



KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE**

GRADE 11

PHYSICAL SCIENCES P2

COMMON TEST

JUNE 2023

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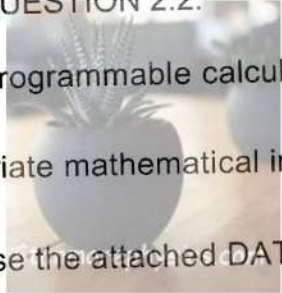
TIME: 2 hours

MARKS: 100

This question paper consists of 10 pages and a periodic table.



INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name on the **ANSWER BOOK**.
 2. This question paper consists of SIX questions. Answer ALL the questions in the ANSWER BOOK.
 3. Start EACH question on a NEW page in the ANSWER BOOK.
 4. Number the answers correctly according to the numbering system used in this question paper.
 5. Leave ONE line between two subsections, 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.
- 

QUESTION 1 (start on a new page)

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A - D) next to the question number (1.1 — 1.7) in the ANSWER BOOK, for example 1.8 D.

1.1 Which ONE of the following is a polar molecule?

- A CH₄
- B CO₂
- C CO
- D Cl₂

(2)

1.2 When NaCl crystals dissolve in water, aqueous Na⁺ and Cl⁻ ions form. What type of force exists between the Na⁺ ions and the H₂O molecules?

- A hydrogen bonding
- B dipole-dipole
- C ion-ion
- D ion-dipole



(2)

1.3 How many electrons are there in each SiH₄ molecule?

- A. 5
- B. 4
- C. 8
- D. 18

(2)

1.4 Which ONE of the following molecules is most unlikely to be formed?

- A Cl₂
- B He₂
- C O₂
- D N₂

(2)

1.5 Which ONE of the following statements concerning the lengths of the single, double and triple bonds between CARBON atoms is TRUE?

- A The single bond is shorter than either the double or triple bond.
- B The double bond is shorter than either the single or triple bond.
- C The triple bond is shorter than either the single or double bond.
- D The single, double, and triple bonds all have the same length. (2)

1.6 Which ONE of the following statements is TRUE?

- A ALL molecules have polar bonds.
- B Polar molecules have ONLY polar bonds.
- C Non-polar molecules CANNOT have polar bonds.
- D All diatomic molecules are non-polar. (2)

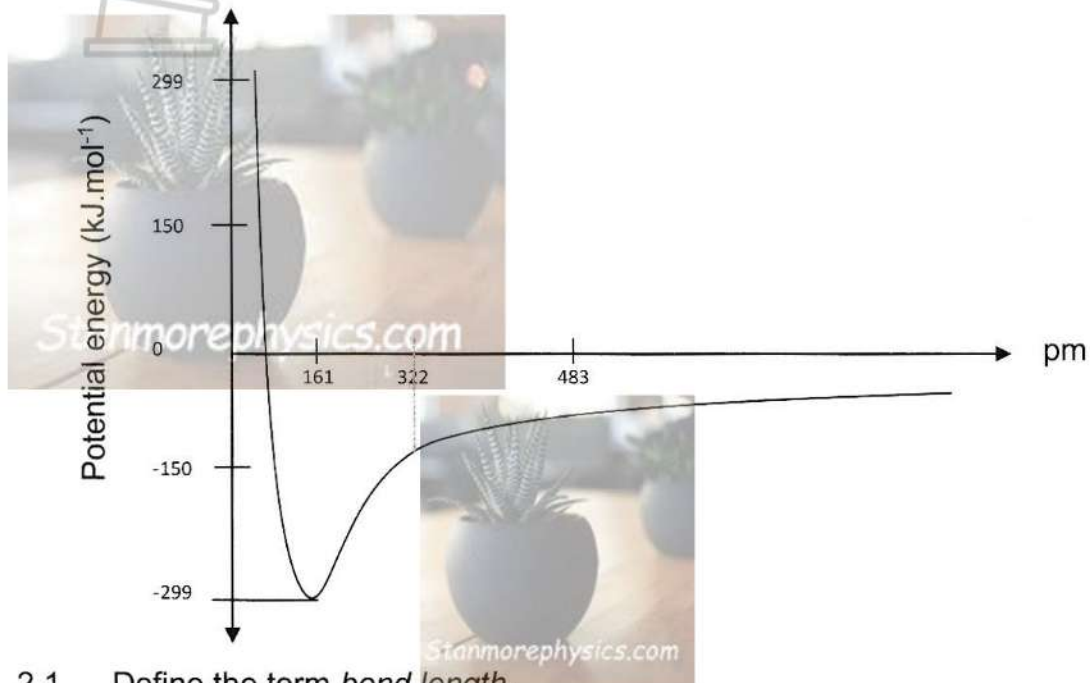
1.7 The amount of energy required to separate the N atoms in a N_2 molecule is $941 \text{ kJ}\cdot\text{mol}^{-1}$. Which ONE of the following values will be correct for the bond energy of O_2 in $\text{kJ}\cdot\text{mol}^{-1}$

