KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES
COMMON TEST
SEPTEMBER 2023

TIME: 2 hours

MARKS: 100

This question paper consists of 8 pages, one graph sheet, and two data sheets.

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name on the **ANSWER BOOK.**
2. This question paper consists of **SEVEN** 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 SHEET.
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 MULTIPLE CHOICE QUESTIONS

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 — 1.6) in the ANSWER BOOK, for example 1.7 D.

1.1 The number of moles of chloride ions in 111g of calcium chloride, $CaC\ell_2$, is ...

A 1
B 2
C 0,5
D 1,47 (2)

1.2 Which ONE of the following contains $6,02 \times 10^{23}$ atoms?

A 18 g of Ar gas.
B 32 g of O_2 gas.
C 5,6 dm^3 of NH_3 gas at STP.
D 22,4 dm^3 of CO gas at STP. (2)

1.3 Which ONE of the following processes is EXOTHERMIC?

A Melting of ice.
B Evaporation of water.
C Combustion of petrol in a car engine.
D Reacting a salt in water to form an ice-pack. (2)

1.4 Consider the following chemical reaction:

$$NH_3\,(g) + H_2O\,(\ell) \rightarrow NH_4^+(aq) + OH^-\,(aq)$$

In this equation, H_2O is the ...

A base because it donates a proton.
B acid because it accepts a proton.
C base because it accepts a proton.
D acid because it donates a proton. (2)

1.5 Which ONE of the following species CANNOT be an ampholyte?

A H_2O
B HPO_4^{2-}
C HSO_4^-
D SO_4^{2-} (2)

1.6 When 50 cm^3 of sulphuric acid, H_2SO_4, of concentration 0,1 $mol \cdot dm^{-3}$ is diluted to a volume of 200 cm^3, the concentration of the new solution (in $mol \cdot dm^{-3}$) will be…

A 0.025
B 0,25
C 0,05
D 0,033 (2)

[12]

QUESTION 2

Aspirin is known by the chemical name acetylsalicylic acid. It is made up of C, H and O only. A sample of aspirin has the following percentage composition:

C	H	O
58,065%	7,527%	

2.1 Define the term *empirical formula*. (2)

2.2 What is the percentage of oxygen in aspirin? (1)

2.3 Determine the empirical formula of aspirin. (5)

2.4 If the molecular mass of aspirin is 186g.mol^{-1}, determine its molecular formula. (2)

[10]

QUESTION 3

3.1 A 2,3 kg sample of iron (III) oxide, Fe_2O_3, is added to 1,7 kg of carbon monoxide (CO) according to the following balanced equation:

$$3Fe_2O_3\,(s) + CO(g) \rightarrow 2Fe_3O_4\,(s) + CO_2\,(g)$$

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

3.1.2 Identify the limiting reagent in the reaction by means of a suitable calculation. (5)

3.1.3 Calculate the maximum mass of Fe_3O_4 that can be produced. (3)

3.1.4 The yield in this reaction was found to be 76%. Calculate the mass of Fe_3O_4 that was actually produced. (3)

3.2 The following reaction takes place in a cylinder with a movable lid:

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

5 volumes of $SO_2(g)$ and 3 volumes of $O_2(g)$ are injected into the cylinder at constant temperature.
If the reaction goes to completion, determine the total volume of gas that will be present in the cylinder. (4)
[17]

QUESTION 4

15g of IMPURE $Mg(OH)_2$ was reacted with excess phosphoric acid to produce 16g of $Mg_3(PO_4)_2$ according to the following balanced equation:

$$3Mg(OH)_2\,(s) + 2H_3PO_4\,(aq) \rightarrow Mg_3(PO_4)_2\,(s) + 6H_2O\,(\ell)$$

4.1 Calculate the percentage purity of the $Mg(OH)_2$. (5)

4.2 If 20g of the same impure $Mg(OH)_2$ was used in the above reaction, how will each of the following be affected?
Choose from INCREASES, DECREASES or REMAINS THE SAME.

4.2.1 The mass of $Mg_3(PO_4)_2$ produced. (1)

4.2.2 The percentage purity of the $Mg(OH)_2$. (1)

4.3 Explain the answer to Question 4.2.2. (2)
[9]

QUESTION 5

A group of science learners carried out an experiment to verify Boyles's Law for a certain gas. The learners set the pressure to pre-determined values and read off the corresponding volume of the gas for each value of the pressure.
The data collected is shown in the table below. **x**, **y** and **z** represent values in the table.

