



Student name _____

CHEMISTRY

Unit 1

Trial Examination

QUESTION AND ANSWER BOOK

Total writing time: 1 hour 30 minutes

Section	Number of questions	Number of marks
A	20	20
B	10	75
Total		95

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, an approved scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 17 pages, with a detachable data sheet in the centrefold and a detachable answer sheet for multiple-choice questions inside the front cover.

Instructions

- Detach the data sheet from the centre of this book and the answer sheet for multiple-choice questions during reading time.
- Write your **name** in the space provided above on this page and on the answer sheet for multiple-choice questions.
- All written responses should be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.

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SECTION A**Specific instructions for Section A**

Section A consists of 20 multiple choice questions. Section A is worth approximately 20 per cent of the marks available. You should spend approximately 19 minutes on Section A.

Choose the response that is **correct** or **best answers the question**, and mark your choice on the multiple choice answer sheet according to the instructions on that sheet.

A correct answer is worth 1 mark. No mark will be given if more than one answer is shown for any question. Marks will **not** be deducted for incorrect answers. You should attempt every question.

Question 1

Late in the 19th century, Sir Joseph John Thomson proposed that atoms were not indivisible. Which constituent of the atom did Thomson discover?

- A. electron
- B. proton
- C. neutron
- D. nucleus

Question 2

Which one of the following alternatives lists the atoms of aluminium, calcium, chlorine and sulfur in order of **increasing** electronegativity?

- A. Ca, Al, S, Cl
- B. Al, S, Cl, Ca
- C. Cl, S, Al, Ca
- D. S, Ca, Al, Cl

Question 3

Which one of the following alternatives lists the atoms of chlorine, fluorine, magnesium and potassium in order of **increasing** atomic radius?

- A. K, Mg, Cl, F
- B. F, Mg, Cl, K
- C. K, F, Mg, Cl
- D. F, Cl, Mg, K

Question 4

Which of the following atoms has the greatest number of neutrons?

- A. ^{58}Fe
- B. ^{57}Co
- C. ^{56}Mn
- D. ^{56}Ni

Question 5

In the ground state, the electrons of a potassium **ion** occupy

- A. 2 shells
- B. 3 shells
- C. 4 shells
- D. 5 shells

Question 6

The percentage, by mass, of carbon in sucrose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$, is closest to

- A. 12 %
- B. 27 %
- C. 33 %
- D. 42 %

Question 7

The mass, in grams, of **one molecule** of methane would be closest to

- A. 2.0×10^{-23}
- B. 2.3×10^{-23}
- C. 2.7×10^{-23}
- D. 9.6×10^{-25}

Question 8

If 31.8 g of copper is found to combine with oxygen to give 47.8 g of an oxide of copper, the mole ratio of Cu to O in this compound is?

- A. 1:1
- B. 1:2
- C. 2:1
- D. 2:3

Questions 9 and 10 refer to the following information.

Element	Electronic Configuration
R	$1s^2 2s^2 2p^6 3s^2 3p^6$
S	$1s^2 2s^2 2p^6 3s^2$
T	$1s^2 2s^2 2p^4$
U	$1s^2 2s^2 2p^2$

Question 9

The element in Period 2 and Group IV is

- A. element R
- B. element S
- C. element T
- D. element U

Question 10

The pair of elements most likely to form an ionic compound is

- A. element R and element S
- B. element S and element T
- C. element T and element U
- D. element U and element R

Question 11

How many lone pairs does the N atom have in its valence shell in an ammonia molecule, NH_3 ?

- A. 0
- B. 1
- C. 2
- D. 3

Question 12

Which of the following is **not** a property of an ionic compound

- A. malleability
- B. crystalline structure
- C. high melting temperature
- D. conduction of electricity when molten

Question 13

A substance melts at high temperature, is insoluble in water, and does not conduct electricity in both the solid and liquid states. This substance is most likely to be

- A. Al
- B. O_2
- C. CH_4
- D. SiO_2

Question 14

Which one of the following formulae represents a polar molecule?

- A. CH_4
- B. CCl_4
- C. CO_2
- D. CH_3Cl

Question 15

The number of hydrogen atoms present in butan-2-ol is

- A. 8
- B. 9
- C. 10
- D. 11

Question 16

212 mg of sodium carbonate, Na_2CO_3 , is weighed out in preparation for an experiment. The amount of sodium carbonate, in mol, in the sample corresponds to

- A. 1.0×10^{-3}
- B. 2.0×10^{-3}
- C. 1.0
- D. 2.0

Question 17

What amount, in mol, of ions is there in 0.50 mol of Na_2CO_3 ?

- A. 0.5
- B. 1.0
- C. 1.5
- D. 2.0

Question 18

The list contains molecular formulae of three organic compounds:

- I. $\text{C}_2\text{H}_4\text{O}_2$
- II. $\text{C}_2\text{H}_6\text{O}$
- III. $\text{C}_2\text{H}_6\text{O}_2$

The listed formulae that could represent carboxylic (alkanoic) acids are

- A. I only
- B. III only
- C. I and III only
- D. I, II, and III

Question 19

Which one of the following substances is **not** able to form an addition polymer?

