KWAZULU-NATAL PROVINCE

EDUCATION

REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES

SEPTEMBER 2025

TEST

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MARKS: 100

TIME: 2 hours

This question paper consists of 8 pages and 2 data sheets.

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INSTRUCTIONS AND INFORMATION

1. This question paper consists of FIVE questions. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You are advised to use the attached DATA SHEETS.
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 et cetera where required.
10. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the correct answer and write only the letter (A–D) next to the question number (1.1–1.8) in the ANSWER BOOK, for example 1.9 E.

1.1 A certain chloride is formed when 0,5 moles of element X combines with 1,5 moles of chlorine. Which ONE of the following is the correct empirical formula for this chloride?

A $XC\ell$

B $XC\ell_2$

C $XC\ell_3$

D $X_2C\ell_3$ (2)

1.2 What is the volume occupied by 1 g of hydrogen gas at STP?

A $11{,}2\ dm^3$

B $22{,}4\ dm^3$

C $33{,}6\ dm^3$

D $44{,}8\ dm^3$ (2)

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1.3 Which ONE of the reactions below will produce hydrogen gas?

A $HC\ell + Mg \rightarrow$

B $HNO_3 + Mg(OH)_2 \rightarrow$

C $H_2SO_4 + MgCO_3 \rightarrow$

D $CH_3COOH + MgO \rightarrow$ (2)

1.4 Which ONE of the following pairs represents the CONJUGATE ACID and CONJUGATE BASE of HPO_4^{2-}?

	CONJUGATE ACID	CONJUGATE BASE
A	PO_4^{3-}	$H_2PO_4^-$
B	$H_2PO_4^-$	H_3PO_4
C	H_3PO_4	PO_4^{3-}
D	$H_2PO_4^{2-}$	PO_4^{3-}

(2)

1.5 Which ONE of the following processes is exothermic?

A Melting ice cubes.

B Baking bread.

C Burning a candle.

D Photosynthesis (2)

1.6 Which ONE of the following is correct for Boyle's Law?

A $p \propto \frac{1}{V}$ when temperature is constant.

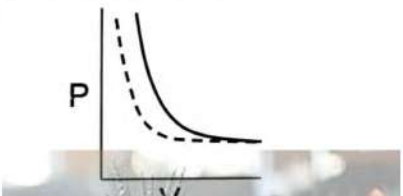
B $p \propto V$ when temperature is constant.

C $p \propto \frac{1}{T}$ when volume is constant.

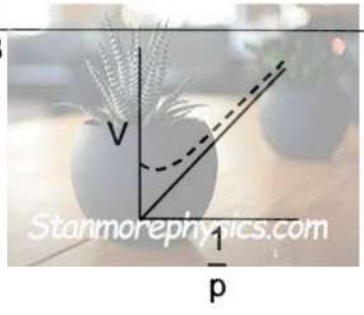
D $p \propto T$ when volume is constant. (2)

1.7 Which ONE of the following graphs represents the deviation of real gas behaviour (broken line) from ideal gas behaviour (solid line)?

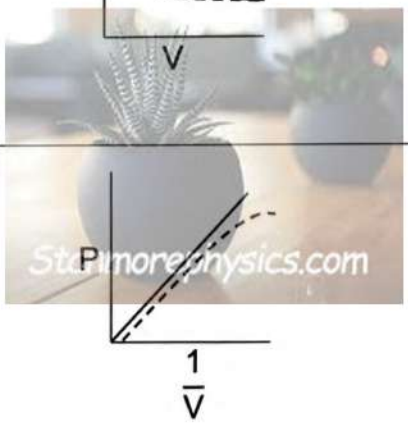
A



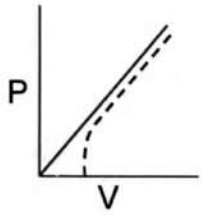
B



C



D



(2)

[2 x 7 = 14]

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QUESTION 2 (Start on a new page.)