- A 941
- B 495
- C 950
- D 1041 (2)

[14]

QUESTION 2 (start on a new page)

The graph below shows how the potential energy changes as two atoms (H and I) approach each other ($1\text{pm} = 1 \times 10^{-12}\text{ m}$)



- 2.1 Define the term *bond length*. (2)
- 2.2 From the graph, write down the bond length of HI in metres. (2)
- 2.3 Define the term *bond energy*. (2)
- 2.4 From the graph, write down the value of the bond energy for HI. (2)
- 2.5 Compare the bond lengths of H-Cl, H-Br and H-I.
- 2.5.1 Which of these molecules has the longest bond length? Give a reason for the answer (3)
- 2.5.2 Write down the NAME of the molecule with the highest bond energy. (2)

[13]

QUESTION 3 (start on a new page)

Study the list of molecules below and answer the questions that follow.



- 3.1 Define a *covalent bond*. (2)
- 3.2 Identify the molecule that has:
- 3.2.1 a triple bond. (1)
- 3.2.2 an ionic bond. (1)
- 3.2.3 ONE single covalent bond only. (1)
- 3.3 Draw the Lewis dot structure for the OF_2 molecule. (2)
- 3.4 NH_3 forms a special type of covalent bond when it combines with the hydrogen ion (H^+).
- 3.4.1 Name this type of covalent bond. (1)
- 3.4.2 Use Lewis diagrams to show the formation of this bond. (4)
- 3.4.3 NAME the ion formed as a result of this bond. (1)
- 3.4.4 Predict the shape of the ion formed. (1)
- 3.4.5 State TWO necessary conditions for the formation of this bond. (2)
- 3.5 Consider the PCl_5 molecule.
- 3.5.1 State the number of bond pairs and the number of lone pairs of electrons respectively, on the **P** atom. (2)
- 3.5.2 Is the bond between P and each Cl atom polar or non-polar? Give a reason for the answer. (2)
- 3.5.3 Is the PCl_5 molecule polar or non-polar? Give a reason for the answer. (2)
- 3.5.4 Define the term *solubility*. (3)
- 3.5.5 Is PCl_5 soluble in CCl_4 ? Give a reason for the answer. (2)

[27]

QUESTION 4 (start on a new page)

The boiling points of SIX compounds, represented by the letters **A**, **B**, **C** and **D**, are given in the table below.



	Compound	Boiling point (°C)
A	CH ₄	-164
B	NH ₃	-33
C	H ₂ O	100
D	SiH ₄	-112
E	Cl ₂	-34,6
F	I ₂	184

- 4.1 Define the term *boiling point*. (2)
- 4.2 Fully explain the difference in boiling points between compounds **A** and **B**. (4)
- 4.3 Define the term *vapour pressure*. (2)
- 4.4 Consider molecules **B** and **C** (H₂O and NH₃)
- 4.4.1 Explain why the boiling point of H₂O is higher than that of NH₃. (4)
- 4.4.2 Which molecule (H₂O or NH₃) has the LOWER vapour pressure? Give a reason for the answer. (2)
- 4.5 Define the term *electronegativity*. (2)
- 4.6 Show that the bonds in the SiH₄ molecule will **not** be ionic. (2)
- 4.7 Chlorine (Cl₂) and iodine (I₂) molecules are both diatomic and non-polar molecules, but have very different boiling points. Explain the difference in the boiling points of chlorine (Cl₂) and iodine (I₂). (4)

[22]

QUESTION 5 (start on a new page)

A group of grade 11 learners decided to investigate the effect of intermolecular forces on evaporation. They placed one drop of each of these liquids on a glass tile and recorded the time taken for each liquid to evaporate completely. The following results were obtained.

