Hoërskool Johan Jurgens

Physical Science Gr. 11

19 September 2025

Term 3 cycle test

Marks: 100

Time: 2 hours

Examiner: S Stoltz

Moderator: N Gertenbach

INSTRUCTIONS AND INFORMATION

1. The question paper consists of six questions and ten pages. Answer all 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 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 (1.1–1.10), for example 1.10 E.

1.1 The CORRECT order of increasing strength in intermolecular forces is:

A. H-bonding < ion – dipole < dipole – dipole < London forces

B. H-bonding > ion – dipole < dipole – dipole > London forces

C. H-bonding > ion – dipole > dipole – dipole > London forces

D. H-bonding > ion – dipole > dipole – dipole < London forces (2)

1.2 Which ONE of the following hypothetical chemical equations represents an exothermic reaction?

A. $AB + CD \rightarrow AC + BD + energy$

B. $AB + CD + energy \rightarrow AC + BD$

C. $AB + CD \rightarrow AC + BD \quad \Delta H > 0$

D. $AB + CD \rightarrow AC + BD \quad \Delta H = +$ (2)

1.3 Which ONE of the following gases occupies the largest volume at STP?

A. 32 g of $O_2(g)$

B. 34 g of $NH_3(g)$

C. 7 g of $N_2(g)$

D. 4 g of He(g) (2)

1.4 Which expression represents the heat of reaction (ΔH) for a chemical change?

A. $(PE_{products}) + (PE_{reactants})$

B. $(PE_{products}) – (PE_{reactants})$

C. $(PE_{products}) \div (PE_{reactants})$

D. $(PE_{products}) \times (PE_{reactants})$ (2)

1.5 Which of the following is NOT a property of an ideal gas?

A. There are no forces of attraction between the molecules.

B. The collisions between the molecules are perfectly elastic.

C. The volume occupied by the gas is equal to the total volume of all the individual molecules.

D. The product of the pressure and the volume of the gas is constant at constant temperature. (2)

1.6 According to the kinetic molecular theory, molecules of gases at the same temperature always have the same ...

A. mass

B. volume

C. pressure

D. average kinetic energy (2)

1.7 Which one of the following statements about a chemical reaction is CORRECT? The actual yield of a chemical reaction is usually:

A. equal to the percentage yield.

B. greater than the percentage yield.

C. less than the theoretical yield.

D. greater than the theoretical yield. (2)

[14]

QUESTION 2

2.1 During a discussion, two learners argue about the boiling points of two compounds. The two compounds under discussion are CO_2 and NH_3. Both learners agree that the two compounds are gases at STP, but they struggle to decide which one of the two compounds will have the lowest boiling point.

2.1.1 Define *boiling point.* (2)

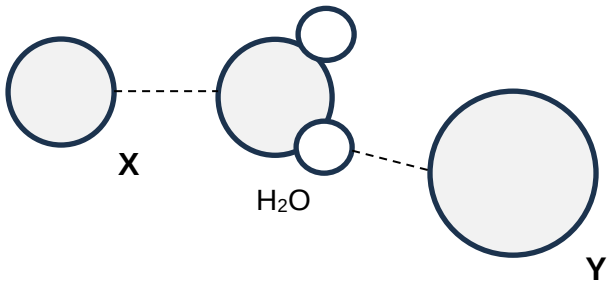
2.1.2 Explain the difference between INTERMOLECULAR forces and INTERATOMIC forces by referring to the forces present in carbon dioxide. (2)

2.1.3 What does the abbreviation **STP** stand for? (1)

2.1.4 Predict which ONE of the two compounds, will have the lower boiling point. Only write CO_2 or NH_3. (1)

2.1.5 Explain your answer to QUESTION 2.1.4 by comparing the:
- Type of intermolecular forces present in both compounds.
- Strength of the intermolecular forces.
- Energy needed to overcome these forces. (4)

2.2 NaCl is dissolved in H_2O.



2.2.1 Name the type of intermolecular forces that exists between water and the dissolved NaCl, as indicated by the dotted lines. (1)