- A. $\text{CH}_3(\text{CH}_2)_5\text{CHCHCl}$
- B. $\text{C}_2\text{H}_2\text{Cl}_2$
- C. $\text{C}_2\text{H}_3\text{Cl}$
- D. $\text{CH}_3\text{CHClCH}_2\text{Cl}$

Question 20

Nanochemistry has many emerging and very exciting applications. On which of the following scales does nanochemistry operate?

- A. 1.0 mm
- B. 1.0×10^{-3} mm
- C. 1.0×10^{-6} mm
- D. 1.0×10^{-9} mm

END OF SECTION A

SECTION B**Specific instructions for Section B**

Section B consists of ten short answer questions numbered 1 to 10; you must answer all of these questions. This section is worth 75 marks which is approximately 79 per cent of the total. You should spend approximately 71 minutes on this section.

The marks allotted to each question and the suggested times are shown at the end of each question. Questions must be answered in the spaces provided in this book.

To obtain full marks for your response you should

- give simplified answers with an appropriate number of significant figures for all numerical questions; unsimplified answers will not be given full marks.
- show all working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.
- make sure all chemical equations are balanced and that the formulas for individual substances include an indication of state (for example, $H_2(g)$; $NaCl(s)$).

Question 1

In 1864, John Newlands published his Periodic Table and his 'Law of Octaves' which stated that the properties of elements repeated every eighth element as shown below.

H	1	F	8	Cl	15	Co & Ni	22	Br	29	Pd	36	I	42	Pt & Ir	50
Li	2	Na	9	K	16	Cu	23	Rb	30	Ag	37	Cs	44	Tl	53
G(Be)	3	Mg	10	Ca	17	Zn	25	Sr	31	Cd	38	Ba & V	45	Pb	54
Bo(B)	4	Al	11	Cr	19	Y	24	Ce & La	33	U	40	Ta	46	Th	56
C	5	Si	12	Ti	18	In	26	Zr	32	Sn	39	W	47	Hg	52
N	6	P	13	Mn	20	As	27	Di & Mo	34	Sb	41	Nb	48	Bi	55
O	7	S	14	Fe	21	Se	28	Ro & Ru	35	Te	43	Au	49	Os	51

- a) i) How is this idea different to the modern Periodic Table, particularly in the first 20 elements?

- ii) Why was this idea different?

- b) Dimitri Mendeleev first announced his version of the Periodic Table around 1869 as shown below.

Group	→	I	II	III	IV	V	VI	VII	VIII
1	H (1)								
2	Li (7)	Be (9.4)	B (11)	C (12)	N (14)	O (16)	F (19)		
3	Na (23)	Mg (24)	Al (27.3)	Si (28)	P (31)	S (32)	Cl (35.5)		
4	K (39)	Ca (40)		Ti (48)	V (51)	Cr (52)	Mn (55)	Fe(56), Co(59) Ni(59), Cu(63)	
5	Cu (63)	Zn (65)			As (75)	Se (78)	Br (80)		
6	Rb (85)	Sr (87)	Yt? (88)	Zr (90)	Nb (94)	Mo (96)		Ru(104), Rh(104) Pd(106), Ag(108)	
7	Ag (108)	Cd (112)	In (113)	Sn (118)	Sb (122)	Te (125)	I (127)		
8	Cs (133)	Ba (137)	Di? (138)	Ce (140)					
9									
10			Er? (178)	La? (198)	Ta (182)	W (184)			Os(195), Ir(197) Pt(198), Au(199)
11	Au (199)	Hg (200)	Tl (204)	Pb (207)	Bi (208)				
12				Th (231)		U (240)			

- i) List two factors that Mendeleev used to devise his Periodic Table.
- ii) Other scientists around the same time such as John Newlands and Lothar Meyer had also developed Periodic Tables. Why was Mendeleev's Periodic Table more widely accepted?

(1 + 1 + 2 + 1 = 5 marks)
(Suggested time: 5 minutes)

Question 4

The element lithium, with $A_r = 6.90$, has two naturally occurring isotopes as shown in the Table below.

Identity of isotope	Relative isotopic mass
Lithium-6	6.015
Lithium-7	7.016

- a) Name the instrument used to determine relative isotopic mass.

- b) What does the relative refer to?

- c) Calculate the percentage of Lithium-6 in the sample.

- d) Write the full isotopic symbol (nuclide representation) for a Lithium-6 atom _____
(1 + 1 + 3 + 1 = 6 marks)
(Suggested time: 6 minutes)

Question 5

Methane (CH_4) is the major component of natural gas. When combusted in air, methane will produce carbon dioxide and water vapour.

- a) Write a balanced equation for the complete combustion of methane in air.

- If 80 g of methane is burnt in excess air:
- b) Calculate the amount, in mol, of methane.

- c) Determine the **number** of hydrogen atoms present in 80 g of methane?

- d) What is the percentage by mass of carbon in methane?

- e) Some of the other gases present with methane, before purification for use in the home, are hydrogen sulfide (H_2S) and carbon dioxide (CO_2). Draw the valence structure of **each** of these molecules and name its shape.