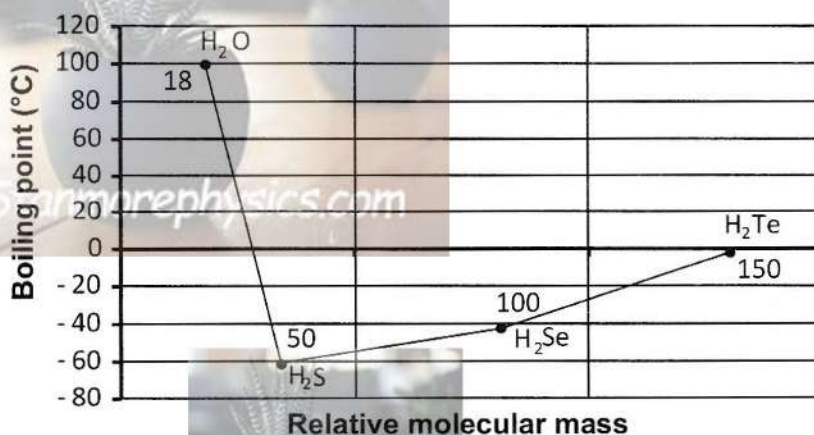
Type of liquid	Structural Formula	Evaporation time (seconds)
Acetone	$ \begin{array}{c} \text{H} \quad \text{O} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \quad \text{H} \end{array} $	5
Ethanol	$ \begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array} $	110
Water	$ \begin{array}{c} \text{O} \\ / \quad \backslash \\ \text{H} \quad \text{H} \end{array} $	> 3600

- 5.1 Name ONE apparatus, apart from the glass tile, that is essential for this investigation. (1)
- 5.2 Identify the independent variable in this investigation. (1)
- 5.3 Write down an investigative question for this investigation. (2)
- 5.4 Name TWO variables that must be kept constant. (2)
- 5.5 Explain why acetone evaporates faster than ethanol. (4)
- 5.6 Explain why it is not advisable to conduct this investigation in windy conditions. (2)

[12]

QUESTION 6 (start on a new page)

The graph below shows the boiling points of the hydrides of group VI of the periodic table versus their relative molecular masses.

GRAPH OF BOILING POINT VERSUS RELATIVE MOLECULAR MASS

- 6.1 What is the phase (solid, liquid or gas) of H₂S at 25°C? (1)
- 6.2 Name the type of Van der Waals forces between molecules of H₂S. (1)
- 6.3 State and explain the trend in the boiling points from H₂S to H₂Te. (3)
- 6.4 Write down the NAME of the hydride:
- 6.4.1 With the weakest intermolecular forces. (1)
- 6.4.2 That requires the most energy to undergo a phase change. (1)
- 6.5 Explain why Hydrogen bonds cannot form between molecules of H₂Te. (2)
- 6.6 Explain why the boiling point of water does not follow the trend as shown in the graph (3)

[12]**TOTAL MARKS: 100**



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MARKING GUIDELINE

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NB: This marking guideline consists of 5 pages.

QUESTION ONE

- 1.1 C ✓✓
- 1.2 D ✓✓
- 1.3 D ✓✓
- 1.4 B ✓✓
- 1.5 C ✓✓
- 1.6 B ✓✓
- 1.7 B ✓✓

[14]

QUESTION TWO

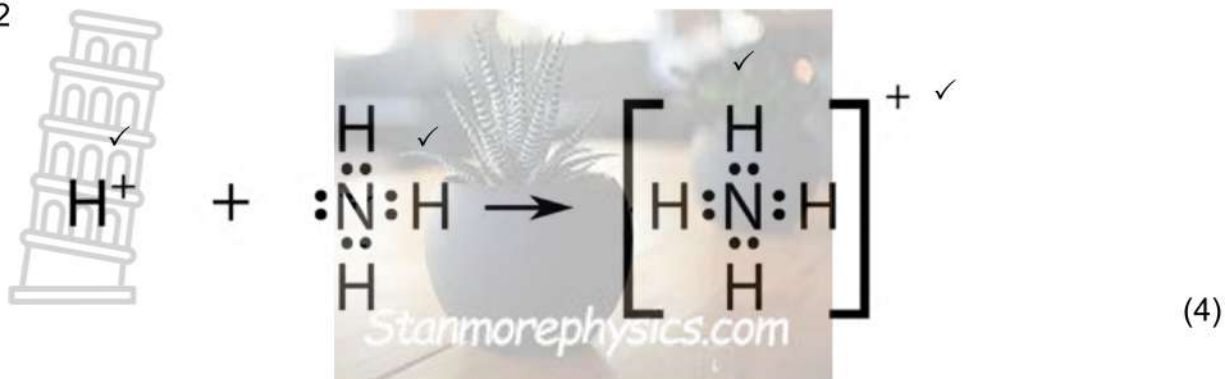
- 2.1 The average distance between the nuclei of two atoms in a molecule. ✓✓ (2)
- 2.2 $161 \times 10^{-12} \text{ m}$ ✓✓ (2)
- 2.3 Amount of energy needed to break one mol of a specific covalent bond in the gaseous phase. ✓✓ (2)
- 2.4 299 kJ.mol^{-1} ✓✓ (2)
- 2.5.1 H-I ✓
 Since the I is a largest atom ✓ when compared to Cl and Br ✓, the H-I bond length will be the longest. (3)
- 2.5.2 Hydrogen iodide ✓✓ (2)