2.2.2 Which ONE of the ions in the above sketch represent a Cl^- ion? Write only **X** or **Y**. (1)

2.2.3 Give a reason for your answer to QUESTION 2.2.2. (2)

2.2.4 Redraw the water molecule, as in the above diagram, and indicate the polarity of the molecule by using partial charges. (2)

2.3 Give ONE TERM that describes each of the following physical properties:

2.3.1 The intermolecular attraction of molecules to molecules of a different substance (e.g. between water and glass). (1)

2.3.2 The tendency of liquid to rise in a very thin tube. (1)

2.3.3 A liquids resistance to flow. (1)

[19]

QUESTION 3

Pure $CaCO_3$ powder was dropped into a test tube containing a 0,12 $mol.dm^{-3}$ HCl solution of unknown volume. The following reaction took place:

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

Upon completion of the reaction, it was found that:

- 1,146 dm^3 of CO_2 was produced at STP.
- 110 cm^3 of HCl with a concentration of 0,09 $mol.dm^{-3}$ remained in the test tube.

3.1 Explain what is meant by an *excess reactant*. (2)

3.2 Identify the excess reactant in the above reaction. (1)

3.3 Calculate the:

3.3.1 Number of moles of CO_2 produced. (3)

3.3.2 Initial mass of HCl(aq) that was present in the test tube. (6)

3.4 5,68 g $CaCO_3$ was added in the reaction vessel to start the reaction.

Calculate the:

3.4.1 Theoretical yield of CO_2 in grams. (5)

3.4.2 Percentage yield of CO_2. (3)

[20]

QUESTION 4

4.1 The following relationship applies to an ideal gas: $\mathbf{pV} \propto \mathbf{T}$

4.1.1 Write down what each of **p** ; **V** and **T** represents in the relationship. (3)

4.1.2 Draw a sketch graph to represent the relationship between **pV** and **T**. (2)

4.1.3 Under what conditions will a real gas deviate the most from ideal gas behaviour? (2)

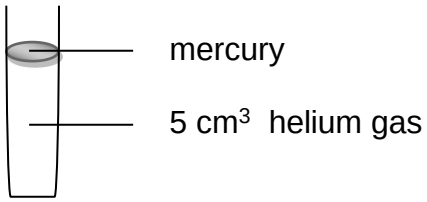
4.2 Describe an ideal gas in terms of:

4.2.1 Volume. (1)

4.2.2 Intermolecular forces. (1)

4.2.3 Collisions. (1)

4.3 The glass tube contains helium gas which is sealed by a drop of mercury (Hg(g)) so that the helium gas cannot escape. The volume of the helium gas is measured on a particular day at sea level in Durban, while the ambient temperature is a constant ***T***.



4.3.1 Give TWO reasons why helium exhibits almost ideal gas properties. (2)

4.3.2 A scientist wants to study the effect of altitude on the mercury level. The glass tube and contents are carefully transported from Durban(standard pressure) to Johannesburg which is 2500 m above sea level and the ambient temperature is still a constant ***T***. The scientist notices that there is a change in the volume of helium gas. Provide precise reasons for this observation. (3)

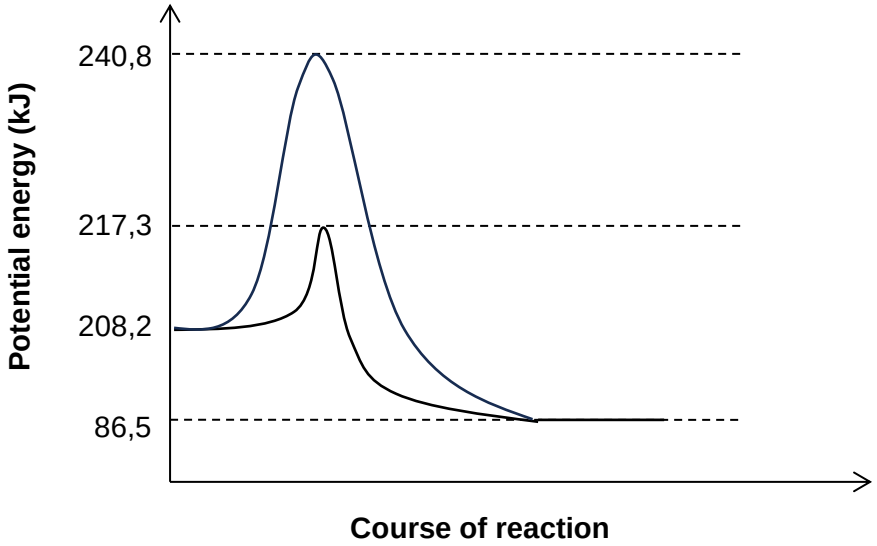
4.3.3 Is the level of the mercury drop HIGHER, LOWER or the SAME in Johannesburg compared to what it was in Durban? (1)

