Hoërskool Dr. Johan Jurgens

Physical Science Gr. 11

June 2025

Mid-year exam – Paper 2

Marks: 100

Time: 2 hours

Examiner: S Stoltz

Moderator: M Botha

INSTRUCTIONS AND INFORMATION

1. The question paper consists of SIX questions. Answer ALL the questions.
2. Start EACH question on a NEW page.
3. Number your answers correctly according to the numbering system used in this question paper.
4. Leave ONE line between two sub-questions, e.g., between QUESTION 2.1 and QUESTION 2.2.
5. A non-programmable calculator may be used.
6. Appropriate mathematical instruments may be used.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your FINAL numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions, etc. where required.
10. You are advised to use the two attached data sheets.
11. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Choose the answer and write only the letter (A – D) next to the question number (1.1 – 1.4), for example 1.10 E.

1.1 Which type of bonding is present in a sample of zinc at STP?

A. Covalent bonding
B. Hydrogen bonding
C. Ionic bonding
D. Metallic bonding (2)

1.2 Which formula represents a nonpolar molecule?

A. CH_4
B. HCl
C. H_2O
D. NH_3 (2)

1.3 Given the equation representing a reaction:

$$F + F \rightarrow F_2$$

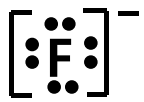
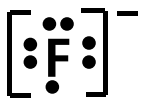
What occurs during this reaction?

A. Energy is absorbed as a bond is formed.
B. Energy is released as a bond is formed.
C. Energy is absorbed as a bond is broken.
D. Energy is released as a bond is broken. (2)

1.4 Based on the periodic table, an atom of which element in Group 16 has the greatest attraction for electrons in a chemical bond?

A. Oxygen
B. Sulphur
C. Selenium
D. Tellurium (2)

1.5 Which Lewis diagram represents a fluoride ion?

A. 	B. 
C. 	D. 

(2)

[10]

QUESTION 2

Consider the following compounds:

H_2, N_2, H_2O, NH_3, CH_4, HF, OF_2, HCN, HOCℓ

2.1 Define a *chemical bond*. (2)

2.2 Write down the formula(e) of the compound(s) from the given list that:

2.2.1 Is non-polar. (2)

2.2.2 Has one lone pair of electrons. (1)

2.2.3 Has a triple covalent bond. (2)

2.2.4 Contains polar bonds but is a non-polar molecule. (1)

2.3 Draw the Lewis structure of the following compounds:

2.3.1 HCN (2)

2.3.2 HOCℓ (2)

2.4 Die ammonium ion (NH_4^+) is formed from ammonia (NH_3).

2.4.1 Give the NAME of the type of bonding that occurs here. (1)

2.4.2 Use Lewis structures to show the formation of NH_4^+ from NH_3. (4)

2.5 Write down the molecular shape of:

2.5.1 H_2O (1)

2.5.2 CH_4 (1)

2.6 The results in the table below were obtained during an investigation to determine the values of the bond length of the different bonds in molecules of HCN.

BONDING ATOMS	BOND LENGTH (nm)
C and H	0,109
C and N	0,116

2.6.1 Define *bond length*. (2)

2.6.2 Explain why the bond length for the bond between the C and N atoms is longer than the bond length between the C and H atoms. (2)

2.6.3 What is the bond order for the bond between the C and N atoms? (1)

[24]

QUESTION 3

The table shows the boiling points of various substances from group 16, at 1 atm, on the periodic table.

Group 16 (VI) hydrides	Boiling Point (K)
H_2O	373,13
H_2S	212,82
H_2Se	213,50
H_2Te	270,95

3.1 Define the term *boiling point* in words. (2)

3.2 Is this a fair investigation? Write only YES or NO.
Give a reason for the answer. (2)

3.3 What is the NAME of the unit in which the boiling points are measured on the table? (1)

3.4 Write down the phase of the above compounds at room temperature. (1)

3.5 Explain, in terms of the strengths of intermolecular forces, why the boiling point of H_2O is much higher than those of the rest of group 16 hydrides. (3)

