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STAV Publishing 2017

Student name

CHEMISTRY

Unit 1

Trial Examination

QUESTION AND ANSWER BOOK

Total writing time: 1 hour 30 minutes

Structure of book

Section	Number of questions	Number of marks
A	20	20
B	10	69
	Total	89

- 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 14 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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2017

CHEMISTRY

Unit 1 Trial Examination

MULTIPLE CHOICE ANSWER SHEET

STUDENT NAME:	

INSTRUCTIONS: **USE PENCIL ONLY**

- Write your name in the space provided above.
- Use a **PENCIL** for **ALL** entries.
- If you make a mistake, **ERASE** it – **DO NOT** cross it out.
- Marks will **NOT** be deducted for incorrect answers.
- **NO MARK** will be given if more than **ONE** answer is completed for any question.
- Mark your answer by **SHADING** the letter of your choice.

	ONE ANSWER PER LINE					ONE ANSWER PER LINE				
1	A	B	C	D	11	A	B	C	D	
2	A	B	C	D	12	A	B	C	D	
3	A	B	C	D	13	A	B	C	D	
4	A	B	C	D	14	A	B	C	D	
5	A	B	C	D	15	A	B	C	D	
6	A	B	C	D	16	A	B	C	D	
7	A	B	C	D	17	A	B	C	D	
8	A	B	C	D	18	A	B	C	D	
9	A	B	C	D	19	A	B	C	D	
10	A	B	C	D	20	A	B	C	D	

SECTION A – Multiple-choice questions

Instructions for Section A
Answer all questions in pencil on the answer sheet provided for multiple-choice questions.
Choose the response that is **correct** or that **best answers** the question.
A correct answer scores 1, an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No mark will be given if more than one answer is completed for any question.

Question 1

5.0×10^{-8} m is equivalent to

A. 50 μm

B. 50 pm

C. 500 mm

D. 50 nm

Question 2

The **radius** of an atom is approximately 10,000 times greater than that of the nucleus. If an atom were magnified so that the radius of its nucleus became 2.0 cm, what would the **radius** of the atom be in **nanometres**?

A. 2.0×10^{8}

B. 2.0×10^{9}

C. 2.0×10^{10}

D. 2.0×10^{11}

Question 3

The number of nucleons in $^{235}U^{3+}$ is

A. 92

B. 232

C. 235

D. 327

Question 4

In 1913, Niels Bohr developed a new model of the hydrogen atom. His model proposed the existence of

A. positively charged protons in the nucleus.

B. subshells for electrons in atom.

C. neutrons in the nucleus.

D. specific energy levels for electrons in atoms.

Question 5

An emission spectrum

A. shows coloured lines on a black background.

B. is obtained when atoms absorb energy.

C. shows black lines on a coloured background.

D. shows all the colours of the rainbow.

Question 6

How many distinct energy levels would the ionisation energy graph of potassium indicate?

A. 2

B. 3

C. 4

D. 5

Question 7

Selenium, Se, occurs in group 16 of the Periodic Table. It is likely that selenium

A. exists as a gas at room temperature and pressure.

B. reacts with metals to form selenides (Se^{2-}).

C. forms a hydride capable of hydrogen bonding.

D. exists as isolated atoms in the solid state.

Question 8

The **core charge** for the element Phosphorus is

A. +2

B. +3

C. +5

D. +15

Question 9

The electron configuration of $_{24}Cr$ is

A. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$

B. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 4p^5$

C. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$

D. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$

Question 10

The first ionisation energy of Period 2 elements

A. increases continuously from Li to Ne.

B. decreases continuously from Li to Ne.

C. increases irregularly from Li to Ne.

D. decreases irregularly from Li to Ne.

Question 11

The formula of potassium oxalate is $K_2C_2O_4$ and the formula of bismuth nitrate is $Bi(NO_3)_3$.
The formula of bismuth oxalate is

A. BiC_2O_4

B. $Bi(C_2O_4)_2$

C. $Bi_2(C_2O_4)_3$

D. $Bi_3(C_2O_4)_2$

Question 12

Sodium vapour lamps are commonly used for street lighting, having a characteristic yellow colour. Which of the following changes in electron configuration could be responsible for this colour?

A. $1s^2\ 2s^2\ 2p^6\ 3s^1 \rightarrow 1s^2\ 2s^2\ 2p^6\ 4s^1$

B. $1s^2\ 2s^2\ 2p^6\ 3s^1 \rightarrow 1s^2\ 2s^2\ 2p^6$

C. $1s^2\ 2s^2\ 2p^6\ 3s^1 \rightarrow 1s^2\ 2s^2\ 2p^6\ 5s^1$

D. $1s^2\ 2s^2\ 2p^6\ 5s^1 \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^1$

Question 13

A student calculated the relative atomic mass of Boron to be 10.6 by using the following data.