2.1 Methane gas, CH_4, of mass 34,5 g is reacted with oxygen gas in a sealed container according to the following balanced chemical equation.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell)$$

The initial volume of the oxygen gas was 69,3 dm^3 when measured at STP

2.1.1 Define the term *limiting reagent.* (2)

2.1.2 Determine the limiting reagent in this reaction. (4)

2.1.3 Determine the total number of moles of gas in the container after the reaction is completed. (4)

2.1.4 Calculate the percentage yield of CO_2 if 58,08 g CO_2 was formed during the reaction. (3)

2.2 The solubility of calcium nitrate is highly endothermic. A 200 cm^3 solution is formed by dissolving 105,6 g $Ca(NO_3)_2$ in water.

2.2.1 Define *concentration.* (2)

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2.2.2 Calculate the concentration of this solution. (4)

2.2.3 Calculate the number of nitrate (NO_3^-) ions in the solution. (3)

2.2.4 How will the temperature of the final solution be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3)

2.3 A 29,05 g sample of a compound contains 11,62 g carbon, 1,94 g hydrogen and 15,49 g oxygen.

2.3.1 Determine the empirical formula of this compound. (5)

2.3.2 The molecular mass of this compound is 90 $g \cdot mol^{-1}$. Determine the molecular formula of this compound. (2)

[32]

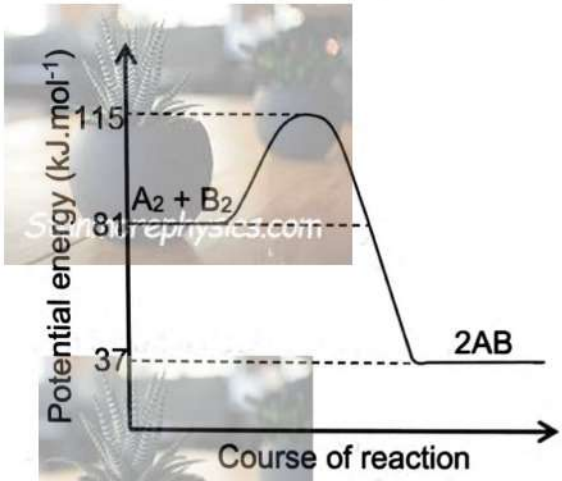
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QUESTION 3 (Start on a new page.)

The following reversible reaction takes place in a closed container.

$$A_2 + B_2 \rightleftharpoons 2AB$$

The graph below shows the changes in chemical potential energy during the course of the reaction.



3.1 Is the forward reaction endothermic or exothermic? Give a reason for the answer. (2)

3.2 Calculate ΔH for the forward reaction. (2)

3.3 Define *activation energy*. (2)

3.4 What is the activation energy for the reverse reaction? (1)

3.5 How does the strength of the bonds within the reactant molecules compare to the strength of the bonds within the product molecules for the forward reaction? Choose from STRONGER THAN, WEAKER THAN, or OF SIMILAR STRENGTH.
Give a reason for the answer. (3)

3.6 Redraw the above graph in your answer book, and label it A.
Do not label the axes or show any given values.
On the same set of axes, draw the graph that will be obtained if a catalyst is added. Label this as graph B. (2)

[12]

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QUESTION 4 (Start on a new page.)

4.1 The balanced equation below represents the ionisation of nitric acid (HNO_3) in water:

$$HNO_3(\ell) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + NO_3^-(aq)$$

4.1.1 Define an acid in terms of the *Lowry-Brønsted theory*. (2)

4.1.2 Write down the FORMULAE of the TWO bases in the equation above. (2)

4.1.3 Is nitric acid a STRONG or a WEAK acid? Give a reason for the answer. (2)

4.1.4 Define an *ampholyte*. (2)

4.1.5 Write down the formula of an ampholyte present in the equation above. (1)

4.2 A learner performs a titration using a standard potassium hydroxide solution of concentration 0,1 mol·dm^{-3} and sulphuric acid of unknown concentration. The balanced equation for the reaction is:

$$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(\ell)$$

4.2.1 Define a *standard solution*. (2)

The titration is done three times (Runs 1, 2 and 3) using the same indicator. The volumes of the acid and the base solutions used for each run are indicated in the table below.