4.3.4 Calculate the volume of the helium gas in the glass tube when it is in Johannesburg and experiences a pressure of 80 kPa. (4)

[20]

QUESTION 5

The graph below shows the energy changes for a certain reaction.
Study the graph and answer the questions that follow.



5.1 Is the reaction EXOTHERMIC or ENDOTHERMIC?
Give a reason for the answer. (2)

5.2 Define the term *activation energy*. (2)

5.3 Write down the values for the:

5.3.1 Energy of the reactants. (1)

5.3.2 Energy of the products. (1)

5.3.3 Activation energy for the reverse reaction. (2)

5.3.4 Activation energy for the catalysed forward reaction. (2)

5.3.5 Energy of the activated complex in the absence of a catalyst. (1)

5.4 Calculate the heat of reaction, (ΔH), for the reverse reaction. (3)

5.5 What effect will the addition of the catalyst have on:
(Choose INCREASES, DECREASES or REMAINS THE SAME)

5.5.1 The energy of the products? (1)

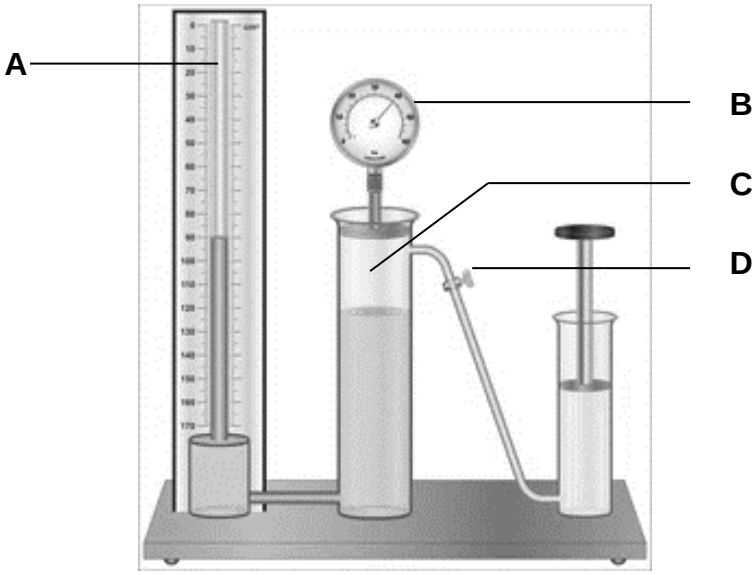
5.5.2 The heat of reaction? (1)

5.5.3 The activation energy for the reverse reaction? (1)

[17]

QUESTION 6

The figure shows the apparatus used to investigate the relationship between the pressure and the volume of a specific mass of gas.