Isotope	Relative abundance	Relative Isotopic Mass
^{10}B	40%	10.0
^{11}B	60%	11.0

The accepted $A_r(B)$ is 10.8. The incorrect result has occurred because the relative

A. isotopic mass of ^{11}B is actually 11.2

B. abundance of ^{10}B is actually 60%

C. isotopic mass of ^{10}B is actually 10.5

D. abundance of ^{11}B is actually 80%

Question 14

0.0250 mol of a gaseous hydrocarbon has a mass of 1.10 g. The molar mass, in g mol^{-1}, of this compound is

A. 2.75

B. 11.0

C. 44.0

D. unable to be determined without further information

Question 15

A covalent bond is the result of the

A. transfer of valence (outer shell) electrons.

B. loss of valence electrons.

C. sharing of valence electrons.

D. formation of charged particles.

Question 16

How many covalent bonds can a nitrogen atom usually form?

A. 1

B. 2

C. 3

D. 4

Question 17

A molecule of tetrafluoromethane, CF_4

A. has four non-polar bonds.

B. is polar.

C. is pyramidal in shape.

D. has no overall dipole.

Question 18

The percentage by mass of carbon in glucose, $C_6H_{12}O_6$, is

A. 12.0%

B. 25.0%

C. 40.0%

D. 41.4%

Question 19

In which **one** of the following are the bonds around each carbon **not** tetrahedral?

A. CH_2CHCH_3

B. CH_4

C. CH_3CH_3

D. $CH_3CH_2CH_3$

Question 20

Which one of the following displays a structure markedly different from the other three?

A. diamond

B. graphite

C. silicon

D. silicon dioxide

END OF SECTION A

CHEMISTRY
Unit 1 Trial Examination

DATA SHEET

Directions to students

Detach this data sheet during reading time. This data sheet is provided for your reference.

SI prefixes , their symbols and values

SI prefix	Scientific notation	Multiplying factor
giga (G)	10^9	1 000 000 000
mega (M)	10^6	1 000 000
kilo (k)	10^3	1000
deci (d)	10^{-1}	0.1
centi (c)	10^{-2}	0.01
milli (m)	10^{-3}	0.001
micro (μ)	10^{-6}	0.000001
nano (n)	10^{-9}	0.000000001
pico (p)	10^{-12}	0.000000000001

Constants and useful formulae

Avogadro's constant $(N_A) = 6.02 \times 10^{23}\ mol^{-1}$

Density (d) of water at 25 °C $= 1.00\ g\ mL^{-1}$

Specific heat capacity (c) of water $= 4.18\ J\ g^{-1}\ °C^{-1}$

Ionic product for water $(K_W) = 1.00 \times 10^{-14}\ mol^2\ L^{-2}$

0 °C = 273 K

1 ppm (m/V) = 1 mg L^{-1}

$n = \frac{m}{M}$; $n = \frac{N}{N_A}$; $c = \frac{n}{V}$; $c_1 V_1 = c_2 V_2$

$\Delta E = mc\Delta T$

$pH = -\log_{10}[H^+]$; $pOH = -\log_{10}[OH^-]$

pH + pOH = 14.0 at 25 °C

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+}		
		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	$Cr_2O_7^{2-}$		
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^-	None
	Cl^-, Br^-, I^-	Ag^+ compounds
	SO_4^{2-}	Pb^{2+}, Ba^{2+}, Ag^+ and Ca^{2+} compounds
Low solubility	CO_3^{2-}, PO_4^{3-}, S^{2-}	Na^+, K^+, and NH_4^+ compounds
	OH^-	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

Useful Rules for Polarity of Bonds

$\Delta EN < 0.5$ non-polar covalent

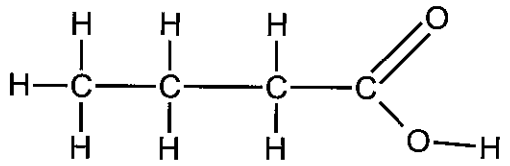
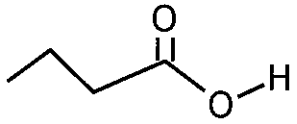
$0.5 < \Delta EN < 1.5$ polar covalent to highly polar covalent

$1.5 < \Delta EN < 2.0$ highly polar covalent or ionic

$\Delta EN > 2.0$ ionic

Some Information on Organic Chemistry

Sample representation of organic molecules

Molecular formula	$C_4H_8O_2$ or C_3H_7COOH
Semi-structural formula	$CH_3CH_2CH_2COOH$
Structural formula	
Skeletal structure	