Pressure (kPa)	Volume (cm^3)	$\frac{1}{Pressure}$ (x 10^{-3} kPa^{-1})
142,9	315	7
166,7	270	6
200	225	5
250	180	**y**
x	135	**z**

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

5.2 For this experiment, identify the:

5.2.1 Independent variable. (1)

5.2.2 Dependant variable. (1)

5.3 State TWO variables that must be kept constant in this experiment. (2)

5.4 Calculate the value of **x** in the table. (2)

5.5 The above table has been redrawn **above your graph sheet on page 11**.

5.5.1 Fill in the correct values for **y** and **z** in the table. (2)

5.5.2 Using the graph sheet provided, plot a graph of volume (V) verses the inverse of pressure $(\frac{1}{p})$. Be sure to submit this sheet together with your answer booklet. (4)

5.6 Write down a suitable conclusion from the graph. (2)

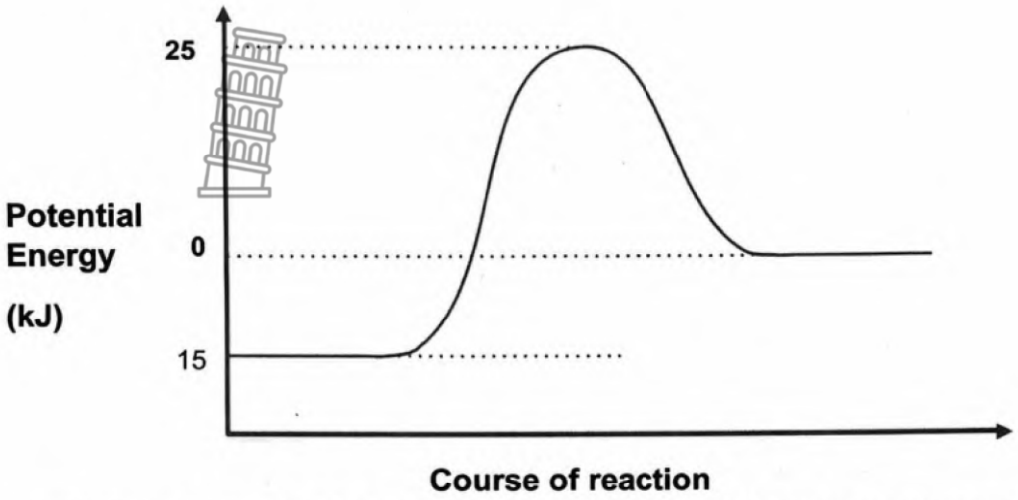
5.7 State TWO properties of an Ideal Gas. (2)

5.8 State TWO conditions under which real gases deviate from ideal gases. (2)

5.9 On the graph that was drawn in QUESTION 5.5.2, draw a sketch to show the deviation of real gas behaviour from ideal gas behaviour (2)
[22]

QUESTION 6

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



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

6.2 Define the term *activated complex*. (2)

6.3 Write down the value for each of the following:

6.3.1 Energy of the reactants (1)

6.3.2 Energy of products (1)

6.3.3 Activation energy for the forward reaction (1)

6.4 Calculate the heat of reaction, ΔH. (3)

6.5 A catalyst is added to speed up the reaction. What effect will the catalyst have on each of the following?
(Choose from INCREASES, DECREASES or REMAINS THE SAME)

6.5.1 Activation energy (1)

6.5.2 The heat of reaction (1)

6.5.3 The energy of the activated complex (1)

6.5.4 Amount of products formed (1)

[14]

JESTION 7

group of learners decide to make a mini volcano by reacting baking soda ($NaHCO_3$) and cetic acid (CH_3COOH) in a TWO step procedure.

STEP 1

They first prepare a standard solution of $NaHCO_3$ of concentration 0,2 mol.dm^{-3} in a 250 cm^3 volumetric flask.

