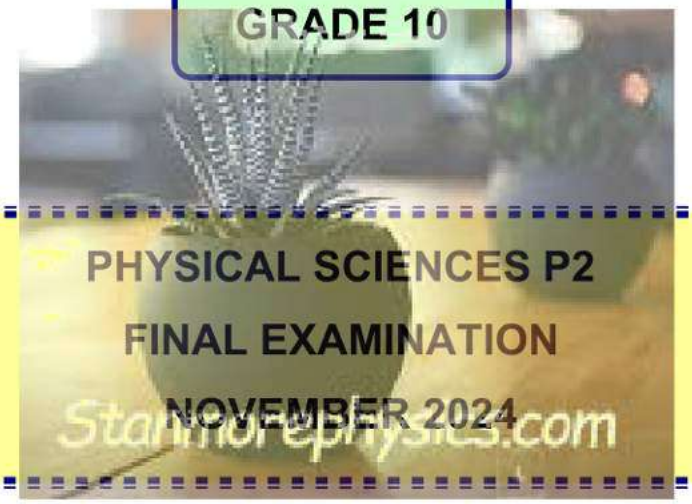
KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 10



PHYSICAL SCIENCES P2

FINAL EXAMINATION

NOVEMBER 2024

MARKS: 100

DURATION: 2 hours

This question paper consists of 10 pages and 2 data sheets.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of SEVEN 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 may use appropriate mathematical instruments.
7. You are advised to use the attached DATA SHEETS.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions et cetera where required.
11. 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. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.5) in the ANSWER BOOK, for example 1.11 E.

1.1 Which of the following is an example of a chemical change?

A The melting of ice.

B The separation of Nitrogen from air using fractional distillation.

C Dissolving potassium iodide in water.

D Milk turning sour (2)

1.2 Which one of the following is the correct description of a substance in the liquid phase?

A The particles of the substance are bonded in fixed positions.

B The substance has a fixed volume but not a fixed shape.

C The particles of the substance always occupy the total volume of the container.

D The temperature of the substance is greater than its boiling point. (2)

1.3 Which one of the following has the largest atomic radius?

A Be

B Mg

C Ne

D Ar (2)

1.4 Which one of the following pairs of ions and atoms have the same number of electrons?

A S^{2-} and Ar

B Mg^{2+} and Mg

C Mg^{2+} and Ar

D N^{3-} and He (2)

1.5 Consider the balanced chemical equation for the reaction below:

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

The number of Oxygen atoms in the SO_3 formed when 22,4 dm^3 SO_2 reacts with excess oxygen (O_2) at STP is …

A $6,02 \times 10^{23}$

B $2 \times 6,02 \times 10^{23}$

C $3 \times 6,02 \times 10^{23}$

D $6 \times 6,02 \times 10^{23}$ (2)

[10]

QUESTION 2 (Start on a new page.)

2.1 A bag of cement has the following percentage composition by mass:

Ingredient	Percentage composition (by mass)
Calcium oxide (CaO)	62
Silicon dioxide (SiO_2)	22
Aluminium oxide (Al_2O_3)	5
Calcium sulphate ($CaSO_4$)	4
Fe_2O_3	3
Magnesium oxide (MgO)	2
Sulphur	1
Alkalis	1
TOTAL	**100**

2.1.1 Is the cement a MIXTURE or a PURE SUBSTANCE?
Give a reason for the answer? (2)

2.1.2 Identify the type of chemical bond that forms when calcium and oxygen combine to form calcium oxide (CaO). (1)

2.1.3 Draw the Lewis structure for calcium oxide (CaO). (2)

2.1.4 Write down the name of the compound Fe_2O_3. (2)

2.1.5 Determine the number of calcium oxide (CaO) particles in a 750 g sample of the cement. (5)

2.2 In a process called Calcination, Calcium carbonate ($CaCO_3$) is heated to form the calcium oxide found in cement.

This balanced chemical equation for this calcination is:

$$CaCO_3 \rightarrow CaO + CO_2$$

2.2.1 Is the reaction described above a SYNTHESIS or DECOMPOSITION reaction? (1)

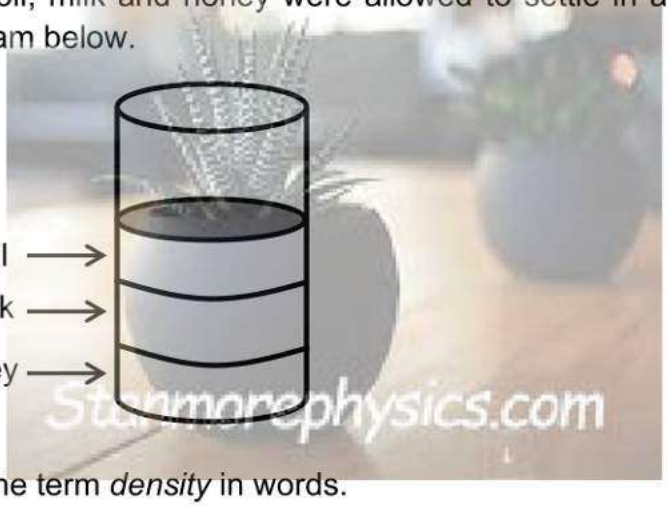
2.2.2 Is calcination of $CaCO_3$ an example of a PHYSICAL or CHEMICAL change?
Explain the answer. (2)

2.3 Calcium carbonate reacts with Hydrochloric acid (hydrogen chloride) to form Calcium chloride, Water and Carbon dioxide.

2.3.1 Write a balanced chemical equation for the above reaction. (3)

2.3.2 Explain why tiny bubbles are noticed during this reaction. (1)

2.4 Equal volumes of oil, milk and honey were allowed to settle in a cylinder as shown in the diagram below.



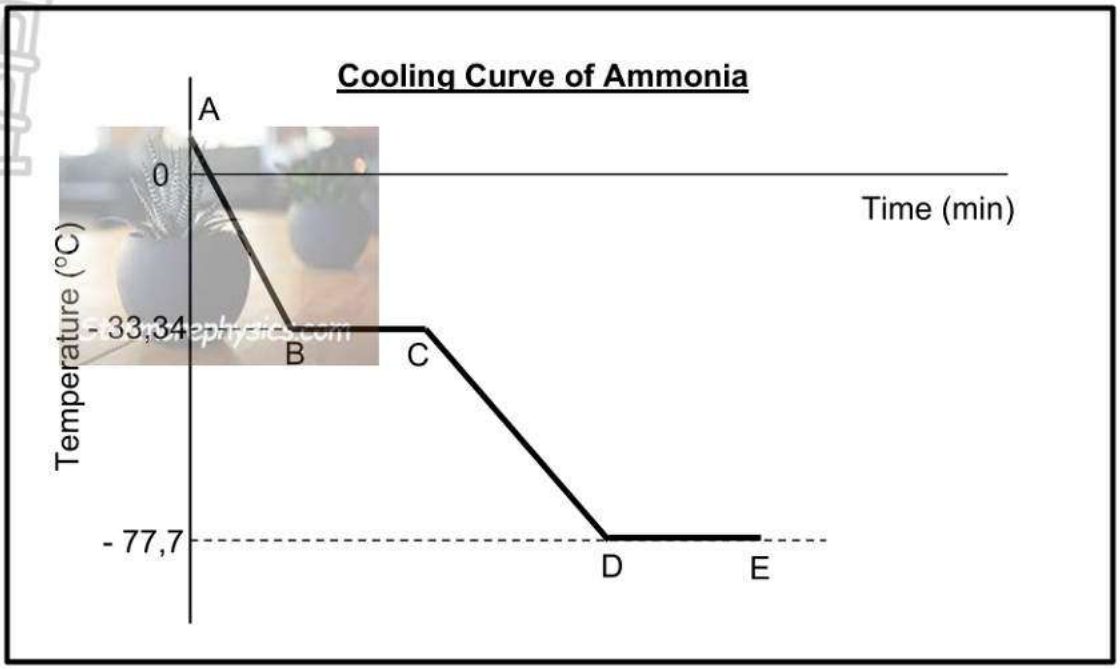
2.4.1 Define the term *density* in words. (2)

2.4.2 Arrange the liquids from lowest to highest density. (1)

[22]

QUESTION 3 (Start on a new page.)