Category of substance	Representation	Functional group
halocarbons	RCH_2F, RCH_2Cl, RCH_2Br, RCH_2I	fluoro, chloro, bromo, iodo
alcohols	RCH_2OH	hydroxy(l)
carboxylic acids	RCOOH	carboxy(l)
amines	RCH_2NH_2	amine
alkenes	RCH=CHR	

An abridged Reactivity Series

$$Au^{+}(aq) + e^{-} \rightleftharpoons Au(s)$$
$$Ag^{+}(aq) + e^{-} \rightleftharpoons Ag(s)$$
$$Fe^{3+}(aq) + e^{-} \rightleftharpoons Fe^{2+}(aq)$$
$$O_2(g) + 2H_2O(l) + 4e^{-} \rightleftharpoons 4OH^{-}(aq)$$
$$Cu^{2+}(aq) + 2e^{-} \rightleftharpoons Cu(s)$$
$$Sn^{4+}(aq) + 2e^{-} \rightleftharpoons Sn^{2+}(aq)$$
$$2H^{+}(aq) + 2e^{-} \rightleftharpoons H_2(g)$$
$$Pb^{2+}(aq) + 2e^{-} \rightleftharpoons Pb(s)$$
$$Sn^{2+}(aq) + 2e^{-} \rightleftharpoons Sn(s)$$
$$Ni^{2+}(aq) + 2e^{-} \rightleftharpoons Ni(s)$$
$$Co^{2+}(aq) + 2e^{-} \rightleftharpoons Co(s)$$
$$Fe^{2+}(aq) + 2e^{-} \rightleftharpoons Fe(s)$$
$$Zn^{2+}(aq) + 2e^{-} \rightleftharpoons Zn(s)$$
$$2H_2O(l) + 2e^{-} \rightleftharpoons H_2(g) + 2OH^{-}(aq)$$
$$Al^{3+}(aq) + 3e^{-} \rightleftharpoons Al(s)$$
$$Mg^{2+}(aq) + 2e^{-} \rightleftharpoons Mg(s)$$
$$Na^{+}(aq) + e^{-} \rightleftharpoons Na(s)$$
$$Ca^{2+}(aq) + 2e^{-} \rightleftharpoons Ca(s)$$
$$K^{+}(aq) + e^{-} \rightleftharpoons K(s)$$

Periodic table of the elements

Key to table

79
Au
197.0
gold

– Atomic number
– Symbol of element
– Relative atomic mass
– Name of element

1 H 1.0 hydrogen																	**2** He 4.0 helium
3 Li 6.9 lithium	**4** Be 9.0 beryllium											**5** B 10.8 boron	**6** C 12.0 carbon	**7** N 14.0 nitrogen	**8** O 16.0 oxygen	**9** F 19.0 fluorine	**10** Ne 20.2 neon
11 Na 23.0 sodium	**12** Mg 24.3 magnesium											**13** Al 27.0 aluminium	**14** Si 28.1 silicon	**15** P 31.0 phosphorus	**16** S 32.1 sulfur	**17** Cl 35.5 chlorine	**18** Ar 39.9 argon
19 K 39.1 potassium	**20** Ca 40.1 calcium	**21** Sc 45.0 scandium	**22** Ti 47.9 titanium	**23** V 50.9 vanadium	**24** Cr 52.0 chromium	**25** Mn 54.9 manganese	**26** Fe 55.8 iron	**27** Co 58.9 cobalt	**28** Ni 58.7 nickel	**29** Cu 63.5 copper	**30** Zn 65.4 zinc	**31** Ga 69.7 gallium	**32** Ge 72.6 germanium	**33** As 74.9 arsenic	**34** Se 79.0 selenium	**35** Br 79.9 bromine	**36** Kr 83.8 krypton
37 Rb 85.5 rubidium	**38** Sr 87.6 strontium	**39** Y 88.9 yttrium	**40** Zr 91.2 zirconium	**41** Nb 92.9 niobium	**42** Mo 96.0 molybdenum	**43** Tc (98) technetium	**44** Ru 101.1 ruthenium	**45** Rh 102.9 rhodium	**46** Pd 106.4 palladium	**47** Ag 107.9 silver	**48** Cd 112.4 cadmium	**49** In 114.8 indium	**50** Sn 118.7 tin	**51** Sb 121.8 antimony	**52** Te 127.6 tellurium	**53** I 126.9 iodine	**54** Xe 131.3 xenon
55 Cs 132.9 caesium	**56** Ba 137.3 barium	**57-71** lanthanoids	**72** Hf 178.5 hafnium	**73** Ta 180.9 tantalum	**74** W 183.8 tungsten	**75** Re 186.2 rhenium	**76** Os 190.2 osmium	**77** Ir 192.2 iridium	**78** Pt 195.1 platinum	**79** Au 197.0 gold	**80** Hg 200.6 mercury	**81** Tl 204.4 thallium	**82** Pb 207.2 lead	**83** Bi 209.0 bismuth	**84** Po (210) polonium	**85** At (210) astatine	**86** Rn (222) radon
87 Fr (223) francium	**88** Ra (226) radium	**89-103** actinoids	**104** Rf (261) rutherfordium	**105** Db (262) dubnium	**106** Sg (266) seaborgium	**107** Bh (264) bohrium	**108** Hs (267) hassium	**109** Mt (268) meitnerium	**110** Ds (271) darmstadtium	**111** Rg (272) roentgenium	**112** Cn (285) copernicium	**113** Nh (280) nihonium	**114** Fl (289) flerovium	**115** Mc (289) moscovium	**116** Lv (292) livermorium	**117** Ts (294) tennessine	**118** Og (294) oganesson

