



Education

KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

**PHYSICAL SCIENCE P2
(CHEMISTRY)**

COMMON TEST

JUNE 2017

**NATIONAL
SENIOR CERTIFICATE**

GRADE 11

MARKS: 100

TIME: 2 Hours

This question paper consists of 9 pages, 2 data pages and graph paper.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of EIGHT questions. Answer ALL the questions in the ANSWER BOOK.
2. Number the answers correctly according to the numbering system used in this question paper.
3. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
4. You may use a non-programmable calculator.
5. You may use appropriate mathematical instruments.
6. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEET.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your FINAL numerical answers to a minimum to TWO decimal places.
9. Give brief motivations, discussions, et cetera where required.
10. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions.

Each question has only ONE correct answer. Write down 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 The shape of the SF_6 molecule is

- A Pyramidal
- B Octahedral
- C Tetrahedral
- D Trigonal Bipyramid

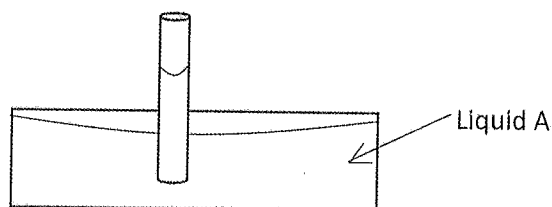
(2)

1.2 Aquatic animals obtain their oxygen that is dissolved in water. The type of intermolecular forces that are found between water and dissolved oxygen is called

- A Hydrogen bonds
- B Dispersion forces
- C Ion-induced dipole forces
- D Dipole-induced dipole forces

(2)

1.3 A thin tube, opened at both ends is placed in liquid A as shown in the sketch below. It is observed that liquid A rises in the tube.



The reason for this observation is

- A Liquid A has no surface tension.
- B Liquid A has high surface tension.
- C The adhesive forces are less than the intermolecular forces.
- D The adhesive forces are greater than intermolecular forces.

(2)

- 1.4 The behaviour of a real gas is approximately the same as that of an ideal gas under the following conditions of temperature and pressure:

	Temperature	Pressure
A.	Low	Low
B.	Moderate	High
C.	Low	High
D.	Moderate	Low

(2)

- 1.5 A cubic container is filled with a gas which exerts pressure p . What will the pressure exerted by the same amount of this gas be if the gas is placed in a cubic container whose side is half of that of the original container?

- A $\frac{1}{8} p$
 B $\frac{1}{4} p$
 C $4p$
 D $8p$

(2)

- 1.6 The number of hydrogen atoms in 1 mole of NH_4OH is

- A 5
 B 6.022×10^{23}
 C $4 \times 6.022 \times 10^{23}$
 D $5 \times 6.022 \times 10^{23}$

(2)

- 1.7 A solution of HCl has a concentration C . A learner pours 25 cm^3 of this solution into a 100 cm^3 volumetric flask and adds water to make a 100 cm^3 solution.

The final concentration of the new solution is:

- A $\frac{1}{4} C$
 B $\frac{3}{4} C$
 C $0,01 C$
 D $4 C$

(2)

[14]

QUESTION 2

2.1 Given the table below answer the questions that follow:

Bond	Bond energy ($\text{kJ}\cdot\text{mol}^{-1}$)	Bond Length (pm)
O – H	463	96
N – H	389	100.8
C – C	348	154

