C ethene
D ethane
E ethanoic acid

7 How many structural (constitutional) isomers are there of formula C_4H_{12}?

A 1
B 2
C 3
D 4
E 5

8 Which one of the following statements about the homologous series of alcohols is correct?

A The general formula of the alcohols is $C_nH_{2n}OH$.
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 all have the functional group —COOH.

9 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

10 2 moles of ethanoic acid, CH_3COOH contain

A 2 moles of carbon atoms

B 4 moles of carbons atoms

C 6 moles of hydrogen atoms

D 2 moles of oxygen atoms

E 4 moles of hydrogen atoms

11 How many oxygen atoms are in 180 g of water?

A 1.8×10^2

B 1.8×10^{25}

C 6×10^{23}

D 6×10^{24}

E 10

12 What mass of oxygen is in 34.5 g of $Al_2O_3 \cdot 2H_2O$?
(RFM $Al_2O_3 \cdot 2H_2O$=138)

A 20 g

B 12 g

C 16 g

D 6.9 g

E not possible to determine from the information given.

13 The number of molecules of sulphur dioxide gas. SO_2, in 5.6 dm^3 at *stp* is

A 1.5 x 10^{23}

B 5.6 x 10^{23}

C 6 x 10^{23}

D 2.4 x 10^{24}

E 3.6 x 10^{24}

14 30 cm^3 of water is added to 50 cm^3 of a solution with molarity M at a constant temperature. After dilution the molarity of the solution is

A 3/5 M

B 3/8 M

C 5/8 M

D 8/5 M

E 5/3 M

15 How many moles of the first reactant would be required to react completely with one mole of the second reactant in the following chemical equation?
$C_5H_{12} + 8\,O_2 \longrightarrow 5\,CO_2 + 6\,H_2O$

A 0.125 mol

B 0.280 mol

C 1 mol

D 8 mol

E 18 mol

16 What mass of iron would contain the same number of atoms as 10 g of silicon? (RAM Fe=56, Si=28)

A 2.8 g

B 5.0 g

C 5.6 g

D 10 g

E 20 g

THE REACTIVITY SERIES

17 This element does not react readily with water or dilute hydrochloric acid. The element is most probably

A iron

B zinc

C potassium

D magnesium

E silver

18 Which compound does NOT decompose when heated in a bunsen flame?

A silver oxide

B lead(II) carbonate

C sodium oxide

D copper(II) nitrate

E sodium nitrate

19 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

20 A metal hydroxide decomposes readily on heating to give the metal and water vapour. The metal could be

A sodium

B potassium

C zinc

D copper

E silver

21 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 Cu^{2+} ions. The metal X could be

A silver

B magnesium

C mercury

D zinc

E lead

THE PERIODIC TABLE

22 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

23 Which statement is correct?

A All elements in a group have the same number of valence electrons.

B All elements in a period have the same number of valence electrons.

C Elements in a group always lose their electrons.

D Elements in a period always gain electrons.

E Elements in a group always form ionic bonds with other elements in the same group.

24 Element W is an alkaline earth metal in period 4. 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

25 Which oxide dissolves in water to give a strongly acidic solution?

A carbon dioxide

B magnesium oxide

C sulphur trioxide

D copper(II) oxide

E sodium oxide

26 An element X in group **II.** forms a compound with an element Y in group **VII.** The most likely formula for this compound is

A XY

B X_2Y_7

C X_2Y

D XY_2

E X_7Y_2

27 The atom with the smallest atomic radius is

A Na

B Mg

C Al

D Si

E P

ELECTROCHEMISTRY

28 If a metal is above hydrogen in the reactivity series. electrolysis of dilute aqueous solutions of its salts produce

A metals at the cathode
B metals at the anode
C oxygen gas at the cathode
D hydrogen gas at the cathode
E hydrogen gas at the anode

29 In electrolysis the cathode

A is the electrode where oxidation occurs.
B is the electrode where reduction occurs.
C is positive.
D dissolves during the electrolytic process.
E does not conduct electricity.

30 Each of the following compounds is electrolysed. first molten. and then as a solution. For which compound would the products of electroylsis most likely be the same?

A copper(II) iodide
B magnesium bromide
C potassium iodide
D sodium hydroxide
E sodium chloride

RATE AND EQUILIBRIUM

31 The rate of reaction approximately doubles for each 10°C increase in temperature. If a certain reaction in the gaseous state takes 120 s at 20°C, how long will it take at 50°C?

A 120 s
B 240 s
C 480 s
D 960 s
E 1920 s

32 According to collison theory. the rate of reaction increases with increasing temperature because

A the frequency of collision increases as well as the number of molecules with the necessary activation energy.
B the number and kind of colliding molecules increases.
C the activation energy increases.
D the surface area of the molecules increases.
E the force and frequency of collision with the walls of the containing vessel increases.