57 La 138.9 lanthanum	**58** Ce 140.1 cerium	**59** Pr 140.9 praseodymium	**60** Nd 144.2 neodymium	**61** Pm (145) promethium	**62** Sm 150.4 samarium	**63** Eu 152.0 europium	**64** Gd 157.3 gadolinium	**65** Tb 158.9 terbium	**66** Dy 162.5 dysprosium	**67** Ho 164.9 holmium	**68** Er 167.3 erbium	**69** Tm 168.9 thulium	**70** Yb 173.1 ytterbium	**71** Lu 175.0 lutetium
89 Ac (227) actinium	**90** Th 232.0 thorium	**91** Pa 231.0 protactinium	**92** U 238.0 uranium	**93** Np (237) neptunium	**94** Pu (244) plutonium	**95** Am (243) americium	**96** Cm (247) curium	**97** Bk (247) berkelium	**98** Cf (251) californium	**99** Es (252) einsteinium	**100** Fm (257) fermium	**101** Md (258) mendelevium	**102** No (259) nobelium	**103** Lr (262) lawrencium

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SECTION B – Short answer questions

Instructions for Section B

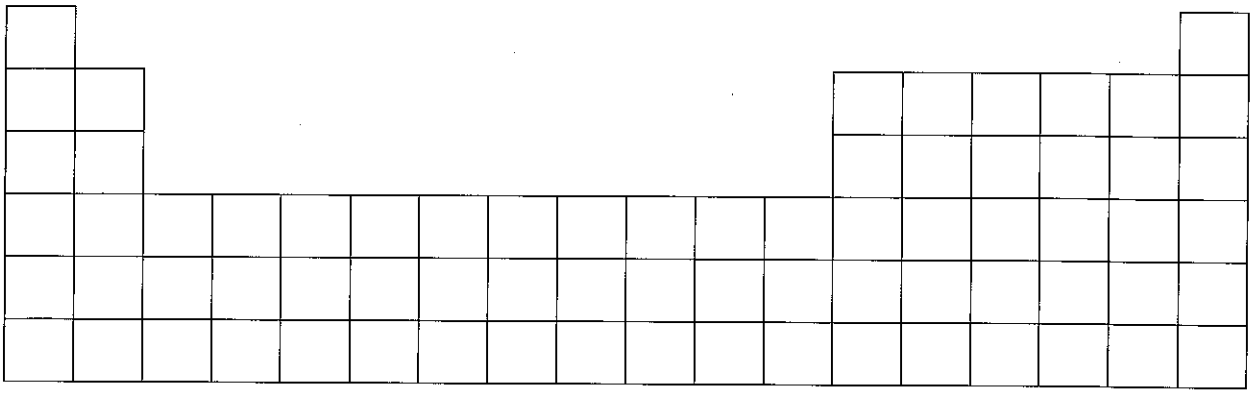
Answer **all** questions in the spaces provided.

To obtain full marks for your responses 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 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

Use the clues given below for each element to place it in its correct position in the outline of part of the periodic table shown.



a. Element A is a period 2 alkali metal.

b. Atoms of element D have the greatest mass of group 14.

c. Atoms of element E have 27 protons in their nuclei.

d. Element G has the highest electronegativity.

e. Element J is a non-metal, with one electron in the outer most shell.

f. Element L is in period 3 and forms an ionic fluoride with empirical formula LF_3.

g. Atoms of element M form doubly charged cations with electronic arrangement 2,8,8.

$7 \times 1 = 7$ marks

Question 2

a. Define the term *isotope*.

_____

_____

_____

1 mark

b. Define *relative atomic mass*.

_____

_____

_____

2 marks

c. A sample of gallium exists as two isotopes, ^{69}Ga, relative abundance 61.2%, and ^{71}Ga, relative abundance 38.8%. Calculate the relative atomic mass of gallium. Show all working.