2.1.1 Define bond length. (2)

2.1.2 From the data provided, what is the relationship between bond length and bond energy? (2)

2.1.3 Calculate the energy required to break all the bonds in one mole of NH_3 . (2)

2.2 Hydrogen and carbon atoms react to form methane.

2.2.1 Name the type of bond between the hydrogen and carbon atoms. (1)

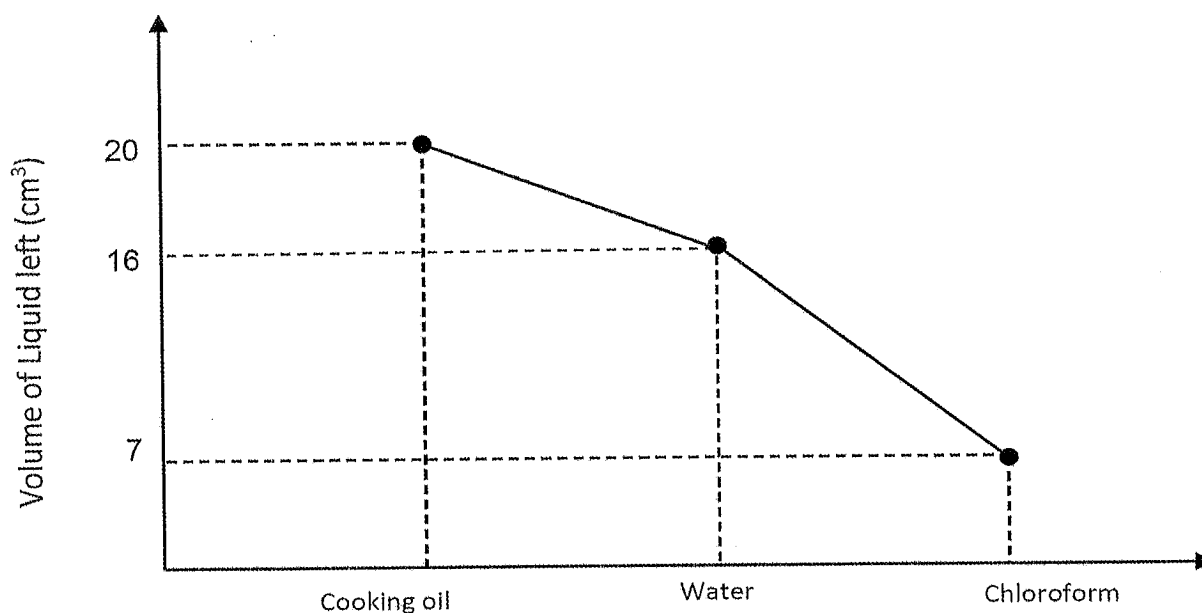
2.2.2 Draw the Lewis Structure for CH_4 . (2)

2.2.3 Calculate the difference in electronegativity between carbon and hydrogen atoms. (1)

2.2.4 Is CH_4 a POLAR or a NON-POLAR molecule? Explain. (2)
[12]

QUESTION 3

Learners conduct an experiment to measure the rate of evaporation of three liquids under the same conditions. The learners placed 20 cm^3 of cooking oil, 20 cm^3 of water and 20 cm^3 of chloroform in separate beakers. All three beakers were left exposed for 5 hours. The experiment was repeated 5 times under identical conditions. The average results obtained are shown in the graph below.



- 3.1 Define vapour pressure. (2)
- 3.2 Write down an investigative question for this experiment. (2)
- 3.3 Name a controlled variable. (1)
- 3.4 Which substance has the lowest vapour pressure?
Give a reason for your answer. (2)
- 3.5 Calculate the rate of evaporation of chloroform in $\text{cm}^3 \cdot \text{hour}^{-1}$. (2)
- 3.6 Is the experiment a fair test? Give a reason for your answer. (2)
- 3.7 Chloroform and water are both solvents, but their evaporation rates differ.
Explain this observation. (3)

[14]

QUESTION 4

A learner investigates the relationship between volume and pressure of an enclosed DIATOMIC gas at room temperature. The following results were recorded by the learner.

Pressure (p) (kPa)	Volume (v) (cm ³)	$\frac{1}{v}$ (cm ⁻³)
100	50	0.02
150	33	0.03
200	25	0.04
250	20	0.05

- 4.1 Name the law being investigated. (1)
- 4.2 Draw a graph of pressure vs $\frac{1}{v}$ on the attached GRAPH PAPER. (4)
- 4.3 What conclusion could be drawn from the graph in question 4.2? (2)
- 4.4 Name ONE factor that must be kept constant in this investigation. (1)
- 4.5 Assume that there is a deviation in the graph at pressures greater than 250 kPa. On the same set of axes show how the graph of pressure vs $1/v$ will appear at pressures higher than 250 kPa. (1)
- 4.6 Fully explain the reason for the deviation in question 4.5. (2)
- [11]**

QUESTION 5

A gas cylinder containing deodorant (perfume) has a warning that it should not be exposed to excessive heat, as exposure to heat may lead to an explosion. The cylinder can withstand a maximum pressure of 120 kPa.