6.1 Name and DEFINE the law investigated by this apparatus. (3)

6.2 Which amount of gas is being investigated, **A** or **C**? (1)

6.3 Name the components of the apparatus indicated by **B** and **D**. (2)

6.4 Can the oil in the apparatus be replaced with water?
Write only YES or NO. (1)

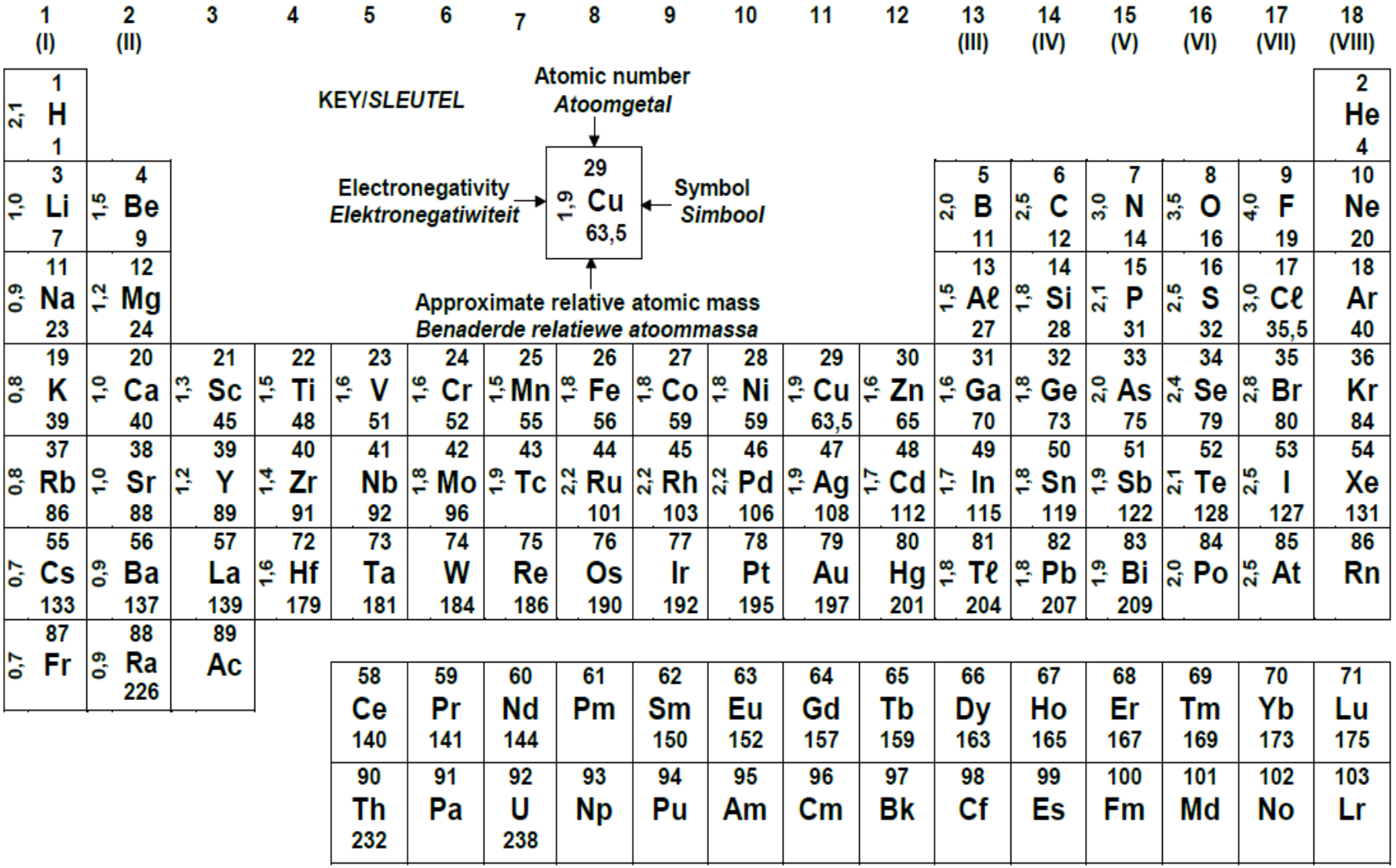
6.5 Explain your answer to QUESTION 6.4. (2)

6.6 One of the requirements of the experiment is to keep the temperature constant. Name a precaution that should be taken to keep the temperature constant. (1)

[10]

TOTAL: 100

TABLE 3: THE PERIODIC TABLE OF ELEMENTS/*TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE*



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 x 10^{23} mol^{-1}
Molar gas constant *Molêre gaskonstante*	R	8,31 $J.K^{-1}.mol^{-1}$
Charge on electron *Lading op elektron*	e	-1,6 x 10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 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 x 10^5 Pa
Standard temperature *Standaardtemperatuur*	$T^\ominus$	273 K