_____

_____

_____

_____

2 marks

d. In a mass spectrum of elemental gallium, what would be the relative abundance ratio of gallium 69 / gallium 71?

_____

1 mark

Total 6 marks

Question 3

The following tables show values for atomic radii and ionic radii.

Table 1 Covalent (atomic) radii in pm

				N	0	F
				70	66	58
Na	Mg	Al	Si	P	S	Cl
186	160	143	117	110	104	99

Table 2 Ionic radii in pm

				N^{3-}	O^{2-}	F^-
				171	146	133
Na^+	Mg^{2+}	Al^{3+}	Si^{4+}	P^{3-}	S^{2-}	Cl^-
98	65	45	42	212	190	181

Using the information in the tables above, explain why

a. the magnesium ion is much smaller than the magnesium atom.

2 marks

b. there is a large increase in ionic radius from silicon to phosphorus.

2 marks

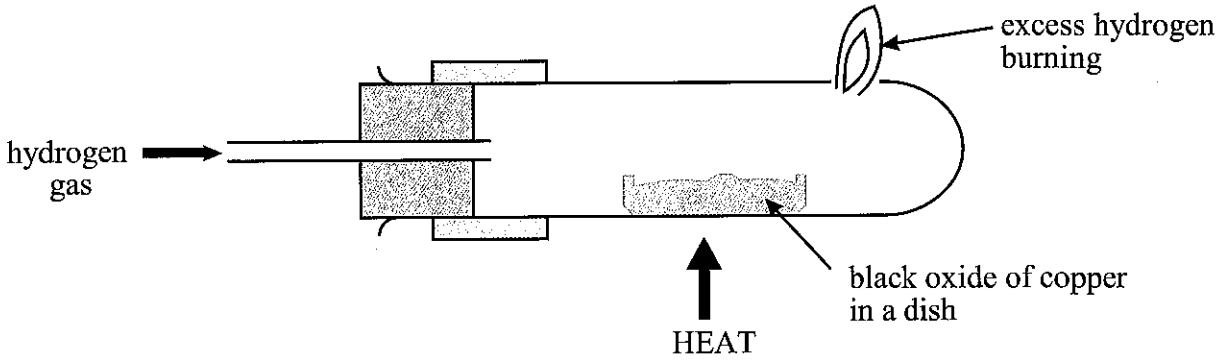
c. the ionic radius of Na^+ is less than that of F^-.

2 marks

Total 6 marks

Question 4

A black oxide of copper was reduced to copper in a stream of hydrogen as shown below.



After heating, the stream of hydrogen gas was maintained until the apparatus had cooled.

The following results were obtained:

- mass of empty dish = 13.80 g
- mass of dish and contents before heating = 21.75 g
- mass of dish and contents after heating and leaving to cool = 20.15 g

a. Explain why the stream of hydrogen gas was maintained until the apparatus cooled.

_____

_____

1 mark

b. Calculate the **empirical formula** of the oxide of copper using the data above, assuming complete conversion of the oxide.

_____

_____

_____

_____

4 marks

c. Write an equation for the reaction that occurred.

_____

1 mark

d. State the **main** change that would be **observed** inside the tube as it was heated.

_____

_____

1 mark

Total 7 marks

Question 5

On the basis of the properties given in the table below, fill in the classification column to classify the substances A, B, C and D as metallic, ionic, molecular or network covalent. Explain your reasoning for each one on the lines provided under the table.

Substance	Melting Point	Electrical Conductivity		Classification
		Molten	Solid	
A	4000 °C	negligible	negligible	
B	–40 °C	negligible	negligible	
C	800 °C	high	very low	
D	300 °C	high	high	

A _____

B _____

C _____

D _____

4 + 4 = 8 marks

Question 6

Sodium dichromate is an **ionic** compound. It contains 17.6 % sodium, 39.7 % chromium and 42.7 % oxygen by mass.

a. Calculate the empirical formula of sodium dichromate. Show all working.

_____

_____

_____

_____

_____

4 marks

b. Given that the empirical formula is the formula of the substance, give the molar mass.

_____

1 mark

c. Write the formula of each of the ions that make up the substance.

_____

2 marks

Total 7 marks

Question 7

a. Complete the table below, by

i. drawing the structural formula **and**

ii. naming the **shape** of the molecules indicated (the last one is done for you).

Molecule	Structural formula	Shape
$CHCl_3$		
CO_2		
SO_2Cl_2		**tetrahedral**

$5 \times 1 = 5$ marks

b. For the three molecules indicated, state whether they are polar or non-polar. Briefly justify your response.