7.1 Define a *standard solution*. (2)

7.2 Calculate the mass of $NaHCO_3$ needed to prepare the standard solution. (4)

STEP 2

They then add 50 cm^3 of the standard solution of $NaHCO_3$ to excess CH_3COOH.
The following balanced equation represents the reaction that takes place.

$$NaHCO_3\,(aq) + CH_3COOH\,(aq) \rightarrow CH_3COONa\,(aq) + H_2O(\ell) + CO_2\,(g)$$

7.3 Define an *Arrhenius acid*. (2)

7.4 Calculate the volume of CO_2 produced. Take the molar gas volume to be 23 dm^3·mol^{-1} (4)

7.5 Write down the formula for the:

7.5.1 conjugate acid of CH_3COO^- (2)

7.5.2 conjugate base of HCO_3^- (2)

[16]
TOTAL : 100

DATA FOR PHYSICAL SCIENCES GRADE 11

PAPER 2 (CHEMISTRY)

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

NAAM/*NAME*	SIMBOOL/*SYMBOL*	WAARDE/*VALUE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume teen STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron Lading op elektron	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant Avogadro se konstante	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$ $n = \frac{N}{N_A}$ $n = \frac{V}{V_m}$	$c = \frac{n}{V}$ $\quad c = \frac{m}{MV}$ $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$P_1V_1 = P_2V_2$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

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)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 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	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 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

KEY/*SLEUTEL*

Atomic number
Atoomgetal

29
1,9
Cu
63,5

Electronegativity
Elektronegatiwiteit

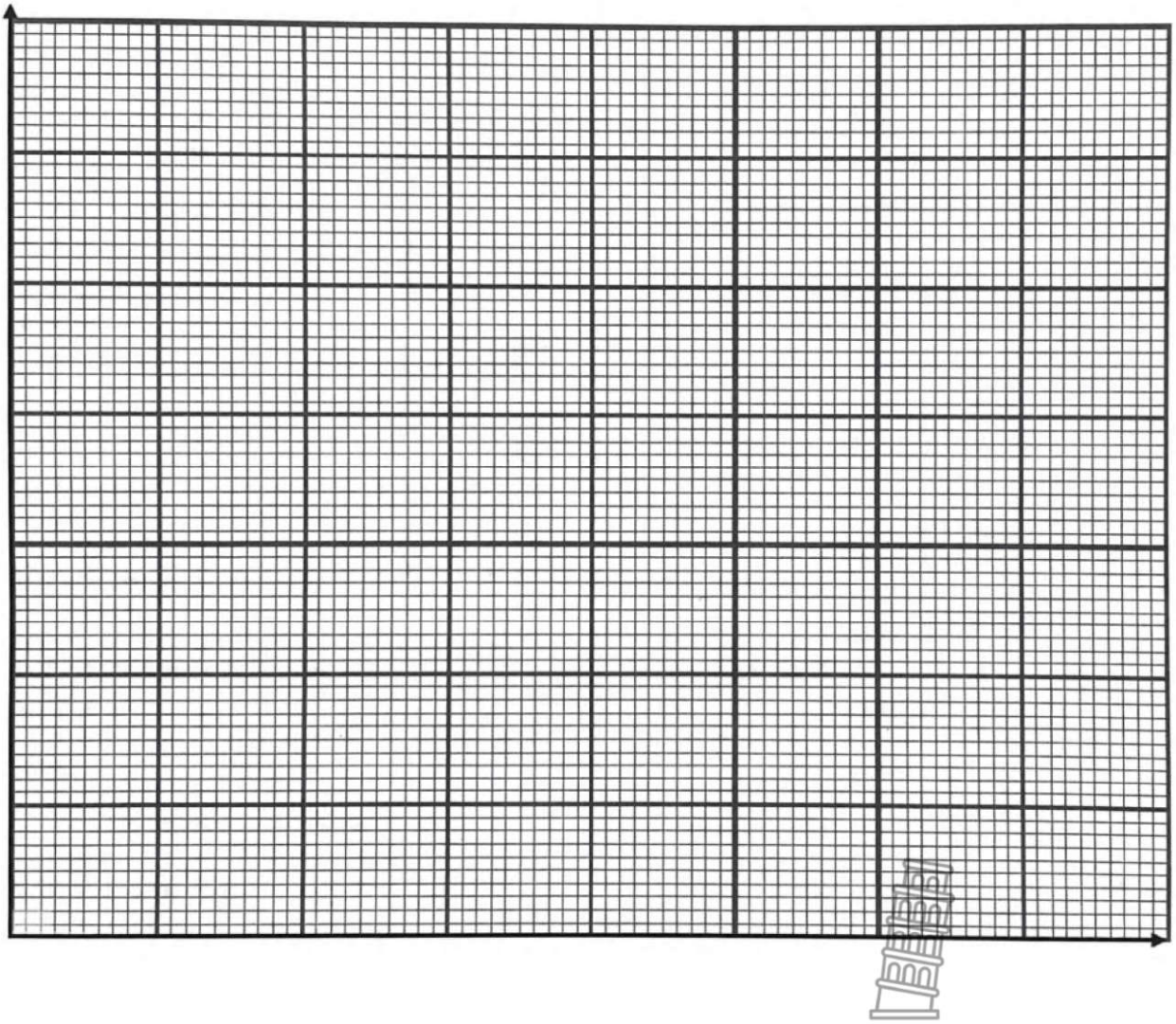
Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