- 5.1 Name the law that is described in the above statement. (1)
- 5.2 The container is stable at 25°C and 101.3 kPa. Determine the minimum temperature that could lead to the cylinder exploding. (4)
- 5.3 Will this cylinder explode at 100 °C and 101,3 kPa? Write down only YES or NO. (1)
- 5.4 Explain your answer to question 5.3. (2)
- [8]**

QUESTION 6

Samples of impure oxalic acid crystals ($\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$) are obtained from the technician of a laboratory. The samples are placed in small packets of 0.350 g each. These samples are used to prepare standard solutions of oxalic acid.

- 6.1 Define a standard solution. (2)
- 6.2 One packet of impure $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ was used to prepare a 250 cm^3 solution. After analysis, the concentration of the prepared solution was found to be $0.01 \text{ mol} \cdot \text{dm}^{-3}$.
Determine mass of $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ in the sample. (4)
- 6.3 Calculate the mass of the impurities in each sample. (2)
- 6.4 What is the percentage purity of the used sample? (3)

[11]**QUESTION 7**

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



Upon completion of the reaction, it was found that:

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

- 7.1 Explain what is meant by an excess reactant. (2)
- 7.2 Identify the excess reactant in the above reaction. (1)
- 7.3 Calculate the number of moles of CO_2 produced. (3)
- 7.4 Calculate the initial mass of $\text{HCl}_{(aq)}$ that was present in the test tube. (6)
- 7.5 $5,68 \text{ g}$ of CaCO_3 was added in the reaction vessel to start the reaction.
- 7.5.1 Calculate the theoretical yield of CO_2 in grams. (4)
- 7.5.2 Calculate the percentage yield of CO_2 . (3)

[19]

QUESTION 8

7,5340 g of pure ethylene glycol was analysed and was found to contain 2,9164 g of carbon, 0,7291 g of hydrogen, and 3,8885 g of oxygen

- 8.1 Explain what is meant by the **empirical formula** of a compound. (2)
- 8.2. Determine the empirical formula of ethylene glycol. (6)
- 8.3 If the molar mass of ethylene glycol is $62 \text{ g}\cdot\text{mol}^{-1}$, what is its molecular formula? (3)

[11]**TOTAL: 100 MARKS**

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
Standard pressure <i>Standaarddruk</i>	p^θ	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP <i>Molêre gasvolume by STD</i>	V_m	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
<i>Molêre gaskonstante</i> Molar gas constant	R	$8.31 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$
Standard temperature <i>Standaardtemperatuur</i>	T^θ	273 K
Avogadro's Constant	N of/or N_A	$6.022 \times 10^{23} \text{ mol}^{-1}$

TABLE 2: FORMULAE/TABEL 2: FORMULES

$n = \frac{m}{M}$	$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$	$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$ $pV = nRT$
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TABLE 3: THE PERIODIC TABLE OF ELEMENTS