3.6 The boiling points increase from H_2S to H_2Te.

3.6.1 Identify the strongest type of intermolecular forces present. (1)

3.6.2 Explain the trend that can be seen in their boiling points. (2)

3.6.3 Give the formula of one of the above-mentioned compounds that will be a liquid at 0 °C? (1)

3.6.4 Which ONE of the hydrides in the table will have the highest vapour pressure? Explain the answer. (3)

3.7 Explain the meaning of “1 atm”. (2)

[18]

QUESTION 4

The article below contains information of ceramic products and how it is formed. Read the article below and answer the questions that follow:

Image Source: http://currentmarketreports01.blogspot.com/

Alumina ($A\ell_2O_3$) Ceramics

Alumina Ceramics Description

Alumina, or aluminium oxide $A\ell_2O_3$, with a molecular mass of 102, is the major source of aluminium in nature. $A\ell_2O_3$ has very high melting point, which is 2 072 °C and it is extremely hard.

Alumina ceramic is the most common technical ceramic material and relatively traditional material. High purity aluminium oxide ceramics as a fine ceramic material is widely used in a lot of industries. This material has superb performances in electrical insulation, high thermal conductivity, high chemical resistance, good wear resistance and low thermal expansion.

Alumina Ceramics Properties

Compound Formula	$A\ell_2O_3$
Molecular Weight	101.96
Appearance (Colour)	White
Melting Point	2,072° C
Boiling Point	2,977° C
Density	3.95 g/cm3
Tensile Strength	44 kpsi
Hardness	2000 Knoop

Alumina Ceramics Application

Alumina tubes are used for industrial furnace and thermal couple protector. High purity alumina materials are excellent for making parts for CVD, ion implants, photolithography, and semiconductor parts.

In traditional industries, ceramics are ideal for products such as injector tubes, gas nozzles and insulators.

Compared with metals, alumina ceramic material is extremely hard, making it an ideal material for abrasive, grinding media.

Alumina mortars and pestles are widely used in laboratories for grinding hard materials.

Article Source: https://www.preciseceramic.com/products/alumina-al2o3/

4.1 Define the term *percentage composition* in words. (2)

4.2 Write down the name and chemical formula of the compound used in ceramic products. (2)

4.3 Identify TWO properties of the compound mentioned in QUESTION 4.2 which makes it suitable for its application. (2)

4.4 Calculate the difference in boiling point of Al_2O_3 and H_2O. (2)

4.5 Determine the percentage composition of Al in Al_2O_3. (4)

[12]

QUESTION 5

5.1 The molar mass of hydrated sodium carbonate is 134 g mol^{-1}.
The formula of the hydrated sodium carbonate is given as $Na_2CO_3.nH_2O$.

5.1.1 Define the term *mole* in words. (2)

5.1.2 Calculate the number of moles crystal water (n) in the substance. (5)

5.2 While analysing a sample of a certain substance, it was found that it has the following percentage composition:

72,05% Cl ; 24,03% C ; 4,02% H

5.2.1 Define the term *empirical formula* in words. (2)

5.2.2 Determine the empirical formula of the substance. Show all calculations. (7)

[16]

QUESTION 6

The amount of substance is so important in chemistry that it is given its own name, which is the **mole**. The number of particles in a mole is equal to $6{,}022 \times 10^{23}$.

6.1 Define the term *one mole.* (2)

6.2 How many atoms will there be in 32 g of sulphur? (2)

6.3 2 moles of sulphur powder react with an unknown amount of zinc powder.

$$sulphur + zinc \xrightarrow{\Delta} zinc\ sulphide$$

6.3.1 Write a balanced chemical equation for this reaction. (3)

6.3.2 What is the meaning of the triangle above the arrow? (1)

6.3.3 Calculate the mass of sulphur that is used. (3)

6.3.4 What mass of zinc will be needed, if all the sulphur is to be used? (3)

6.3.5 Calculate the theoretical yield for this reaction. (3)

6.3.6 It was found that 175 g of zinc sulphide (ZnS) was produced.
Calculate the percentage yield. (3)

[20]