NAME OF LEARNER :_____ **GR 11** ____

Answer sheet for QUESTION 5.5

Pressure (kPa)	Volume (cm^3)	$\frac{1}{Pressure}$ (x 10^{-3} kPa^{-1})
142,9	315	7
166,7	270	6
200	225	5
250	180	**y**
x	135	**z**



Education

KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES

MARKING GUIDELINES

COMMON TEST

SEPTEMBER 2023

NATIONAL

SENIOR CERTIFICATE

GRADE 11

VERIFIED

NB: This memorandum consists of 8 pages.

QUESTION ONE

1.1 B ✓✓
1.2 C ✓✓
1.3 C ✓✓
1.4 D ✓✓
1.5 D ✓✓
1.6 A ✓✓ **[12]**

QUESTION TWO

2.1 Simplest whole number ratio of atoms in a compound ✓✓ (2)

2.2 Percentage O = 100 - (58,065 + 7,527)
= 34,408%✓ (1)

2.3

	C	H	O	
Mass in 100g	58,065g	7,527g	34,408g	✓
n = m/M	$\frac{58,065g}{12}$	$\frac{7,527g}{1}$	$\frac{34,408g}{16}$	✓
	= 4,83875	= 7,527	= 2,1505	
Divide by smallest mol	$\frac{4,83875}{2,1505}$	$\frac{7,527}{2,1505}$	$\frac{2,1505}{2,1505}$	✓
Ratio	2,25	3,5	1	
	9	14	4	
				(5)
Empirical formula	$C_9H_{14}O_4$ ✓✓			

2.4 M ($C_9H_{14}O_4$) = 9(12) + 14(1) + 4(16) ✓
= 186 $g.mol^{-1}$
∴ molecular formula is $C_9H_{14}O_4$✓ (2)

[10]

QUESTION 3

3.1

3.1.1 The reactant that gets finished first / is used up completely in a chemical reaction ✓✓ (2)

NOTE: For questions 3.1.2 and 3.1.3, award marks if ONE table is provided for both questions.

3.1.2 **MARKING CRITERIA**:

- Formula n = $\frac{m}{M}$
- Substitution for mass(m) and molar mass (M) for Fe_2O_3
- Substitution for mass(m) and molar mass (M) for CO
- Ratio applied correctly 3:1 or 14,375: 4,792
- Final answer: Fe_2O_3

n Fe_2O_3 = $\frac{m}{M}$ ✓

= $\frac{2300}{2(56) + 3(16)}$ ✓

= 14,375 mol

n CO = $\frac{m}{M}$

= $\frac{1700}{12 + 16}$ ✓

= 60,71 mol

n Fe_2O_3 : n CO

3 : 1 ✓

Limiting reagent is Fe_2O_3 ✓ (5)

3.1.3 **POSITIVE MARKING FROM QUESTION 3.1.2**

$Fe_2O_3 : Fe_3O_4$

3 : 2

14,375 : x

x = $\frac{4,375 \times 2}{3}$ ✓

= 9,58mol

n (Fe_3O_4) = $\frac{m}{M}$

9,58 = $\frac{m}{232}$ ✓

m = 2222,56g / 2,22 kg ✓

M Fe_3O_4 = 3(56) + 4(16)

= 232 g.mol^{-1} (3)

3.1.4 **POSITIVE MARKING FROM QUESTION 3.1.3**

Actual mass of Fe_3O_4 produced = $\frac{76}{100}$ ✓ × 2222,56✓
= 1689,15 g✓ (3)

3.2 2 vols SO_2 reacts with 1 vol O_2
5 vols SO_2 reacts with 2,5 vols O_2 to produce 5 vols SO_3✓

Total volume = (3-2,5) ✓ +5 ✓= 5,5 vols✓ (4)
[17]