$CHCl_3$ _____

_____

_____

CO_2 _____

_____

_____

SO_2Cl_2 _____

_____

_____

3 marks

Total 8 marks

Question 8

Name the following molecules using IUPAC names.

a. $CH_3CH_2CH_2CH_2CH_2OH$ _____

b. $CH_3CHClCH_3$ _____

c. CH_3CH_2COOH _____

d. $CH_3CH(CH_3)CH_2CH_3$ _____

e. $CH_3CH_2CHCH_2$ _____

$5 \times 1 = 5$ marks

Question 9

The formula C_5H_{12} can be represented by different bonding arrangements.

In the space below, draw **full** structures **and** give the IUPAC names for all possible arrangements.

6 marks

Question 10

a. **Fully** describe the structure **and** bonding in

i. silicon (like diamond)

ii. graphite

3 + 4 = 7 marks

b. Why would silicon be predicted to have a much lower melting point than diamond?

2 marks

Total 9 marks

END OF TRIAL EXAMINATION

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CHEMISTRY

Unit 1

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SOLUTIONS BOOK

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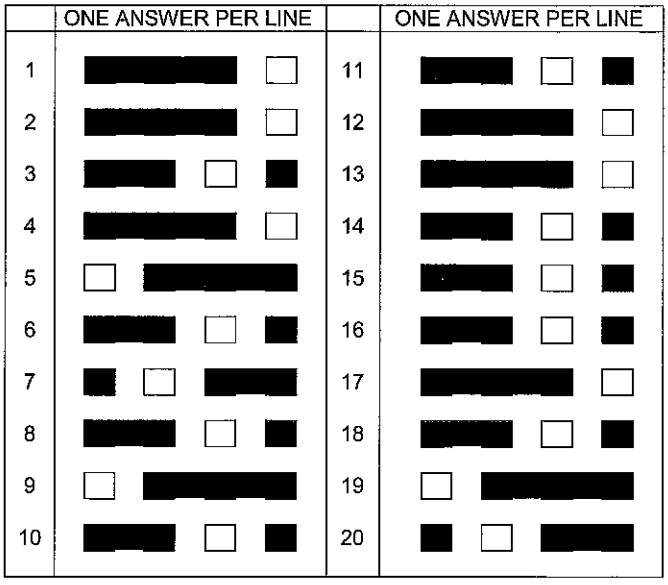
ABN 61 527 110 823

Use this page as an overlay for marking the multiple choice answer sheets. Simply photocopy the page onto an overhead projector sheet. The correct answers are open boxes below. Students should have shaded their answers. Therefore, any open box with shading inside it is correct and scores 1 mark.



SECTION A (Total 20 marks)

1.	D	**2.**	D	**3.**	C	**4.**	D	**5.**	A
6.	C	**7.**	B	**8.**	C	**9.**	A	**10.**	C
11.	C	**12.**	D	**13.**	D	**14.**	C	**15.**	C
16.	C	**17.**	D	**18.**	C	**19.**	A	**20.**	B

Comments for Section A answers

Question 1
5.0×10^{-8} m $\times$ $1.0 \times 10^{9} = 50$ nm **Correct answer: D**

Question 2
$\frac{1}{10\,000} = \frac{2}{x}$ therefore $x = 2 \times 10^{4}$ cm $= 2 \times 10^{5}$ mm $= 2 \times 10^{11}$ nm **Correct answer: D**

Question 3
Nucleons are particles in the nucleus i.e. protons and neutrons = 235. The 3+ simply means 3 less electrons which is not relevant for the nucleus. **Correct answer: C**

Question 4
Bohr postulated electron 'shells' i.e. specific energy levels for electrons in atoms. The Schrödinger model suggested that subshells were present. **Correct answer: D**

Question 5
An emission spectrum shows coloured lines on a black background. These lines represent electrons emitting energy as excited electrons return to lower levels. **Correct answer: A**

Question 6
Potassium has four occupied electron shells. Therefore there will be four distinct energy levels on an ionisation energy graph. **Correct answer: C**

Question 7
Selenium is in the same group as oxygen. It would be expected to form a 2– ion in its reaction with a metal. **Correct answer: B**

Question 8
Core charge = nuclear charge – screening electrons which for potassium is 15 – 10 = +5
Correct answer: C

Question 9
The electron configuration for Cr is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$ and not the expected $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$. The half-filled d subshell is a more stable arrangement.
Correct answer: A

Question 10
First ionisation energy increases across the period as core charge increases and the electrons are more tightly held. However, because of the 2p subshell, the transition is not continuous.
Correct answer: C

Question 11
$K_2C_2O_4$ has the ions K^+ and $C_2O_4^{2-}$ and $Bi(NO_3)_3$ has Bi^{3+} and NO_3^- ions. The formula of bismuth oxalate will be $Bi_2(C_2O_4)_3$. **Correct answer: C**