TABLE 2: FORMULAE/TABEL 2: FORMULES

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

19 SEPTEMBER 2025 GRADE 11 CYCLE TEST: MEMO

QUESTION 1

1.1 C (2)
1.2 A (2)
1.3 B (2)
1.4 B (2)
1.5 C (2)
1.6 D (2)
1.7 C (2)

[14]

QUESTION 2

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

2.1.2 INTERMOLECULAR forces are the forces that exist between the molecules of CO_2. ✓
INTERATOMIC forces occur between the atoms of carbon and oxygen within the molecule itself. ✓ (2)

2.1.3 Standard temperature and pressure. ✓ (1)

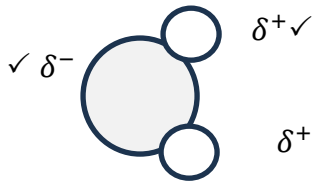
2.1.4 CO_2 ✓ (1)

2.1.5 CO_2: London forces✓; NH_3: H-bonds✓
London forces are weaker than H-bonds. ✓ // H-bonds are stronger than London forces.
Less energy is needed to overcome the London forces in CO_2, therefore CO_2 has a lower boiling point. ✓ // More energy will be needed to overcome the H-bond forces in NH_3, therefore NH_3 will have a higher boiling point. (4)

2.2.1 Ion – dipole ✓ (1)

2.2.2 **Y** ✓ (1)

2.2.3 The radius of the Cl^- - ion is greater than the radius of a Na^+ ion. ✓✓**OR**
The Cl^- - ion is directed in such a way that it is attracted to the positive part of the water molecule (hydrogen side). ✓✓ (2)

2.2.4 

(2)

2.3.1 Adhesion ✓ (1)

2.3.2 Capillarity ✓ (1)

2.3.3 Viscosity ✓ (1)

[19]

QUESTION 3

3.1 The reactant that remains after a reaction is complete.✓✓ (2)

3.2 HCl ✓ (1)

3.3.1 $n = \frac{V}{V_m}$✓

$n = \frac{1,146}{22,4}$✓
$n = 0,0512\ mol$✓ (3)

3.3.2 Ratio: $HCl : CO_2$
2 : 1

2✓ (0,0512) = 0,102 mol HCl reacted

$n_{HCl(excess)} = cV$✓
= 0,09(110 x 10^{-3}) ✓
= 9,9 x 10^{-3} mol

$n_{HCl(i)} = moles\ that\ reacted + excess\ moles$
= 0,102 + 9,9 x 10^{-3} ✓
= 0,11 mol

$m_{HCl(i)} = nM$
= (0,112)(36,5) ✓
= 4,088 g✓ (6)

3.4.1 $n = \frac{m}{M}$ ✓
$n = \frac{5,68}{100}$ ✓
$n = 0,0568\ mol$

Ratio: $CaCO_3 : CO_2$
1 : 1✓

m = nM
= (0,0568)(44) ✓
= 2,4992 g✓ (5)

3.4.2 $\%\ yield = \frac{actual}{theoretical} \times 100$

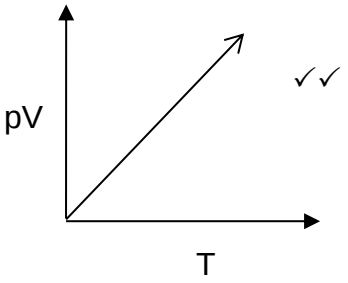
$= \frac{2,25}{2,4992}$✓✓ $\times 100$
$= 90,03\%$ ✓ (3)

[20]

QUESTION 4

4.1.1 p: pressure exerted by the gas ✓
V: volume occupied by the gas ✓
T: temperature of gas ✓ (3)

4.1.2



✓✓ (2)

4.1.3 High pressure ✓and low temperature ✓ (2)

4.2.1 Has identical particles of <u>zero volume</u>. ✓ (1)

4.2.2 <u>No intermolecular forces</u> between particles. ✓ (1)