RUN	VOLUME OF KOH (cm^3)	VOLUME OF H_2SO_4 (cm^3)
1	25	21,10
2	25	20,90
3	25	21,24

4.2.2 Using the above data, determine the concentration of the H_2SO_4 solution. (5)

4.2.3 The following is a list of possible indicators that can be used.

Indicator	Methyl orange	Bromothymol blue	Phenolphthalein
pH range	4 – 6	6 – 8	8 – 10

Which indicator is most suitable for this titration? Give a reason for the answer (2)

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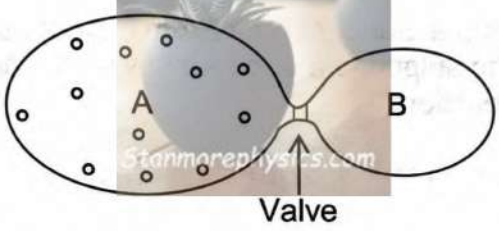
4.3 A solution is formed by adding 30cm^3 of HCℓ of concentration 0,15 mol·dm^{-3} to 20 cm^3 of $Ca(OH)_2$ of concentration 0,1 mol·dm^{-3}, according to the following balanced equation.

$$Ca(OH)_2 + 2HC\ell \rightarrow CaC\ell_2 + 2H_2O$$

Determine the final pH of the solution. (8)
[26]

QUESTION 5 (Start on a new page.)

5.1 A gas is contained in Chamber A, which has a volume of 5,3 dm³, and is sealed off from Chamber B, which has a volume of 3.2 dm³. Initially, only Chamber A contains gas at a pressure of 135,2 kPa, while Chamber B is a vacuum (contains no gas). The chambers are then connected by opening a valve between them, and the gas is allowed to expand freely. The temperature remains constant and no gas escapes.



5.1.1 State *Boyle's Law* in words. (2)

5.1.2 Explain, in terms of Boyle's Law, what happens to the pressure of the gas after the valve is opened. (2)

5.1.3 Calculate the final pressure of the gas after the valve is opened. (4)

5.2 Sketch a graph that shows the relationship between **pressure (y-axis)** and **volume (x-axis)** for a fixed amount of gas at constant temperature. (2)

5.3 State the conditions of temperature and pressure under which a real gas behaves as an ideal gas. (2)

5.4 Which real gas behaves the closest to an ideal gas? Explain the answer. (4)
[16]

TOTAL: 100

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DATA FOR PHYSICAL SCIENCES GRADE 11
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$
Molar gas constant *Molêre gaskonstante*	R	$8{,}31\ J{\cdot}K^{-1}{\cdot}mol^{-1}$
Standard pressure Standaarddruk	p^θ	$1{,}013 \times 10^5\ Pa$
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22{,}4\ dm^3{\cdot}mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^θ	273 K

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$p_1V_1 = p_2V_2$ (T constant)	$pH = -\log [H_3O^+]$
$n=\frac{m}{M}$	$n=\frac{N}{N_A}$
$n=\frac{V}{V_m}$	$c=\frac{n}{V}$ OR/*OF* $c=\frac{m}{MV}$

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



1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 H 1																	2 He 4
1,0 Li 7	1,5 Be 9											2,0 B 11	2,5 C 12	3,0 N 14	3,5 O 16	4,0 F 19	10 Ne 20
0,9 Na 23	1,2 Mg 24											1,5 Aℓ 27	1,8 Si 28	2,1 P 31	2,5 S 32	3,0 Cℓ 35,5	18 Ar 40
0,8 K 39	1,0 Ca 40	1,3 Sc 45	1,5 Ti 48	1,6 V 51	1,6 Cr 52	1,5 Mn 55	1,8 Fe 56	1,8 Co 59	1,8 Ni 59	1,9 Cu 63,5	1,6 Zn 65	1,6 Ga 70	1,8 Ge 73	2,0 As 75	2,4 Se 79	2,8 Br 80	36 Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1,4 Zr 91	41 Nb 92	1,8 Mo 96	1,9 Tc	2,2 Ru 101	2,2 Rh 103	2,2 Pd 106	1,9 Ag 108	1,7 Cd 112	1,7 In 115	1,8 Sn 119	1,9 Sb 122	2,1 Te 128	2,5 I 127	54 Xe 131
0,7 Cs 133	0,9 Ba 137	57 La 139	1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	1,8 Tℓ 204	1,8 Pb 207	1,9 Bi 209	2,0 Po	2,5 At	86 Rn
0,7 Fr 87	0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

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