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

$$N_2O_4(g) \rightleftharpoons 2\,NO_2(g) \quad \Delta H = +ve$$

Which 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 tetraoxide by liquefaction
E lowering of the temperature

34 An aqueous solution of hydrofluoric acid. HF, is at equilibrium.
$HF(aq) \rightleftharpoons H^+(aq) + F^-(aq)$
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)

35 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 SIX QUESTIONS*** in the space provided on your question paper. Indicate clearly how you arrive at your answers. This section is worth 42 marks.

1 A phosphorus-chlorine compound is 22.54% phosphorus and 77.46% chlorine by mass. and has a molar mass of $137.5\,\mathrm{g\,mol^{-1}}$.

(a) Calculate the empirical formula of the compound. (2 marks)

(b) Determine its molecular formula. (2 marks)

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

.....

2 Trimethyl aluminium $Al(CH_3)_3$. is an extremely reactive compound which bursts into flames in the presence of oxygen. It can be prepared from the reaction of aluminium metal and dimethyl mercury. $Hg(CH_3)_2$. The balanced chemical equation for this reaction is.

$$2\,Al(s) + 3\,Hg(CH_3)_2(l) \longrightarrow 2\,Al(CH_3)_3(l) + 3\,Hg(l)$$

If 5.4 g of aluminium metal react with excess dimethyl mercury

(a) Calculate the mass of trimethyl aluminium produced. (3 marks)

(b) Calculate the mass of liquid mercury formed. (2 marks)

(c) If the liquid mercury formed in this reaction could exist as an gas at standard temperature and pressure. what volume would it occupy? (2 marks)

3 (a) How many moles of HCl are present in $15\,cm^3$ of 6 M HCl? (2 marks)

(b) What is the molarity of the solution formed when $15\,cm^3$ of 6.00 M HCl is diluted with $25.0\,cm^3$ of water? (2 marks)

(c) How many moles of HCl are present in the diluted solution? (1 mark)

4 The water-gas process for producing hydrogen. reacts methane and steam at high temperature:

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3\,H_2(g) \quad \Delta H = +ve$$

Express the effect that each of the following changes will have on the water-gas equilibrium. Express the effect with the words, 'shifts right', 'shifts left' or 'no shift'. (4 marks)

(a) decrease temperature .....

(b) increase total pressure .....

(c) catalyst added .....

(d) remove steam .....

5 Predict the products of the following reactions and write a balanced equation. including states symbols. in each case. If there is no chemical change. write "no reaction". (10 marks)

(a) $Zn(s) + H_2SO_4(aq) \longrightarrow$ .....

(b) $Ag(s) + HCl(aq) \longrightarrow$ .....

(c) $K(s) + H_2O(l) \longrightarrow$ .....

(d) $Pb(NO_3)_2(s) + \text{heat} \longrightarrow$ .....

(e) $Cu(s) + AgNO_3(aq) \longrightarrow$ .....

6 Some manganese(IV) oxide was added to a solution of hydrogen peroxide. Oxygen gas was liberated during the reaction $2\,H_2O_2(aq) \longrightarrow O_2(g) + 2\,H_2O(l)$ and collected in a syringe. The apparatus is shown in Figure 1. Figure 2 shows the volume of oxygen in cm^3, measured at stp, at various times after the start of the reaction.

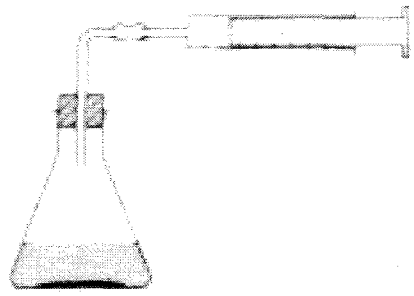


Figure 1: apparatus for measuring the volume of oxygen liberated during the reaction.

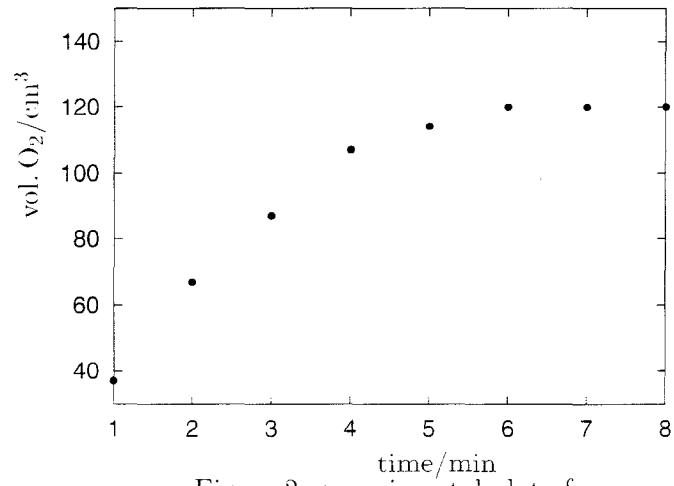


Figure 2: experimental plot of the volume of oxygen in cm^3 at minute intervals

(a) Join the points on the graph with a 'best fit' curve. (1 mark)