QUESTION 4

4.1 **MARKING CRITERIA**:

- Substitution of 262 g·mol^{-1} into formula ($n = \frac{m}{M}$) to convert 16 g of $Mg_3(PO_4)_2$ to moles. ✓
- Apply ratio of 3:1 for n($Mg_3(PO_4)_2$) : n($Mg(OH)_2$). ✓
- Substitution of 58 g·mol^{-1} to calculate mass of pure $Mg(OH)_2$. ✓
- Substitution into correct formula to calculate % purity. ✓
- Final answer. ✓

$Mg_3(PO_4)_2$ produced: $n = \frac{m}{M}$
$= \frac{16}{262}$✓ = 0,061 mol

Mol of pure $Mg(OH)_2$ used = 3(0,061) ✓ = 0,183 mol

Mass of $Mg(OH)_2$ used: m = nM = 0,183 x 58✓
= 10,614 g

% purity = $\frac{10,612}{15} \times 100$ ✓
= 70,76 %✓ (5)

4.2.1 Increases. ✓ (1)

4.2.2 Remains the same. ✓ (1)

4.3 The ratio of the mass of pure $Mg(OH)_2$ in a given sample to the total mass of the sample remains constant. ✓✓ (2)
[9]

QUESTION 5

5.1 The volume of an enclosed mass of (dry) gas is inversely proportional to the pressure when the temperature remains constant.✓✓ (2)

5.2.1 pressure✓ (1)

5.2.2 volume✓ (1)

5.3 Mass (of gas) ✓
Temperature (of gas)✓ (2)

5.4 $p_1V_1 = p_2V_2$

$(250)(180) = (\mathbf{x})(135)$ ✓

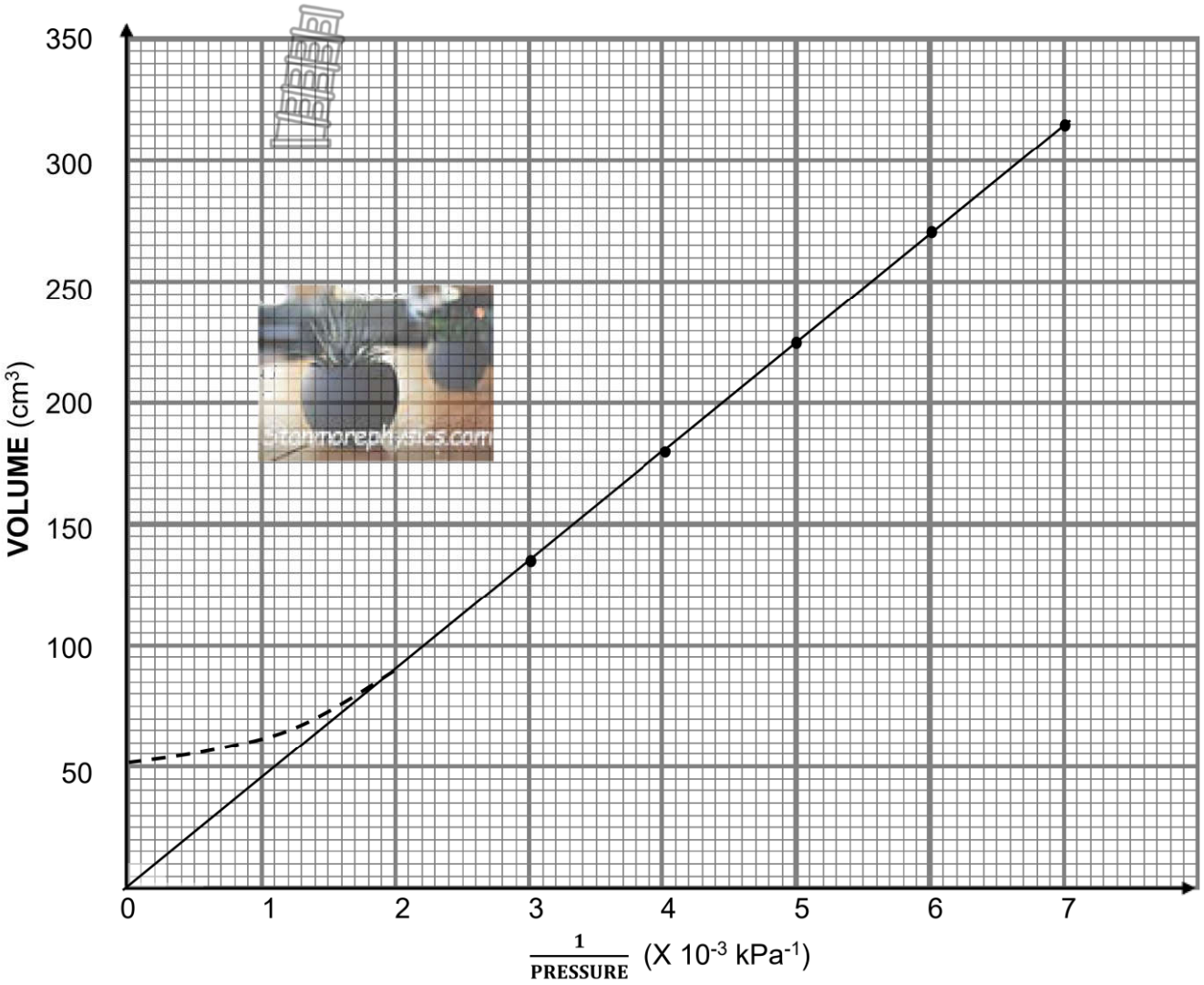
$\mathbf{x} = 333{,}33$ (kPa) ✓ OR ANY VALUES FROM TABLE (2)