TOTAL: 100

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11

(CHEMIE)
DATA FOR PHYSICAL SCIENCES GRADE 11
(CHEMISTRY)

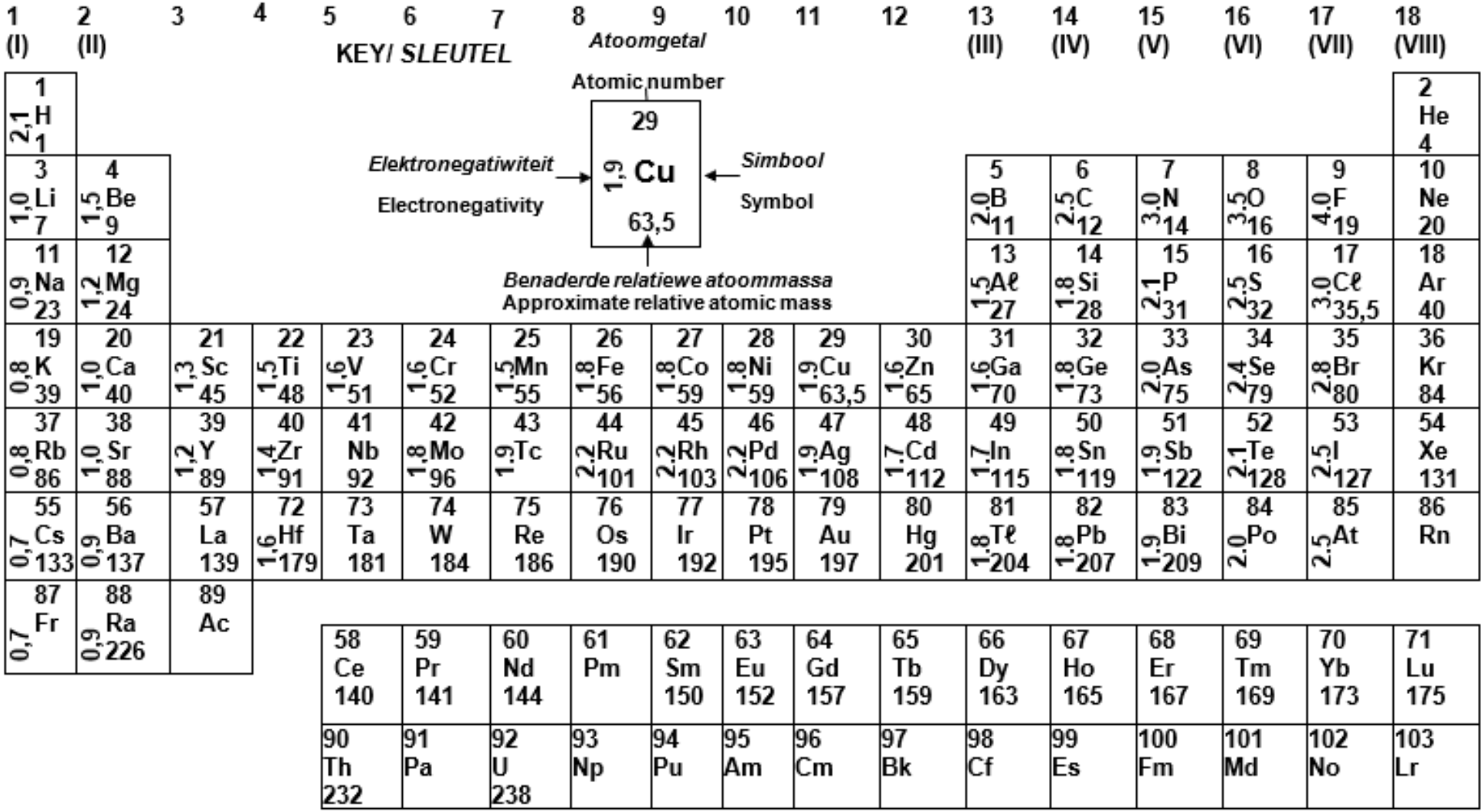
TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