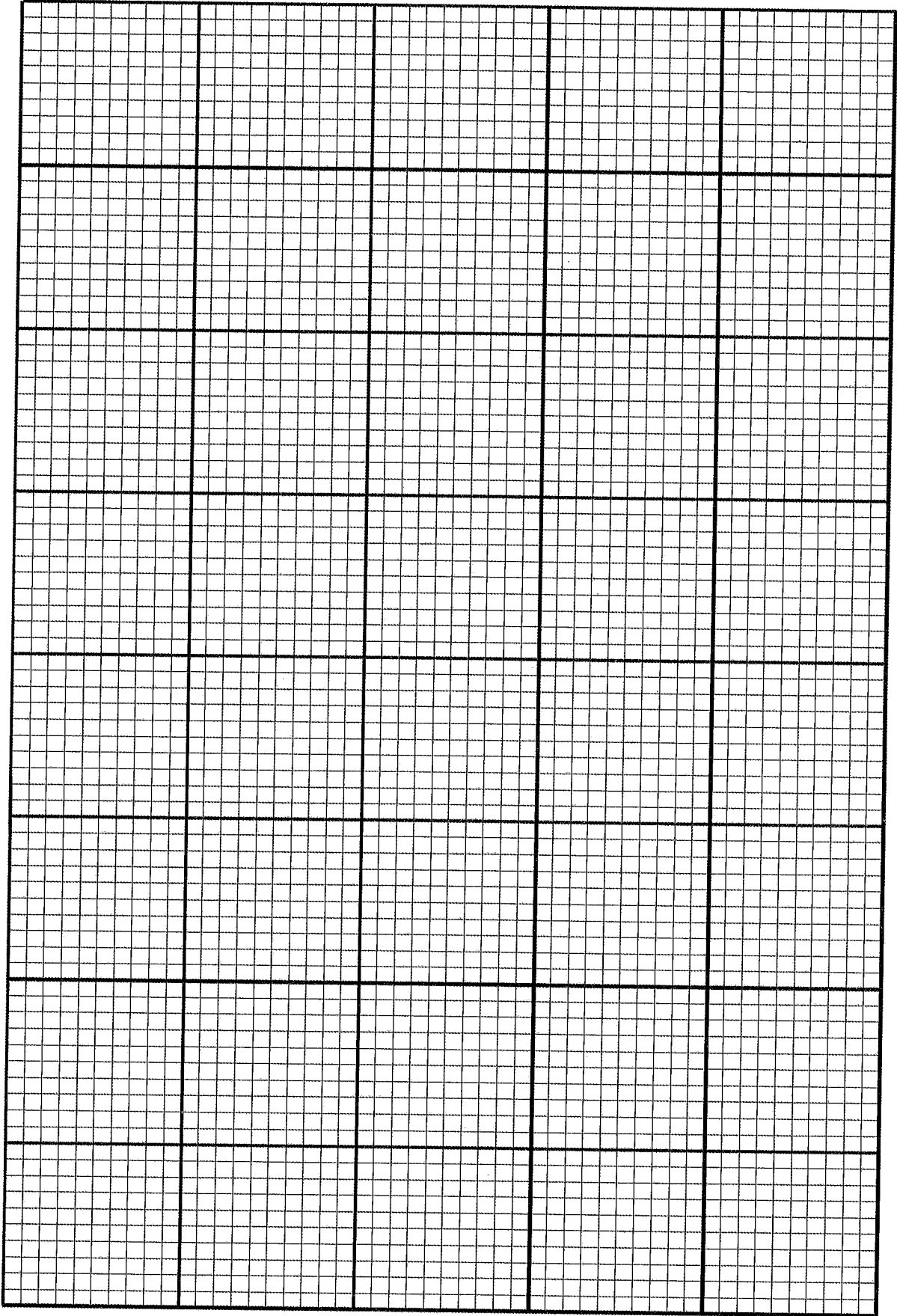
1 1 H 1,0	2 (II) He 4	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
1 H 1,0	2 He 4	3 Li 7	4 Be 9	KEY/SLEUTEL													
11 Na 23	12 Mg 24	Atomic number →															
19 K 39	20 Ca 40	Electronegativity →															
37 Rb 86	38 Sr 88	Symbol ↓															
55 Cs 133	56 Ba 137	Simbool ↓															
87 Fr	88 Ra 226																
Approximate relative atomic mass Benaderde relatiewe atoommassa																	
1 H 1,0	2 He 4	3 Li 7	4 Be 9	5 B 11	6 C 12	7 N 14	8 O 16	9 F 19	10 Ne 20	11 Na 23	12 Mg 24	13 Al 27	14 Si 28	15 P 31	16 S 32	17 Cl 35,5	18 Ar 40
19 K 39	20 Ca 40	21 Sc 45	22 Ti 48	23 V 51	24 Cr 52	25 Mn 55	26 Fe 56	27 Co 59	28 Ni 59	29 Cu 63,5	30 Zn 65	31 Ga 70	32 Ge 73	33 As 75	34 Se 79	35 Br 80	36 Kr 84
37 Rb 86	38 Sr 88	39 Y 89	40 Zr 91	41 Nb 92	42 Mo 96	43 Tc 101	44 Ru 101	45 Rh 103	46 Pd 106	47 Ag 108	48 Cd 112	49 In 115	50 Sn 119	51 Sb 122	52 Te 128	53 I 127	54 Xe 131
55 Cs 133	56 Ba 137	57 La 139	58 Ce 140	59 Pr 141	60 Nd 144	61 Pm 145	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	72 Hf 179
87 Fr	88 Ra 226	89 Ac	90 Th 232	91 Pa 231	92 U 238	93 Np 237	94 Pu 244	95 Americium 243	96 Curium 247	97 Berkelium 247	98 Einsteinium 252	99 Fermium 253	100 Mendelevium 258	101 Nobelium 259	102 Livermorium 261	103 Tennessine 261	104 Oganesson 261

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce 140	Pr 141	Nd 144	Pm	Sm 150	Eu 152	Gd 157	Tb 159	Dy 163	Ho 165	Er 167	Tm 169	Yb 173	Lu 175

90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th 232	Pa	U 238	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

NAME:

TEAR – OFF SHEET





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PHYSICAL SCIENCE P2 MARKING GUIDELINE

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N.B. This marking guideline consists of 8 pages.

