Bergvliet High School

GRADE 10

Physical Science Exam
Paper 2
November 2023

MARKS: 100
TIME: 2 hours
EXAMINER: T.Abrahams
MODERATOR/S: Z.Booysen,G.0'Connor, S. Van Harte

This question paper consists of 8 pages and 1 data sheets.
Detach this sheet and attach it to the front of your answer sheets.

Name: **MEMORANDUM** Teacher: Am,Bn, Vh, Oc

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Question 1	Marker	Moderator	**Question 6**	Marker	Moderator
Question 2	Marker	Moderator	**Question 7**	Marker	Moderator
Question 3	Marker	Moderator	**Question 8**	Marker	Moderator
Question 4	Marker	Moderator	**Total**		
Question 5	Marker	Moderator	**Percentage**		
Signature	Marker		**Signature**	Moderator	

INSTRUCTIONS

1. Write your name in the appropriate space on the Cover Page and all pages of your ANSWER PAPER.
2. The question paper consists of ? questions. Answer ALL the questions on the paper provided.
3. Start EACH question on a NEW page on the answer pages.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

QUESTION 1

Four options are provided as possible answers to the following questions. Choose the answer and place a **X** on the letter (A–D) on the table below:

1.1.1	A	B	C	D
1.1.2	A	B	C	D
1.1.3	A	B	C	D
1.1.4	A	B	C	D
				/8

Question 1 Multiple choice questions

Four options are provided as possible answers to the following questions.
Choose the answer and place a **X** on the letter (A–D) on the table above:

1.1 Air can be classified as a/an …

A Element

B Compound

C Homogenous mixture ✓✓

D Heterogenous mixture 2

1.2 According to the kinetic molecular theory the particles of a solid …

A vibrate in their fixed positions and have a fixed shape. ✓✓
B are free to move and are compressible.
C are free to move and have a fixed shape
D vibrate in their fixed positions and are compressible. 2

1.3 What is the total number of nucleons in the ion of calcium when calcium loses two electrons to form Ca^{2+}?

A 40 ✓✓
B 18
C 22
D 20 2

1.4 In a 20 g sample of molecules, which sample below has the greatest number of moles?

A NH_3

B N_2

C CO_2

D H_2 ✓✓ 2

1.5 Which ONE of the following electron configurations represents an ion of an alkali metal?

A $1s^2$ ✓✓
B $1s^2\ 2s^2$
C $1s^2\ 2s^2\ 2p^5$
D $1s^2\ 2s^2\ 2p^6\ 3s^1$ 2

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Question 2 Start question on new page

The table below gives the temperature for bromine every 2 minute as bromine (starting at solid phase) was heated:

Time (min)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32
Temperature (ºC)	-9	-7	-7	-7	-2	4	10	22	34	46	58	58	58	58	64	68	72

2.1 Define the term *boiling point.*

Boiling point is the temperature where the vapour pressure of the liquid is equal to external /atmospheric pressure ✓✓ 2

2.2 What is the boiling point of bromine?

58 ºC ✓ 1

2.3 At which phase is bromine at 10 minutes?

Liquid ✓ 1

2.4 Which phase change occurs between 20 and 26 minutes?

boiling / liquid to gas ✓ 1

2.5 Explain why the temperature remains constant between 2 and 6 minutes.

a phase change is taken place, ✓ energy is being used to weaken bonds between particles✓ 2

2.7 Between what time frames are the following true for the particles of bromine?

2.7.1 There are very large spaces between the particles.

28 - 32 min ✓ 1

2.7.2 The particles use the energy to completely break the intermolecular forces between them.

20 – 26 min ✓ 1

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Question 3 Start question on new page

Chlorine is a non-metallic element with an atomic number of 17 and can exist as isotopes.