3.1 The cooling curve of AMMONIA is represented in the graph below. The graph is not drawn to scale.



3.1 Write down the boiling point of ammonia. (1)

3.2 Explain in terms of temperature, energy and movement of particles, the changes that takes place between Point C and Point D. (3)

3.3 Explain the change taking place between Point D and Point E. (1)

3.4 At which region of the graph, **A to B** or **C to D**, are the particles closer together. Explain your answer. (3)

3.5 The melting and boiling points of three substances is indicated in the table below.

Substance	**Water**	**Ethanol**	**Ethanoic acid**
Melting Point (°C)	0	- 114,1	16,6
Boiling Point (°C)	100	78,37	117,9

3.5.1 Define the term *melting point* in words. (2)

3.5.2 Which substance from the table has the weakest forces between its particles? Explain your answer. (2)

3.5.3 What is the phase of Ethanoic acid at room temperature? (1)

[13]

QUESTION 4 (Start on a new page.)

4.1 The three stable isotopes of Magnesium and their percentage abundance is indicated below:

Isotope	Percentage Abundance
Mg - 24	78,99 %
Mg - 25	10 %
Mg - 26	REMAINDER

4.1.1 Why does the atomic mass of Mg – 24 differ from that of Mg – 26? (1)

4.1.2 Determine the relative atomic mass of magnesium (3)

4.2 The following is an extract from the periodic table (refer to page 12).

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)
2,1 H 1				KEY/*SLEUTEL*			Atomic number *Atoomgetal*										2 He 4
1,0 3 Li 7	1,5 4 Be 9			Electronegativity *Elektronegatiwiteit*			1,9 29 Cu 63,5 ← Symbol *Simbool*					2,0 5 B 11	2,5 6 C 12	3,0 7 N 14	3,5 8 O 16	4,0 9 F 19	10 Ne 20
0,9 11 Na 23	1,2 12 Mg 24						Approximate relative atomic mass *Benaderde relatiewe atoommassa*					1,5 13 Aℓ 27	1,8 14 Si 28	2,1 15 P 31	2,5 16 S 32	3,0 17 Cℓ 35,5	18 Ar 40

4.2.1 Define the term *electronegativity* in words. (2)

4.2.2 Describe the trend in electronegativity from left to right across a period. (1)

4.2.3 Explain the trend described in QUESTION 4.2.2. (2)

4.2.4 No electronegativity value is indicated for Neon (Ne). Provide a reason for this observation. (2)

4.3 Use the balanced chemical equation below to prove the law of conservation of mass.

$$2Ca_3(PO_4)_2 + 6SiO_2 \rightarrow 6CaSiO_3 + P_4O_{10}$$ (3)

[14]

QUESTION 5 (Start on a new page)

Aluminium powder (Al) reacts with Sulphuric acid (H_2SO_4) according to the balanced equation below.

$$2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$$

In one such reaction exactly 5 g Aluminium (Al) reacts with Sulphuric acid (H_2SO_4) of concentration 0,1 mol.dm^{-3} at STP.

5.1 Define the term *concentration* in words. (2)

5.2 Calculate the :

5.2.1 Number of moles of Al that reacted (3)

5.2.2 Volume of H_2SO_4 (in dm^3) that reacted (4)

5.2.3 Volume of H_2 gas (in dm^3) that formed at STP (4)

[13]

QUESTION 6 (Start on a new page)

6.1 A compound is made up of Sodium (Na), Phosphurus (P) and Oxygen (O) only. A 10 g sample of this compound consists of 4,21 g Sodium (Na) and 1,89 g Phosphurus (P).
Determine the empirical formula of this compound. (6)

6.2 15,75 g of hydrated oxalic acid, $H_2C_2O_4.\mathbf{x}H_2O$ is dissolved in water to make a 250 cm^3 solution of concentration 0,5 mol.dm^{-3}.