- Name of shape _____
- Name of shape _____
- (2 + 1 + 2 + 1 + 4 = 10 marks)
(Suggested time: 9 minutes)

Question 6

Complete the following table.

Name of compound	Formula of compound
	$\text{CH}_2\text{CHCH}_2\text{CH}_3$
	CH_3OH semi-structural formula required
butanoic acid	
	$\text{CH}_3\text{CH}_2\text{CHClCH}_3$

(4 × 1 = 4 marks)

(Suggested time: 4 minutes)

Question 7

- a) A student adds an iodine (I_2) crystal to each of two test tubes. One test tube contains 10 mL of water and the other 10 mL of hexane. Predict in which solvent the iodine will be most soluble. Explain your selection.

- b) Na_2S and H_2S have quite different physical properties.

- i) State two physical properties for each substance.

Na_2S : _____

H_2S : _____

- ii) Describe the **structure and bonding** in each substance to account for the different physical properties.

Na_2S : _____

H_2S : _____

(3 + 2 + 4 = 9 marks)

(Suggested time: 9 minutes)

Question 8

- a) Draw a structural formula (showing all lone pairs on the central atom) for each of the following molecules and state the shape of the molecule.

Molecule	Structural Formula	Shape
N_2		
CCl_4		
SF_2		

- b) For the three molecules indicated above, state whether they have high polarity, low polarity or are non-polar. Briefly justify your response.

N_2 _____

CCl_4 _____

SF_2 _____

(6 + 3 = 9 marks)

(Suggested time: 9 minutes)

Question 9

A freshly cut piece of potassium reacts violently in a gas jar containing chlorine gas. A white smoke consisting of potassium chloride is formed and eventually deposits as a white solid in the gas jar.

- a) Write a balanced equation for the reaction between potassium and chlorine gas.

- b) Explain the changes, in detail, that occur in both the potassium and chlorine atoms during the reaction.

- c) Explain why the melting point of the potassium chloride (770°C) is much greater than that of chlorine (-101°C).

(2 + 2 + 4 = 8 marks)
 (Suggested time: 7 minutes)

Question 10

The table provides formulae of some hydrocarbons.

Compound	Formula
A	CH_4
B	C_2H_2
C	C_2H_4
D	C_2H_6
E	C_3H_4
F	C_3H_6
G	C_3H_8
H	C_4H_6
I	C_4H_8
J	C_4H_{10}

- a) i) Write all the letters corresponding to the compounds from the table above that represent non-cyclic saturated alkanes.

- ii) Give the general formula of this series. _____

- iii) Select **one** of the compounds in the table for which isomeric forms exist. Indicate the letter corresponding to this compound in the box provided.

- iv) Draw the structural formulae *and* name **two** isomers corresponding to this letter.

- b) i) Select a compound with **3 carbon atoms** and a double bond from the table. Indicate the letter corresponding to this compound in the box provided.

- ii) This compound can be polymerised. Write a chemical equation to illustrate the polymerisation reaction of your selected compound from part i).

- iii) Name the organic product of this reaction.

(2 + 1 + 1 + 4 + 1 + 1 + 1 = 11 marks)
(Suggested time: 10 minutes)

END OF EXAMINATION

Table of some selected ions

1+	2+	3+
Silver Ag^+	Zinc Zn^{2+}	Iron(III) Fe^{3+}
Copper(I) Cu^+	Copper(II) Cu^{2+}	Chromium(III) Cr^{3+}
Ammonium NH_4^+	Mercury(II) Hg_2^{2+}	
	Iron(II) Fe^{2+}	
1-	2-	3-
Hydroxide OH^-	Carbonate CO_3^{2-}	Phosphate PO_4^{3-}
Nitrate NO_3^-	Sulfate SO_4^{2-}	
Nitrite NO_2^-	Sulfite SO_3^{2-}	
Ethanoate CH_3COO^-	Dichromate $\text{Cr}_2\text{O}_7^{2-}$	
Permanganate MnO_4^-	Hydrogenphosphate HPO_4^{2-}	
Hydrogencarbonate HCO_3^-		
Hydrogensulfate HSO_4^-		

Some Solubility Data

Level of Solubility	Ionic compounds containing	Exceptions
Generally soluble	Na^+ , K^+ , NH_4^+ , NO_3^- , CH_3COO^- Cl^- , Br^- , I^-	None Ag^+ compounds
	SO_4^{2-}	Pb^{2+} , Ba^{2+} , Ag^+ and Ca^{2+} compounds
Low solubility	CO_3^{2-} , PO_4^{3-} , S^{2-} OH^-	Na^+ , K^+ , and NH_4^+ compounds Na^+ , K^+ , NH_4^+ , Ba^{2+} and Sr^{2+} compounds

Some electronegativity values

H 2.1

Li 1.0	Be 1.6	B 2.0	C 2.5	N 3.0	O 3.5	F 4.0
Na 0.9	Mg 1.3	Al 1.6	Si 1.9	P 2.2	S 2.6	Cl 3.2