5.5.1 **POSITIVE MARKING FROM QUESTION 5.4**

Pressure(kPa)	**Volume(cm^3)**	$\frac{1}{P}$ **(x 10^{-3} kPa^{-1})**
142,9	315	7
166,7	270	6
200	225	5
250	180	**4**✓
333,3	135	**3**✓

(2)

Graph of Volume vs 1/Pressure



(4)

Marking Rubric

	Criteria	Mark
1	Volume on y-axis and Inverse of pressure on x-axis	1
2	All points correctly plotted -1 if more than 2 points plotted incorrectly	2
3	Line of best fit drawn	1
4	Deviation for Question 5.9	2

5.6 Volume is directly proportional to 1/pressure OR v α 1/p. ✓✓ (2)

5.7 Particles: are identical in all respects.✓ / are in a state of random motion.✓ collisions are completely elastic / no force of attraction or repulsion except when they collide / particles themselves do not have volume.
(any two) (2)

5.8 High pressure ✓ Low temperature✓ (2)

5.9 On graph/ see Rubric✓✓ (2)
[23]

QUESTION 6

6.1 Endothermic.✓
$\Delta H > 0$ ✓ / $E_p > E_r$ (2)

6.2 The unstable transition state from reactants to products.✓✓ (2)

6.3.1 -15 kJ✓ (*Accept 15 kJ*) (1)

6.3.2 0 (kJ)✓ (1)

6.3.3 40 kJ✓ (*Accept 10 kJ*) (1)

6.4 $\Delta H = E_{products} - E_{reactants}$
✓ ✓
$= 0 - (-15)$
$= +15$ kJ✓ (3)

Accept: 0 – 15
= -15 kJ

6.5.1 Decreases.✓ (1)

6.5.2 Remains the same.✓ (1)

6.5.3 Remains the same.✓ (1)

6.5.4 Remains the same.✓ (1)
[14]

QUESTION 7

7.1 A solution whose concentration is known precisely. ✓✓ (2)

7.2

OPTION 1

$c = \frac{m}{MV}$ ✓

0,2 ✓ $= \frac{m}{(84)(0,25)}$ ✓

m = 4,2g ✓

OPTION 2

$c = \frac{n}{V}$ ✓

$0,2 = \frac{n}{0,25}$ ✓

n = 0,05 mol

$n = \frac{m}{M}$

$0,05 = \frac{m}{84}$ ✓

m = 4,2g ✓

(4)

7.3 Substance that produces hydronium ions (H_3O^+) when dissolved in water. ✓✓ (2)

7.4 $n(NaHCO_3) = C \times V$

$= 0,2 \times 0,05$ ✓

$= 0,01$ mol

$NaHCO_3 : CO_2$

1 : 1

$n\ CO_2 = 0,01$ mol ✓

$n = \frac{V}{V_m}$

$0,01 = \frac{V}{23}$ ✓

$V = 0,23\ dm^{-3}$ ✓

(4)

7.5.1 CH_3COOH ✓ (2)

7.5.2 CO_3^{2-} ✓ (2)

[16]

TOTAL: 100