6.2.1 Calculate the molar mass of $H_2C_2O_4.\mathbf{x}H_2O$ (3)

6.2.2 Determine "**x**", the number of moles of water of crystallization. (3)

6.3 The reaction between lead (II) nitrate ($Pb(NO_3)_2$) and potassium iodide(KI) is given by the balanced chemical equation below:

$$Pb(NO_3)_2(s) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$$

The percentage yield of lead (II) iodide (PbI_2) is 75 %.

Determine the mass of potassium iodide (KI) required to form 80 g of PbI_2. (6)

[18]

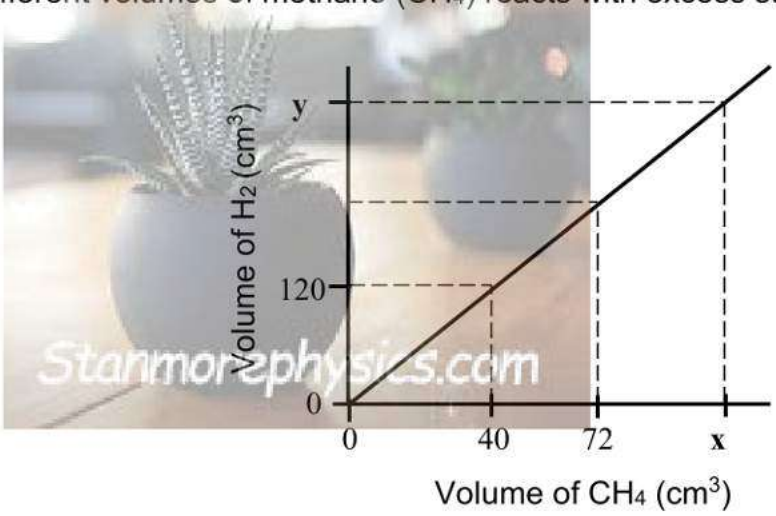
QUESTION 7 (Start on a new page)

Hydrogen gas (H_2) is prepared from the reaction between methane (CH_4) and steam (H_2O).

The reaction is represented by the following balanced equation:

$$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$$

The graph below (not drawn to scale), shows the **volume of hydrogen (H_2) formed** when different volumes of methane (CH_4) reacts with excess steam (H_2O) at STP.



7.1 Calculate the gradient of the graph (2)

7.2 What does the gradient of the graph represent? (2)

7.3 Determine the volume of H_2 (in cm^3) formed when 72 cm^3 of methane (CH_4) reacted with excess steam. (2)

7.4 The TOTAL VOLUME of gas formed when **x** cm^3 of CH_4 reacts with excess H_2O to form **y** cm^3 of H_2 is 420 cm^3.
Determine the values of **x** and **y** on the graph. (4)

[10]

DATA FOR PHYSICAL SCIENCES GRADE 10

CHEMISTRY

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Standard pressure	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature	T^{θ}	273 K
Avogadro's constant	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$

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

Electronegativity
Elektronegatiwiteit

29
1,9 Cu
63,5

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

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QUESTION 1

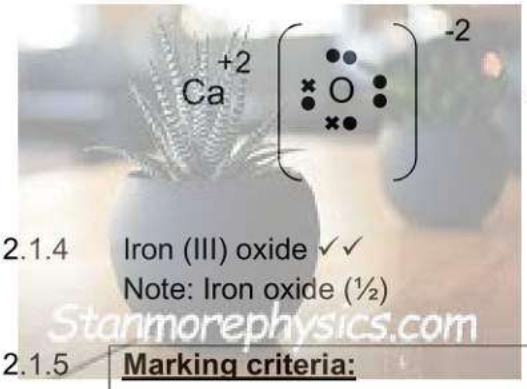
1.1 D ✓✓ (2)
1.2 B ✓✓ (2)
1.3 B ✓✓ (2)
1.4 A ✓✓ (2)
1.5 C ✓✓ (2)
[10]

QUESTION 2

2.1.1 Mixture. ✓
It consists of different substances that are not chemically combined. ✓ (2)

2.1.2 Ionic bond✓ (1)

2.1.3 (2)