3.1 Define the term :

3.1.1 Atomic number

The number of protons ✓ in the nucleus of an atom. ✓ 2

3.1.2 Isotope

Atoms of the same element having the same number of protons, ✓
but different numbers of neutrons. ✓

OR

Atoms (of the same element) with the same atomic number ✓ but different mass numbers. ✓ 2

3.2 Natural chlorine consists of Cℓ-35 and Cℓ-37.

3.2.1 Write down the sp-notation for Cℓ-37.

$1s^2 2s^2 2p^6$ ✓ $3s^2 3p^5$ ✓ 2

3.2.2 The relative atomic mass of chlorine is 35,5. Calculate the percentage of Cℓ-35 in natural chlorine.

%Cℓ-35 = x and %Cℓ-37 = y
x + y = 100 ✓……1
$35,5 = \frac{X(35) + Y(37)}{100}$

1 in 2:

$35,5 = \frac{X(35) + (100-X)37}{100}$ ✓ …… **2**

3550 = 35x + 3700 - 37x
∴ x = 75 ✓

%Cℓ-35 = x ∴ %Cℓ-37 = 100 –x
$\left(\frac{X}{100}\right)35 + \left(\frac{X-100}{100}\right)37 = 35.5$ ✓

0,35x + 37 – 0,37x = 35,5
1,5 = 0,02x
x = 75 ✓

3

3.3 Chlorine gas ($C\ell_2$) consists of molecules.
Write down the :

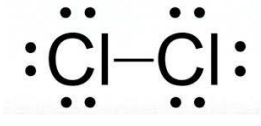
3.3.1 Number of valence electrons in a chlorine atom

7 ✓ 1

3.3.2 Type of bonding in chlorine molecule

Covalent ✓ 1

3.3.3 Lewis structure for the chlorine molecule



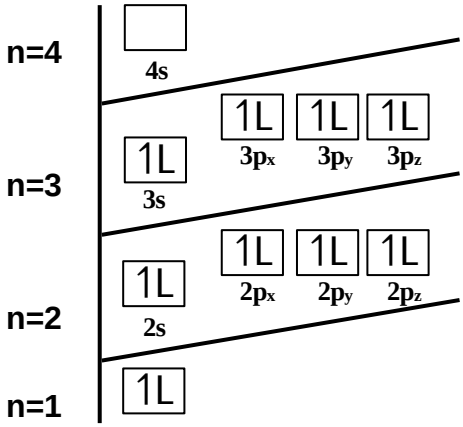
✓✓

2

3.4 Calcium reacts with chlorine to form calcium chloride

3.4.1 Draw the Aufbau diagram for a calcium ion

3



Marking criteria

- Main energy levels shown ✓ (1, 2, 3 etc.).
- Orbitals labelled as s or p. Ignore if 4th level and 4s not shown. ✓
- Nine electron pairs shown as arrows in opposite directions in blocks/circles. ✓

3.4.2 Write down the chemical symbols of the particles found in the calcium chloride crystal (lattice).

2

Ca^{2+} ✓ & $C\ell^{-}$ ✓

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Question 4 Start question on new page

Study the table of the first and second ionization energies and answer the questions that follow.

	FIRST IONISATION ENERGY ($kJ.mol^{-1}$)	SECOND IONISATION ENERGY ($kJ.mol^{-1}$)
Li	520	7297
Be	899	1757
B	801	2427
C	1086	2352
N	1402	2854
O	1214	3391
F	1681	3381
Ne	2080	3964

4.1 Define the term *first ionization energy.*

The energy required to remove the first electron from a neutral atom ✓ in a gaseous state ✓ 2

4.2 Use information from the table to explain why:

4.2.1 Metals form cations easily

Metals have lower first ionisation energy than non-metals ✓ therefore metals would rather lose electrons to form a positive ion (cation). ✓ 2

4.2.2 Non-metals form anions easily

Non-metals have higher first ionisation energy than metals, ✓ therefore non-metals would rather gain electrons to form the negative ions (anions). ✓ 2

4.3 Explain why the second ionisation energy of lithium is higher than its first ionisation energy.

The second electron is removed from the energy level very close to the nucleus, therefore the force of attraction between the electron and the nucleus is stronger ✓ hence more energy is needed to remove the second electron. ✓ 2

8

Question 5 Start question on new page

Study the physical and chemical processes below and answer the questions that follow:

X: $H_2O(s) \rightarrow H_2O(g)$
Y: $CaCO3(s) \Delta \rightarrow CaO(s) + CO2(g)$
Z: Iron + Oxygen → Iron(III) oxide

5.1 Define the term *physical change.*

A change in which no new substances are formed. ✓✓

Or

A change in which energy changes are small in relation to chemical changes. ✓✓ 2

5.2 Write down the LETTER of the process that represents the following:

5.2.1 Physical change

X ✓ 1

5.2.2 Decomposition reaction

Y ✓ 1

5.3 State TWO properties of a reaction that indicate that a chemical change has taken place.

Colour change. ✓
Formation of gas✓
Formation of a precipitate ✓
Change in temperature✓ (Any two) 2

5.4 For process Z, write down

5.5.1 A BALANCED CHEMICAL EQUATION (Show the phases of ALL reactants and products

$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$

• Reactants ✓ ; products ; ✓ phases; ✓ balancing✓ 4

5.5 A 20 g sample of $CaCO_3$ (s) in process Y decomposes to form 11,2 g of CaO. In a second sample, 30 g decomposes to form x g of CO_2.

5.6.1 State the law of constant composition.

States that, no matter how a chemical compound is prepared, it always contains the same elements in the same proportion by mass. ✓✓ 2

5.6.2 Use the law in QUESTION 5.6.1 to calculate mass x of the CO_2 formed

Mass of CO2 in the 1st sample

= 20 – 11,2 ✓

= 8,8 g

Proportion of CO2 in the 1st sample

$= \frac{8.8}{20}$ ✓

∴ Mass of CO2 in the 2nd samplE

$= \frac{8,8}{20}$ X 30 ✓

= 13,2 g ✓

OR

100 g $CaCO_3 \rightarrow$ 44 g CO_2 ✓

30 g $CaCO_3 \rightarrow$ x g CO_2 ✓

$x = \frac{30 \times 44}{100}$ ✓

x = 13,2 g ✓

OR

20 g $CaCO_3 \rightarrow$ 11,2 g CaO ✓

30 g $CaCO_3 \rightarrow$ x g CaO ✓

x = 16, 83 g CaO✓

∴ Mass of CO_2 in the 2nd sample = 30 – 16, 83 = 13,2 g✓

4

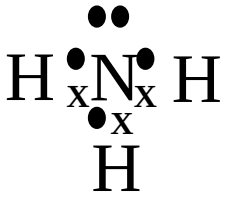
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Question 6 Start question on new page

6.1 Nitrogen and hydrogen react to form ammonia according to the following reaction:

$$N_2 + 3H_2 \rightarrow 2NH_3$$

6.1.1 Draw the Lewis structure of NH_3



Lone pair ✓

Dots and crosses for bonded pair ✓

Nitrogen central atom ✓

3

6.1.2 How many valence electrons does nitrogen have? 1

5 ✓

6.2 What type of chemical bond exists between the nitrogen and hydrogen atoms?

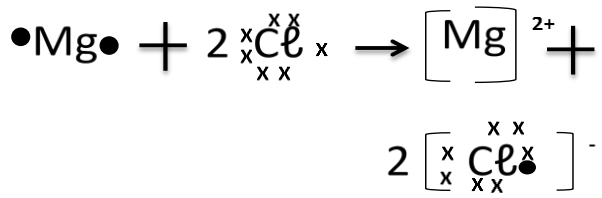
Covalent bond ✓

1

6.3 Magnesium and chlorine react to form magnesium chloride according to the following reaction:

$$Mg + C\ell_2 \rightarrow MgC\ell_2$$

6.3.1 Give the Lewis notation of the above reaction.



Left-hand side ✔

Mg with charge and no electrons ✔

Cℓ with charge and gained electron shown ✔

3

6.3.2 Explain how the bond between magnesium and chlorine is formed.

Magnesium having low electronegativity and low ionisation energy will donate its valence electrons ✔Chlorine atoms having high electronegativity will accept the valence electrons. ✔Magnesium will acquire a positive charge and the chlorines a negative charge, which results in an electrostatic attraction. ✔

3

6.4 What is the difference between the chemical bond in question 6.2 and 6.3.2?

In a covalent bond electrons are shared between atoms ✔and in an ionic bond electrons are transferred from one atom to another. ✔

2

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Question 7 Start question on new page

The empirical formula of a certain compound is to be determined. On analysis of a sample of the compound it was found to contain 40% C, 6,6% H and 53,3% O.