QUESTION 1

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

[14]

QUESTION 2

2.1.1 Bond length is the average distance between the nuclei of two bonded atoms ✓✓ (2)

2.1.2 as the bond length increases, the bond energy decreases ✓✓ (2 or 0)

or

as the bond length decreases the bond energy increases ✓✓

$$2.1.3 \Delta H = 3 \times (\text{N} - \text{H})$$

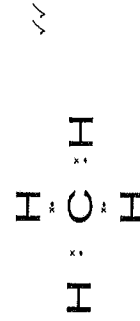
$$= 3 \times 389 \checkmark$$

$$= 1\,167 \text{ kJ} \cdot \text{mol}^{-1} \checkmark$$

2.2

2.2.1 Covalent bond ✓

2.2.2



$$2.2.3 \Delta \text{EN} = 2.5 - 2.1 = 0.40 \checkmark$$

(1)

2.2.4. Non-polar ✓, C-H bonds are polar but the molecule is symmetrical ✓

(2)

OR CH₄ is tetrahedral in shape.

[12]

QUESTION 3

3.1 Vapour pressure is the pressure exerted by the vapour at equilibrium with its liquid in a closed system ✓✓ (2 or 0)

3.2 How does the nature of a liquid affect the rate of evaporation? ✓✓ (2)

OR

What is the relationship between different types of liquids and the rate of evaporation of these liquids? ✓✓

(one mark for identifying the two variables, and one mark for framing it into a question).

3.3 Volume ✓ or Temperature or Atmospheric pressure. (1)

3.4 Cooking oil ✓, it does not change into vapour easily ✓ (2)

3.5

$$\text{rate} = \frac{\Delta V}{\Delta t} \quad \checkmark$$

$$= \frac{7-20}{5}$$

$$= -2,6 \text{ cm}^3 \text{ hr}^{-1} \quad \checkmark$$

(2)

3.6 yes ✓, only one variable was changed ✓ (2)

3.7 Water is held by strong hydrogen bonds ✓ while chloroform has weak dipole-dipole forces / van der Waal forces ✓.

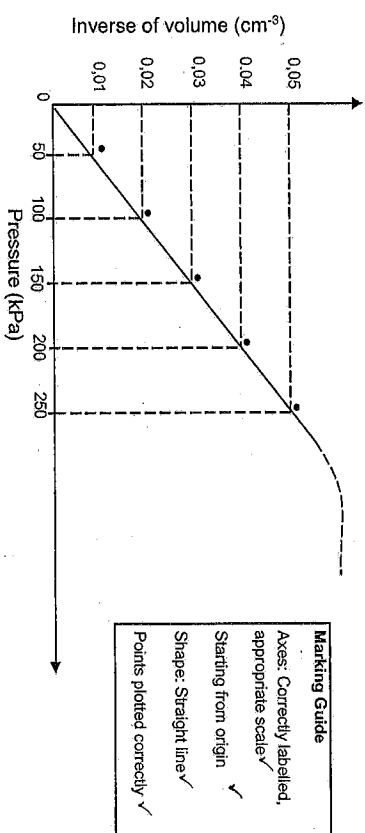
Therefore, water requires more energy to vaporize than chloroform. ✓

[14]

QUESTION 4

4.1 Boyle's law ✓ (1)

4.2 Figure 1: Graph of pressure vs inverse of volume (4)



4.3 Pressure is inversely proportional to the volume. ✓✓ (2)

OR

The inverse of volume is directly proportional to pressure. ✓✓

4.4. Temperature ✓ / Quantity of gas or number of moles of gas OR mass of gas. (1)

4.5 on the Graph sheet ✓ (1)

4.6 At high pressures, the volume of the gas is reduced.

Increasing the pressure further does not result in a decrease in the volume, ✓ as predicted by Boyle's Law, because the space occupied by the particles themselves cannot be ignored. ✓ (2)

[11]

QUESTION 5

5.1 Gay-Lussac's law ✓

(1)

5.2

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \checkmark$$

(4)

$$\frac{101.3 \times 10^3 \checkmark}{298} = \frac{120 \times 10^3 \checkmark}{T} \checkmark$$

$$T = 353.01 \text{ K} \checkmark$$

5.3 Yes ✓

(1)