✓✓

2.1.4 Iron (III) oxide ✓✓ (2)
Note: Iron oxide (½)

2.1.5

Marking criteria:

- Multiply 750 by 0.62 ✓
- Substitute 465 and 56 into formula ✓
- n = $\frac{N}{N_A}$ ✓
- Substitute 6,02 x 10^{23} ✓
- Final answer: 5 x 10^{24} particles ✓

m(CaO) = 750 x 0.62 ✓

= 465 g

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

$= \frac{465}{56}$ ✓

= 8,3 mol

$n(CaO) = \frac{N}{N_A}$ ✓

$8,3 = \frac{N}{6,02 \times 10^{23}}$ ✓

N(CaO) = 5 x 10^{24} particles✓ (5)

2.2.1 Decomposition. ✓ (1)

2.2.2 Chemical change. ✓
New substances are formed / A chemical reaction took place. ✓ (2)

2.3.1 $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$ LHS ✓
RHS ✓
Balancing ✓ (3)

2.3.2 CO_2 gas is formed ✓ (1)

2.4.1 The mass per unit volume of a substance ✓✓ (2)

2.4.2 Oil, milk, honey ✓ (1)

[22]

QUESTION 3

3.1 - 33,34 °C ✓ (1)

3.2 The temperature of the substance decrease. ✓ The average kinetic energy of the particles decrease. ✓ Particles move slower. ✓ (3)

3.3 The phase is changing from liquid to solid. ✓ (1)

3.4 C to D. ✓ Ammonia is in a liquid phase from C to D but in a gas phase from A to B. ✓ Particles are close together in liquids than gas ✓ (3)

3.5.1 The temperature at which a solid, given sufficient heat, becomes a liquid. ✓✓ (2)

3.5.2 Ethanol. ✓ It has the lowest melting and boiling points✓ (2)

3.5.3 Liquid✓ (1)

[13]

QUESTION 4

4.1.1 Mg – 26 has 2 more neutrons that Mg – 24. OR
Mg – 24 has 2 less neutrons that Mg – 26. ✓ (1)

4.1.2 % Mg – 26 = 100 – 78.99 – 10 = 11,01% ✓

$$\text{Relative atomic mass} = 24\times\frac{78,99}{100} + 25\times\frac{10}{100} + 26\times\frac{11,01}{100}$$ ✓

= 24,32 AMU ✓ (3)

4.2.1 A measure of the tendency of an atom in a molecule to attract bonding electrons ✓✓ (2)

4.2.2 The electronegativity increases ✓ (from left to right across a period) (1)

4.2.3
- As you move from left to right across a period the effective nuclear charge increase OR As you move from left to right across a period the atomic radius decreases✓
- The force of attraction between the nucleus and the bonding electrons increase. ✓ (2)

4.2.4
- Neon has a complete valence shell / The outermost energy level in neon is full. ✓
- It will not bond with other elements. ✓ (2)

4.3 Mass of reactants = 2[40x3 + 2(31 + 4x16)] + 6[28 + 2x16] ✓ = 980 $g.mol^{-1}$
Mass of products = 6[40 + 28 + 16x3] + 31x4 +16x10 ✓ = 980 $g.mol^{-1}$
Mass of reactants is equal to the mass of products. Therefore mass is conserved. ✓ (3)

[14]

QUESTION 5

5.1 The number of moles of solute per cubic decimetre of solution. ✓✓ (2)

5.2.1
$$n(Al) = \frac{m}{M} \checkmark$$
$$= \frac{5}{27} \checkmark$$
$$= 0,19 \text{ mol} \checkmark$$ (3)

5.2.2 **POSITIVE MARKING FROM 5.2.1**

$Al : H_2SO_4$
$2 : 3$ ✓
$n(H_2SO_4) = 0,285$ mol
$$c(H_2SO_4) = \frac{n}{V} \checkmark$$
$$0,1 = \frac{0,285}{V} \checkmark$$
$V(H_2SO_4) = 2,85 \text{ dm}^3$ ✓ (4)