7.1 Define the term *empirical formula.* 2

The empirical formula is the simplest whole number ratio of atoms in a compound. ✓✓

7.2 Determine the empirical formula of the compound. Show ALL calculations.

If 100 g of the compound is available then:

53,3 g O	40 g C	6,6 g H
M(O) = 16 g·mol^{-1}	M(C) = 12 g·mol^{-1}	M(H) = 1 g·mol^{-1}
n = m/M	n = m/M	n = m/M
n = 53,3/16	n = 40/12	n = 6,6/1
n = 3,3125 mol ✓	n = 3,3 mol ✓	= 6,6 mol✓

Thus O : C : H

3,3125/3.3 : 3,3/3.3 : 6,6/3.3✓

1 : 1 : 2

Emiprical formul = C H_2 O ✓ 5

7.3 If the molecular mass of the compound is 60 g·mol-1, calculate the molecular formula of the compound

M(CH_2O)

= 12 + 2(1) + 16

= 30 g·mol-1 ✓

$$\frac{Formule\ mass = 60}{Emperical\ mass = 30} = 2✓$$

Thus the molecular formula = (CH_2O) x 2 = C_2 H_4 O_2 ✓ 3

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Question 8 Start question on new page

Mikaeel and Ryan heated a 2.558g of hydrated sodium carbonate (Na2CO3 ·xH2O) to drive off the water, resulting in 0.948g of anhydrous sodium carbonate. The mass of the water driven out was 1.61g.

8.1 Explain the meaning of the term hydrated

Hydrated: surrounded by water molecules✓ 1

8.2 Calculate the number of mol of the anhydrous salt (water free) salt?

$n_{Na2CO3} = \frac{m}{M}$ ✓

$= \frac{0.948}{106}$ ✓

= 0.0089 mol ✓ 3

8.3 Mikaeel then take 10 cm3 of the prepared solution and allow it to react completely with 5 cm3 of dilute hydrochloric acid, according the following balanced chemical equation:

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

8.3.1 Define the term a *mole of a substance*

The amount of a substance having the same number of particles as there are atoms in 12 g carbon-12. ✓✓ 2

8.3.2 What type of chemical reaction is represented by the chemical equation above?

Acid-base ✓/gas forming 1

8.3.3 Calculate the number of moles of hydrochloric acid in 5 cm^3 of hydrochloric acid if its concentration is 1 $mol \cdot dm^{-3}$

$C_{HCL} = \frac{n}{V}$ ✓

$1 = \frac{n}{0.005}$ ✓

n= 0,005 mol ✓ 3

8.4 Calculate the mass of sodium chloride formed in the reaction in QUESTION 8.3 5

n(NaCl) : n(HCl) =

1 : 1

$n(NaCl) = \frac{1}{1} \times 0{,}005$✓

n(NaCl) = 0,005 mol

$n(NaCl) = \frac{m}{M}$✓

0,005✓ $= \frac{m}{58.5}$✓

m = 0,29 g ✓

DATA FOR PHYSICAL SCIENCES GRADE 10
(CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS

NAME/*NAAM*	**SYMBOL/*SIMBOOL***	**VALUE/*WAARDE***
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9{,}11 \times 10^{-31}\ kg$
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22{,}4\ dm^3 \cdot mol^{-1}$
Standard pressure *Standaarddruk*	$p^\ominus$	$1{,}013 \times 10^5\ Pa$

TABLE 2: FORMULAE/TABEL 2: FORMULES

$n = \frac{m}{M}$	$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$	$n = \frac{N}{N_A}$

THE PERIODIC TABLE OF ELEMENTS // *DIE PERIODIEKE TABEL VAN ELEMENTE*