Question 12
The transition must be an **emission** from a higher level to a lower level.
For example: $1s^2\ 2s^2\ 2p^6\ 5s^1 \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^1$ **Correct answer: D**

Question 13
$$RAM = \frac{\%_1 \times RIM_1 + \%_2 \times RIM_2}{100} = \frac{20 \times 10.0 + 80 \times 11.0}{100} = 10.8$$ **Correct answer: D**

Question 14
$$n = \frac{m}{M} \text{ therefore } M = \frac{m}{n} = \frac{1.10}{0.0250} = 44.0 \text{ g mol}^{-1}$$ **Correct answer: C**

Question 15
A covalent bond is the result of the sharing of valence electrons. **Correct answer: C**

Question 16
$_7N$ has an electron arrangement of 2,5 and therefore N usually wants to form 3 bonds to achieve an octet. **Correct answer: C**

Question 17
CF_4 has polar bonds but the dipoles sum to zero so it is non-polar overall. **Correct answer: D**

Question 18
$M(C_6H_{12}O_6) = 180 \text{ g mol}^{-1}$. $\%\ C = \frac{6 \times 12.0}{180} \times 100\% = 40.0\%$ **Correct answer: C**

Question 19
In CH_2CHCH_3 the first two carbons are trigonal planar (C=C).
In CH_4, carbon has tetrahedral arrangement around it.
In CH_3CH_3 each carbon has a tetrahedral arrangement around it.
In $CH_2CH_2CH_3$ propane is an alkane and must have tetrahedral arrangements around each carbon.
Correct answer: A

Question 20
Graphite has a layer lattice arrangement of C atoms. All the others have continuous covalent arrangements. **Correct answer: B**

SECTION B – Short answer questions (Total 69 marks)

Question 1 (7 marks)
(1 mark each for the correct placement of the seven elements listed)

J																
A															G	
											L					
	M							E								
												D				

Question 2 (6 marks)

a. Isotopes are atoms of the same element (same atomic number) but a different number of neutrons **(1 mark)**.

b. A_r is the weighted mean mass **(1 mark)** of all the **naturally** occurring isotopes based on ^{12}C set at 12 exactly **(1 mark)**.

c. $A_r = \frac{\%_1 \times RIM_1 + \%_2 \times RIM_2}{100} = \frac{61.2 \times 69 + 38.8 \times 71}{100}$ **(1 mark)** = 70 (2 sf) **(1 mark)**

d. $\frac{61.2}{38.8} = 1.58$ (3 sf) **(1 mark)**

Question 3 (6 marks)

a. The magnesium ion has one less occupied electron shell (2,8) than a magnesium atom (2,8,2) **(1 mark)**. The remaining electrons are also held more tightly as the core charge has increased for the ion **(1 mark)**.

b. For silicon, the atom size would be reduced in forming Si^{4+} because there would be one less shell containing electrons and the remaining electrons are held more strongly **(1 mark).** For phosphorus, the additional electrons mean that all electrons are held less tightly and the ion increases in size **(1 mark)**. *(Students may also validly argue that an increase is also likely because of increased repulsion of electrons in the second shell.)*

c. Both Na^+ and F^- have an electron configuration of 2,8 **(1 mark)**. However, the core charge (effective nuclear charge) for sodium is +1 whereas the core charge on fluorine is +7 **(1 mark)**.

Question 4 (7 marks)

a. The flow of hydrogen is maintained until the apparatus is cooled so that oxygen cannot enter the tube and re-oxidise the copper **(1 mark)**.

b. m(Cu) = 20.15 – 13.80 = 6.35 g **(1 mark)**; m(O) = 21.75 – 13.80 – 6.35 = 1.6 **(1 mark)**

$n(Cu) = \frac{6.35}{63.5} = 0.100$ mol; $n(O) = \frac{1.6}{16.0} = 0.10$ **(1 mark)**

$\frac{n(Cu)}{n(O)} = \frac{1}{1}$ hence the EF is CuO **(1 mark)**

c. $CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(g)$ **(1 mark)**

d. Solid changes from black to orange brown **(1 mark)**

Question 5 (8 marks)

in table:

A network covalent lattice **(1 mark)**
B (covalent) molecular substance **(1 mark)**
C network ionic lattice **(1 mark)**
D metallic lattice **(1 mark)**

Reasoning:

A strong bonding and no charged particles **(1 mark)**
B relatively weak bonds between molecules **(1 mark)**; (also relatively low m.p., no charges)
C relatively strong bonds and ions free to move in molten state **(1 mark)**
D conducts in both solid and molten states **(1 mark)**