4.2.3 All collisions of the molecules with themselves or the walls of the container, are <u>perfectly elastic</u>. ✓ (1)

4.3.1 Helium consists of small atoms which only exert very weak van der Waals forces ✓ on each other. These small atoms do not contribute significantly to the total gas volume ✓. (2)

4.3.2 <u>Air pressure decreases with an increase in height above sea level</u> ✓
(because the air that exerts a force on each square meter is less in Johannesburg than in Durban). A consequence of this is that <u>the lower air layer is less compressed in JHB</u> ✓than in DBN.
If the <u>temperature remains constant</u> <u>$p_1V_1 = p_2V_2$ for the specified mass of helium gas</u>.✓ (3)

4.3.3 HIGHER ✓ (1)

4.3.4 $$p_1V_1 = p_2V_2\checkmark$$
$$5(1{,}013 \times 10^5\checkmark) = 80 \times 10^3\checkmark(V_2)$$
$$V_2 = 6{,}33\ cm^3\checkmark$$ (4)

[20]

QUESTION 5

5.1 EXOTHERMIC ✓
$\Delta H < 0$ ✓ / $E_{products} < E_{reagents}$ (2)

5.2 The minimum energy needed for a reaction to take place. ✓✓ (2)

5.3.1 208,2 kJ ✓ (1)

5.3.2 86,5 kJ ✓ (1)

5.3.3 240,8 – 86,5 ✓ = 154,3 kJ ✓ (2)

5.3.4 217,3 – 208,2 ✓ = 9,1 kJ ✓ (2)

5.3.5 240,8 kJ ✓ (1)

5.4 $\Delta H = E_{Products} - E_{Reagents}$ ✓ = 208,2 – 86,5 ✓ = 121,7 kJ ✓ (3)

5.5.1 REMAINS THE SAME ✓ (1)

5.5.2 REMAINS THE SAME ✓ (1)

5.5.3 DECREASES ✓ (1)

[17]

QUESTION 6

6.1 Boyle's law. ✓
The pressure of an enclosed gas is inversely proportional to the volume it occupies at constant temperature. ✓✓ (3)

6.2 **A** ✓ (1)

6.3 **B:** Pressure gauge ✓
D: Stop-cock / Valve✓ (2)

6.4 NO ✓ (1)

6.5 Water will evaporate into space **A**. ✓
The gas in **A** must be dry. ✓ (If there is water vapor in **A**, it will affect the pressure and volume readings.) (2)

6.6 Change the pressure very slowly.//
Wait a while before the readings are made.✓ (1)

[10]

TOTAL: 100

TAXONOMY LEVELS					
GRADE 11					
PHYSICAL SCIENCES					
19 September 2025 Control test					
MARKS: 100					
QUESTION	RECALL	COMPREHENSION	ANALYSIS APPLICATION	EVALUATION SYNTHESIS	TOTAL
DESIRED %	15%	40%	35%	10%	100%
1.1		2			
1.2		2			
1.3			2		
1.4		2			
1.5		2			
1.6	2				
1.7		2			
2.1.1	2				
2.1.2			2		
2.1.3		1			
2.1.4			1		
2.1.5			4		
2.2.1		1			
2.2.2				1	
2.2.3				2	
2.2.4				2	
2.3.1			1		
2.3.2			1		
2.3.3			1		
3.1	2				
3.2		1			
3.3.1			3		
3.3.2			6		
3.4.1			5		
3.4.2			3		
4.1.1	3				
4.1.2				2	
4.1.3		2			
4.2.1		1			
4.2.2		1			
4.2.3		1			
4.3.1				2	
4.3.2				3	
4.3.3		1			
4.3.4			4		
5.1		2			
5.2	2				
5.3.1		1			
5.3.2		1			

5.3.3		2			
5.3.4		2			
5.3.5		1			
5.4			3		
5.5.1		1			
5.5.2		1			
5.5.3		1			
6.1	3				
6.2		1			
6.3		2			
6.4				1	
6.5		2			
6.6		1			
Total	**14**	**37**	**36**	**13**	**100**
Actual %	**14,0**	**37,0**	**36,0**	**13,0**	**100,0**
Desired %	**15%**	**40%**	**35%**	**10%**	**100**