(b) What is the purpose of the manganese(IV) oxide in the reaction mixture? (1 mark)

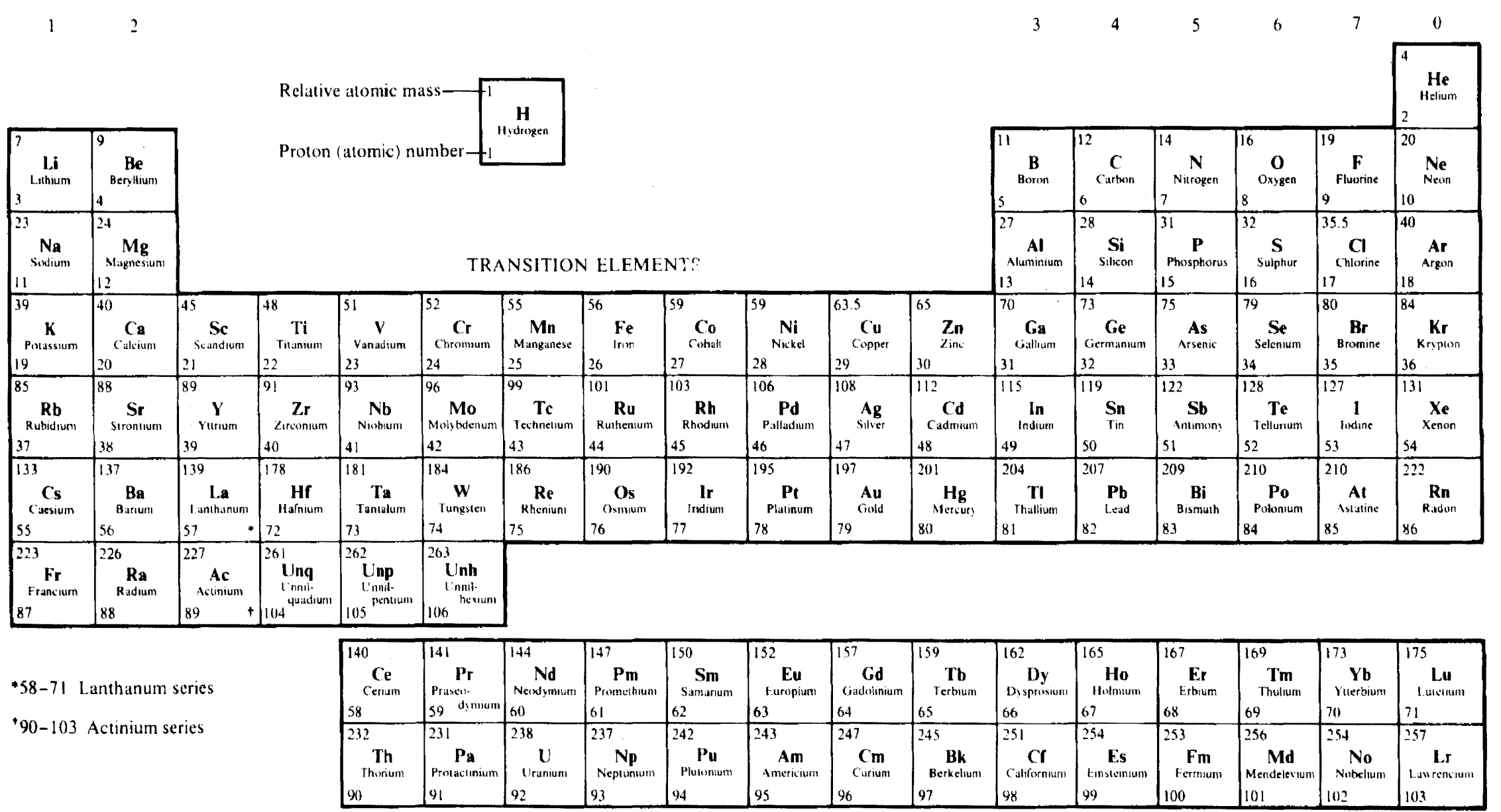
.....

(c) What is the total number of moles of oxygen formed in this reaction? (3 marks)

(d) Determine the *average rate* of production of oxygen in $cm^3\,s^{-1}$ during the first and fourth minutes of this reaction? (3 marks)

(e) On your graph. sketch the curve that you would predict if the reaction were carried out at higher temperature. (2 marks)

† END OF EXAMINATION †



*58–71 Lanthanum series

†90–103 Actinium series