[13]

QUESTION 3

- 3.1 The sharing of electrons when orbitals overlap ✓✓ (2)
- 3.2.1 N_2 ✓ (1)
- 3.2.2 NaCl ✓ (1)
- 3.2.3 HCl ✓ (1)
- 3.3 $\text{:}\ddot{\text{F}}\text{:}\ddot{\text{O}}\text{:}\ddot{\text{F}}\text{:}$ ✓✓ (2)
- 3.4.1 Dative covalent bond. ✓ (1)

3.4.2



3.4.3 Ammonium ion (1)

3.4.4 Tetrahedral (1)

3.4.5 - one atom has to have an empty valence shell. (2)
 - The other atom has to have a lone pair of electrons. (2)

3.5.1 5 bond pairs, 0/Zero/No lone pairs. (2)

3.5.2 Polar $\Delta EN = 3,0 - 2,1 = 0,9 / \Delta EN < 2,1$ (2)

3.5.3 Non-polar No net dipole (moment). (2)

3.5.4 Yes Non-polar substance will dissolve in non-polar. "Like dissolves Like" (3)

3.5.5 The property of a solid, liquid or gaseous chemical substance (solute) to dissolve in a solid, liquid or gaseous solvent to form a homogenous solution. (2)

[27]

QUESTION 4

4.1 The temperature at which the vapour pressure of a liquid equals atmospheric pressure. (2)

4.2. • Between molecules of A are weak London forces/dispersion forces/ induced dipole forces. (2)
 • Between molecules of B are strong hydrogen bonds. (2)
 • Hydrogen bonds are stronger than London forces/dispersion forces/ induced dipole forces. (2)
 • More energy needed to overcome intermolecular forces in B than in A. (2)

4.3 The pressure exerted by a vapour at equilibrium with its liquid in a closed system. (2)

4.4.1 Both ammonia molecule and water molecule contain hydrogen bonds. (2)

However, ammonia has ONE site for hydrogen bonding/ ONE lone pair of electrons, while water has TWO sites for hydrogen bonding/TWO lone pair of electrons. ✓

Therefore, force of attraction between water molecules are stronger than that of ammonia molecules. ✓ (4)

Thus more energy is needed to overcome intermolecular forces in water, therefore higher boiling point. ✓

4.4.2 C/ H₂O / water ✓ It has the higher boiling point. ✓ (2)

4.5 The measure of the tendency of an atom in a molecule to attract bond pairs. ✓✓ (2)

4.6 $\Delta EN = 2,1 - 1,8$
 $= 0,3$ ✓
 Since $\Delta EN < 2.1$ ✓, Bonds are not ionic (2)

4.7 The chlorine (Cl₂) molecule has smaller molecular mass than the iodine (I₂) molecule ✓. For non-polar molecules, the strength of the induced dipole forces/London forces increases with an increase in molecular mass. ✓
 Intermolecular forces are weaker between molecules of chlorine. ✓
 Less energy is required to overcome the intermolecular forces in chlorine. ✓ (4)

[22]

QUESTION 5

5.1 Dropper/stop watch ✓ (1)

5.2 Type of liquid ✓ (1)

5.3 What is the relationship between type of liquids and the evaporation time? ✓✓ (2)

5.4 Equal amounts of liquids ✓
 Temperature ✓ (2)

5.5 Acetone has weak dipole-dipole force. ✓
 Ethanol has (London forces and) strong Hydrogen bonds. ✓
 Therefore, the intermolecular forces are stronger in ethanol. ✓
 At the same temperature, liquids with weaker intermolecular forces will evaporate faster. ✓ (4)

5.6 Wind affects / speeds up evaporation ✓ and will vary during the experiment. ✓ (2)

[12]

QUESTION 6

- 6.1 Gas ✓ (1)
- 6.2 Dipole-dipole forces. ✓ (1)
- 6.3 Boiling point increase from H_2S to H_2Te . ✓
Since Molecular size/ Molecular mass increase from H_2S to H_2Se to H_2Te . ✓✓ (3)
- 6.4.1 Hydrogen sulphide ✓ (1)
- 6.4.2 Water ✓ (1)
- 6.5 In H_2Te , H is bonded to Te which has a relatively low EN. Therefore cannot form (2)
hydrogen bonds. ✓✓
- 6.6 Water has a boiling point much higher than the other three hydrides ✓
due to the presence of strong hydrogen bonds ✓ and therefore
more energy is needed to overcome intermolecular forces between molecules of
water. ✓ (3)

[12]

TOTAL MARKS:100