5.4 The temperature $(273+100) \text{ K}$ ✓ is greater than the minimum temperature.
hence the cylinder would explode

(2)

[8]

QUESTION 6

6.1 A standard solution is a solution whose concentration is known precisely. ✓ ✓ (2 or 0)

6.2

$$c = \frac{m}{MV} \checkmark$$

$$0.01 \checkmark \frac{m}{126 \times 0.250 \checkmark}$$

$$m = 0.315 \text{ g} \checkmark$$

(4)

6.3 mass of impurities = $0.350 - 0.315 \checkmark = 0.035 \text{ g} \checkmark$

(2)

6.4

$$\begin{aligned} \% \text{purity} &= \frac{\text{mass of pure substance}}{\text{mass of impure substance}} \checkmark \\ &= \frac{0.315}{0.350} \times 100\% \checkmark \\ &= 90\% \checkmark \end{aligned}$$

(3)

[11]

QUESTION 7

7.1 Excess reactant is that reactant that is left after the reaction is complete. ✓ ✓

OR

That reactant whose initial amount is greater than the amount that reacts. ✓ ✓ (2 or 0)

7.2 HCl ✓

(1)

7.3

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

$$\frac{1.46}{22.4} \checkmark$$

$$= 0.0512 \text{ mol} \checkmark$$

(3)

7.4 Ratio: HCl : CO₂
2 : 1

$$2 \times 0.0512 = 0.102 \text{ mol of HCl reacted.}$$

$$\text{No of mol of HCl in excess} = C \times V \checkmark$$

$$= 0.09 \times 0.110 \checkmark$$

$$= 0.010 \text{ mol.}$$

$$\text{Initial moles of HCl} = \text{moles that reacted} + \text{excess moles}$$

$$= 0.102 + 0.010 \checkmark$$

$$= 0.112 \text{ mol}$$

$$\text{Initial mass of HCl} = n \times M$$

$$= 0.112 \times 36.5 \checkmark$$

$$= 4.088 \text{ g} \checkmark$$

(6)

7.5.1

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

$$= \frac{5.68}{100}$$

$$= 0.0568 \text{ mol} \quad \checkmark$$

Ratio	CaCO_3	:	CO_2
	1	:	1
		:	0.0568 mol (theoretical) $\checkmark$
m		:	$n \times M$
		:	$0.0568 \times 44 \quad \checkmark$
		:	$2.4992 \text{ g} \quad \checkmark$

7.5.2

$$\% \text{yield} = \frac{\text{actual}}{\text{theoretical}} \times 100\% \quad \checkmark$$

$$= \frac{2.25}{2.4992} \times 100\% \quad \checkmark$$

$$= 90.03\% \quad \checkmark$$

(3)
[19]

QUESTION 8

8.1 An empirical formula is the simplest atomic ratio of a molecule $\checkmark \checkmark$ (2)

8.2 Option 1 (6)

	C	H	O
Mass (g)	2.9164	0.7291	3.8885
Molar mass ($\text{g} \cdot \text{mol}^{-1}$)	12	1 $\checkmark$	16
$n = \frac{m}{M} \text{ (mol)}$	0.24303 $\checkmark$	0.7291 $\checkmark$	0.24303 $\checkmark$
Ratio	1	3 $\checkmark$	1

Empirical formula is $\text{CH}_3\text{O} \checkmark$

OPTION 2

	C	H	O
Percentage (%)	38.7097	9.6774	51.6129
Mass (g)	38.7097	9.6774	51.6129
Molar mass ($\text{g} \cdot \text{mol}^{-1}$)	12	1	16
$n = \frac{m}{M} \text{ (mol)}$	3.2258 $\checkmark$	9.6774 $\checkmark$	3.2258 $\checkmark$
Ratio	1	3	1

Empirical formula is $\text{CH}_3\text{O} \checkmark$ 8.3 M Molecular formula = integer $\times$ M empirical formula (3)

$$62 = \text{integer} \times (12 + 16 + 3 \times 1) \quad \checkmark$$

$$\text{Therefore: integer} = 2 \quad \checkmark$$

$$\text{Molecular formula} = \text{C}_2\text{H}_6\text{O}_2 \quad \checkmark$$

[11]

TOTAL MARKS: [100]