5.2.3 **POSITIVE MARKING FROM 5.2.1 AND 5.2.2**

$Al : H_2$
$2 : 3$ ✓

OR

$H_2SO_4 : H_2$
$3 : 3$ (or 1:1) ✓

$n(H_2) = 0,285$ mol
$$n(H_2) = \frac{V}{V_m} \checkmark$$
$$0,285 = \frac{V}{22,4} \checkmark$$
$V(H_2) = 6,38 \text{ dm}^3$ ✓ (4)

[13]

QUESTION 6

6.1

Marking criteria:

- Calculate mass of oxygen ✓
- Calculate the number of moles of each element (3 x 1 = 3) ✓✓✓
- Determine the simplest ratio of all elements ✓
- Final answer: Na_3PO_4 ✓

m(O) = 10 – 4,21 – 1,89 = 3,9 g ✓

Element	mass (g)	$n = \frac{m}{M}$	Simplest Ratio	
Na	4,21	$\frac{4,21}{23} = 0,18$ ✓	$\frac{0,18}{0,06} = 3$	✓ (Obtaining all simplest ratios)
P	1,89	$\frac{1,89}{31} = 0,06$ ✓	$\frac{0,06}{0,06} = 1$	
O	3,9	$\frac{3,9}{16} = 0,24$ ✓	$\frac{0,24}{0,06} = 4$	

Empirical Formula: Na_3PO_4 ✓ (6)

6.2.1

OPTION 1

$c = \frac{m}{MV}$ ✓

$0,5 = \frac{15,75}{M(0,25)}$ ✓

$M(H_2C_2O_4.xH_2O) = 126\ g.mol^{-1}$ ✓

OPTION 2

$c = \frac{n}{V}$ ✓

$0,5 = \frac{n}{0,25}$

$n(H_2C_2O_4.xH_2O) = 0,125\ mol$ ✓

$m = n \times M$

$15,75 = 0,125 \times M$

$M(H_2C_2O_4.xH_2O) = 126\ g.mol^{-1}$ ✓ (3)

6.2.2 **POSITIVE MARKING FROM 6.2.1**

$M(H_2C_2O_4.xH_2O) = M(H_2C_2O_4) + xM(H_2O)$

126 ✓ $= \underline{2 + 2x12 + 4x16 + x(18)}$ ✓

$x = 2$ ✓ (3)

6.3

Marking criteria:

- Substitute into formula to determine theoretical mass of PbI_2✓
- $n = \frac{m}{M}$ ✓
- Substitute 461 ✓
- 2:1 ratio between KI and PbI_2✓
- Substitute n(KI) and 166✓
- Final answer: 76,36 g ✓

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

$$75 = \frac{80}{\text{theoretical yield}} \times 100 \checkmark$$

$m(PbI_2)_{theoretical} = 106{,}67$ g

$$n(PbI_2) = \frac{m}{M} \checkmark$$

$$= \frac{106{,}67}{461} \checkmark$$

$n(PbI_2) = 0{,}23$ mol

KI : PbI_2

2 : 1 ✓

$n(KI) = 0{,}46$ mol

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

$$0{,}46 = \frac{m}{166} \checkmark$$

$m(KI) = 76{,}36$ g ✓

OR

$m(PbI_2)_{actual} = m(PbI_2)_{theoretical} \times 0{,}75$

$80 = m(PbI_2)_{theoretical} \times 0{,}75$ ✓

(6)

[18]

QUESTION 7

7.1 Gradient = $\frac{120-0}{40-0}$ ✓

= 3 ✓ (2)

7.2 The volume/mole ratio ✓ between hydrogen and methane ✓ (2)

7.3 $V(H_2) = 72 \times 3$ ✓

= 216 cm^3 ✓ (2)

7.4

Marking Criteria:

- Separating the 420 cm^3 in the ratio 1:3 to determine the $V(H_2)$ ✓
- y = 315 ✓
- Dividing y by 3 ✓
- x = 105 ✓

$CO : H_2$

1 : 3

$V(H_2) = \frac{3}{4} \times 420$ ✓

= 315 cm^3

y = 315 ✓

x = 315 ÷ 3 ✓

= 105 ✓ (4)

[10]

TOTAL: **100**