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·mol^{-1}
Standard pressure *Standaarddruk*	p^e	$1{,}013 \times 10^5$ Pa
Molar gas constant *Molêre gaskonstante*	R	8,31 J.K^{-1}.mol^{-1}
Standard temperature *Standaardtemperatuur*	T^e	273 K

TABLE 2: FORMULAE/TABEL 2: FORMULES

$n = \frac{m}{M}$	$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$	$n = \frac{N}{N_A}$
$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$	$pV = nRT$		

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



PHYSICAL SCIENCE
GRADE 11
2025 JUNE – CHEMISTRY
EXAMINATION – MARKS: 100 - MARKING GUIDELINE

QUESTION 1

1.1 D ✓✓ (2)
1.2 A ✓✓ (2)
1.3 B ✓✓ (2)
1.4 A ✓✓ (2)
1.5 A✓✓ (2)
[10]

QUESTION 2

2.1 A mutual attraction between two atoms resulting from the simultaneous attraction between their nuclei and the outer electrons. ✓✓ (2)

2.2.1 H_2, ✓ N_2, ✓ CH_4 (ANY TWO) (2)

2.2.2 NH_3 ✓ (1)

2.2.3 N_2,✓ HCN ✓ (2)

2.2.4 CH_4 ✓ (1)

2.3.1

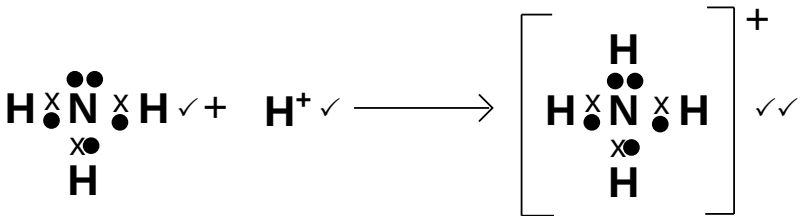
✓✓ (2)

2.3.2

✓✓ (2)

2.4.1 Dative covalent bond ✓ / coordinate covalent bond (1)

2.4.2



(4)

2.5.1 Bent ✓/ angular (1)

2.5.2 Tetrahedral ✓ (1)

2.6.1 The distance between the nuclei of two bonded atoms. ✓✓ (2)

2.6.2 The N atom is bigger than the H atom, ✓ resulting in a bigger distance between the N and C nuclei. ✓ (2)

2.6.3 3 ✓ (1)
[24]

QUESTION 3

3.1 The temperature at which the vapour pressure of a substance equals atmospheric pressure.✓✓ (2)

3.2 Yes ✓, Only one independent variable. ✓ / All variables are controlled except molecular mass. (2)

3.3 Kelvin ✓ (1)

3.4 Gas ✓ (1)

3.5 • H_2O has Hydrogen bonds, while the rest has dipole-dipole forces. ✓
• Hydrogen bonds are much stronger than dipole-dipole forces. ✓
• Thus more energy will be needed to overcome the hydrogen bonds than the dipole-dipole forces. ✓ (3)

3.6.1 Dipole-dipole forces ✓ (1)

3.6.2 • The molecular mass increases as you go down in the groups.✓
• As the molecular mass increases the strength of the dipole-dipole forces increases.✓ (2)

3.6.3 H_2Te ✓ (1)

3.6.4 H_2S ✓– the substance with the weakest intermolecular forces ✓ will have the lowest boiling point and therefore the highest vapour pressure.✓ (3)

3.7 "1 atm" refers to one standard atmosphere of pressure✓, which is approximately equal to the average atmospheric pressure at sea level, and is defined as 101 325 Pascals ✓ (Pa) or 1,013 x 10^5 Pa. (2)

[18]

QUESTION 4

4.1 The percentage of the total mass of the substance that is made up of each element. ✓✓ (2)

4.2 Aluminium oxide ✓ Al_2O_3 ✓ (2)

4.3 High melting point / Electrical insulator / High thermal conductivity / High chemical resistance / Good wear resistance / Low thermal expansion ANY TWO ✓✓ (2)

4.4 2 977 – 100 ✓= 2 877 ✓ (2)