Question 6 (7 marks)

a. Assume 100 g; m(Na) = 17.6 g, m(Cr) = 39.7 g, m(O) = 42.7 g

n(Na) : n(Cr) : n(O)

$\frac{17.6}{23.0} : \frac{39.7}{52.0} : \frac{42.7}{16.0}$ **(1 mark)**

0.765 : 0.763 : 2.67 **(1 mark)** (then divide each by 0.763)

1.00 : 1.00 : 3.50 → 2.00 : 2.00 : 7.00 **(1 mark)**

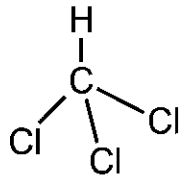
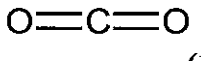
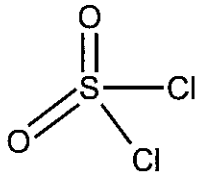
EF is $Na_2Cr_2O_7$ **(1 mark)**

b. $2 \times 23.0 + 2 \times 52.0 + 7 \times 16.0 = 262$ g mol^{-1} **(1 mark)**

c. Na^+ **(1 mark)** $Cr_2O_7^{2-}$ **(1 mark)**

Question 7 (8 marks)

a. **(1 mark for the correct structural formula, 1 mark for the correct shape)**

Molecule	Structural formula	Shape
$CHCl_3$	 **(1 mark)**	tetrahedral **(1 mark)**
CO_2	 **(1 mark)**	linear **(1 mark)**
SO_2Cl_2	 **(1 mark)**	tetrahedral **(given)**

b. $CHCl_3$ is **polar**; it has polar bonds (see electronegativity table in data sheet) but the sum of the dipoles is not equal to zero **(1 mark)**.

CO_2 is **non-polar**; although it has polar bonds, the molecule is symmetrical **(1 mark)**.

SO_2Cl_2 is **polar**; it has polar bonds and the molecule lacks symmetry **(1 mark)**.

Question 8 (5 marks)

a. 1-pentanol *or* pentan-1-ol **(1 mark)**

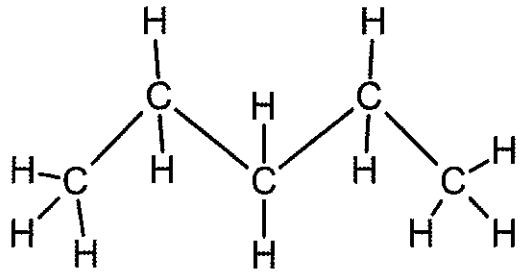
b. 2-chloropropane **(1 mark)**

c. propanoic acid **(1 mark)**

d. 2-methylbutane **(1 mark)**

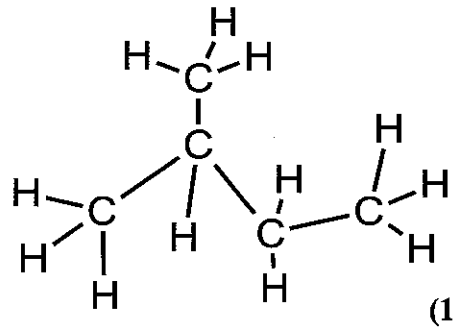
e. 1-butene *or* but-1-ene **(1 mark)**

Question 9 (6 marks)



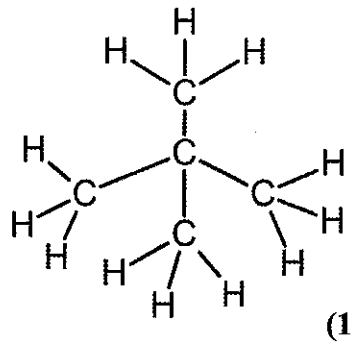
pentane **(1 mark)**

(1 mark)



2-methylbutane **(1 mark)**

(1 mark)



dimethylpropane **(1 mark)**

(1 mark)

Question 10 (9 marks)

a. **i.** Silicon is a continuous covalent lattice of Si atoms **(1 mark)**.
Each Si is bonded to 4 other Si atoms **(1 mark)** in a tetrahedral arrangement **(1 mark)**.

ii. Graphite is a continuous layer lattice **(1 mark)**.
There is an hexagonal arrangement of C atoms in each layer with each C bonded to only three C atoms **(1 mark)**. Each C atom has one spare electron which contributes to a delocalised cloud across each layer **(1 mark)**. The layers in graphite are held together by weak dispersion forces **(1 mark)**.

b. Silicon atoms are larger than carbon atoms **(1 mark)**. This makes the Si to Si bond length longer than the C to C bond length and the bonds are not as strong **(1 mark)**. Hence it has a significantly lower melting point to diamond which actually sublimes.

END OF SUGGESTED SOLUTIONS