4.5 $M(Al_2O_3) = 2(27) + 3(16)$ ✓
$= 102$ ✓

$\%Al = \frac{54}{102} \times 100$ ✓
$= 52{,}9\%$ ✓ (4)

[12]

QUESTION 5

5.1.1 A mole is the number of substance that contains the same number of elementary units as in 12 g C-12 atoms, present in 12 g of carbon-12.✓✓ (2)

5.1.2 $M(Na_2CO_3) = 106\ g.mol^{-1}$ ✓

$M(nH_2O) = 134 - 106$✓ $= 28\ g.mol^{-1}$ ✓

$N(H_2O) = 28 \div 18$✓ $= 1.56 = 2$ mole ✓ (5)

5.2.1 The formula which gives the simplest whole-number ratio of atoms in the compound. ✓✓ (2)

5.2.2

n	n(Cl) $= \frac{72,05}{36}$ $= 2,001$✓	n(C) $= \frac{24,03}{12}$ $= 2,003$✓	n(H) $= \frac{4,02}{1} = 4,02$✓
	$\frac{2,003}{2,001} = 1$✓	$\frac{2,003}{2,001} = 1$✓	$\frac{4,02}{2,001} = 2$ ✓

CH_2Cl✓

(7)

[16]

QUESTION 6

6.1 One mole is the amount of substance having the same number of particles as there are atoms in 12 g carbon-12. ✓✓ (2)

6.2 $6,022 \times 10^{23}$✓✓ sulphur atoms (2)

6.3.1 S✓ $+ Zn$✓ $\xrightarrow{\Delta} ZnS$ ✓ (3)

6.3.2 Heat ✓ must be added to the reaction (1)

6.3.3 $m_{sulphur} = nM$ ✓

$= 2(32)$ ✓

$= 64\ g$ ✓ (3)

6.3.4 $n_{zinc}:n_{sulphur} = 1:1 \quad \therefore 2\ mol\ zinc$ ✓

$m_{zinc} = nM$

$= 2(65)$ ✓

$= 130\ g$ ✓ (3)

6.3.5 $m_{ZnS} = nM$ ✓

$= 2(65 + 32)$ ✓

$= 194\ g$ ✓ (3)

6.3.6 $\%\ yield = \frac{actual\ yield}{theoretical\ yield} \times 100$ ✓

$= \frac{175}{194}$ ✓ $\times 100$

$= 90{,}02\ \%$ ✓ (3)

[20]

TOTAL: 100

TAXONOMY LEVELS					
GRADE 11					
PHYSICAL SCIENCES – Chemistry P2					
CONTROL TEST - TERM 2 - 2025					
MARKS: 100					
QUESTION	**RECALL**	**COMPREHENSION**	**ANALYSIS APPLICATION**	**EVALUATION SYNTHESIS**	**TOTAAL**
DESIRED %	**15%**	**35%**	**40%**	**10%**	**100%**
1.1		2			2
1.2		2			2
1.3	2				2
1.4		2			2
1.5		2			2
2.1	2				2
2.2.1		2			2
2.2.2		1			1
2.2.3		2			2
2.2.4		1			1
2.3.1			2		2
2.3.2			2		2
2.4.1	1				1
2.4.2			4		4
2.5.1		1			1
2.5.2		1			1
2.6.1	2				2
2.6.2		2			2
2.6.3		1			1
3.1	2				2
3.2		1			1
3.3				2	2
3.4			1		1
3.5			3		3
3.6.1		1			1
3.6.2			2		2
3.6.3			1		1
3.6.4			3		3
3.7				2	2
4.1	2				2
4.2	2				2
4.3		2			2
4.4		2			2
4.5			4		4

5.1.1	2				
5.1.2		5			
5.2.1		2			
5.2.2				7	
6.1	2				
6.2			2		
6.3.1			3		
6.3.2		1			
6.3.3			3		
6.3.4			3		
6.3.5			3		
6.3.6			3		
Total	**17**	**33**	**39**	**11**	**100**
Actual %	**17**	**33**	**39**	**11**	**100**
Desired %	**15%**	**35%**	**40%**	**10%**	**100**