KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 10

PHYSICAL SCIENCES P2 (CHEMISTRY)

NOVEMBER 2023

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 EIGHT 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 1.6 D.

1.1 Which of the following is not a property of a metal?

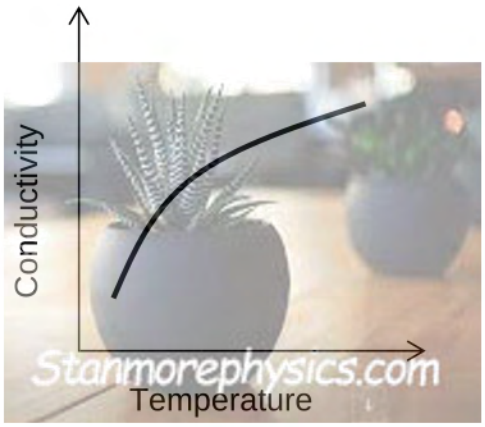
A Shiny

B Ductile and malleable

C Thermal conductor

D Insulator of electricity (2)

1.2 An investigation is conducted to study the effect of temperature on the conductivity of a substance. The results are represented in the graph below.



Which ONE of the following is the substance being investigated?

A Copper

B Aluminium

C Silicon

D Zinc (2)

1.3 Which one of the following is an example of a chemical change?

A Separating oil and water mixture using a decanter.

B Condensation of water vapour.

C Magnesium burning in air.

D Dissolving sugar in water. (2)

1.4 Consider the balanced chemical equation below:

$$4A\ell(s) + 3O_2(g) \rightarrow 2A\ell_2O_3(s)$$

Which one of the following is the correct number of oxygen atoms required to form 4 moles of aluminium oxide ($A\ell_2O_3$)?

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

B $12 \times 6{,}02 \times 10^{23}$

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

D $36 \times 6{,}02 \times 10^{23}$ (2)

1.5 Consider the unbalanced chemical equation below:

$$NH_3 + O_2 \rightarrow NO + H_2O$$

Which ONE of the sets of coefficients will balance the equation?

A 2, 2, 2, 3

B 2, 3, 2, 3

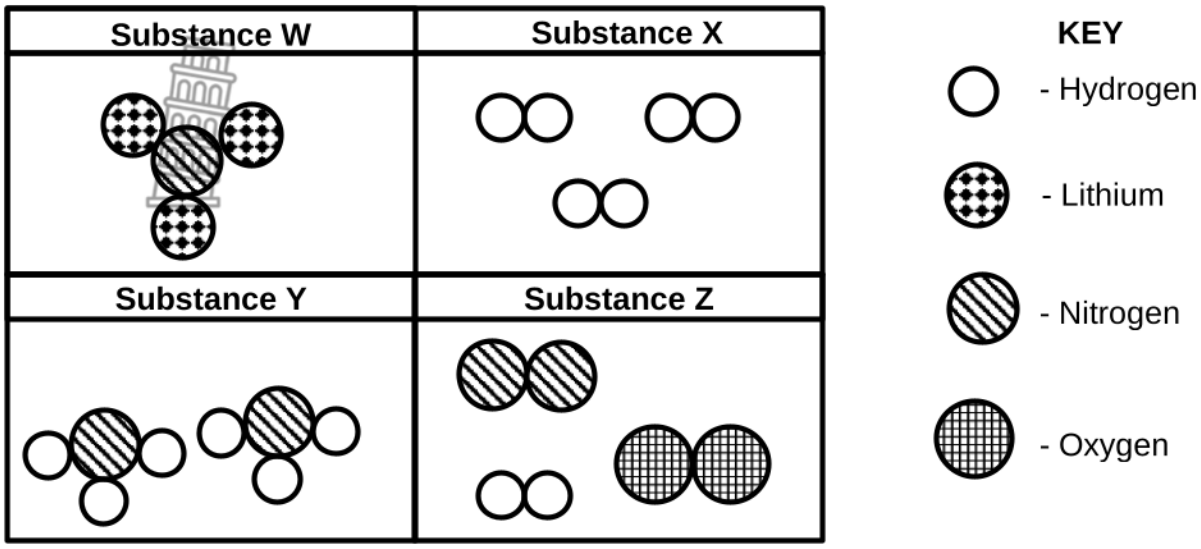
C 5, 4, 5, 6

D 4, 5, 4, 6 (2)

[10]

QUESTION 2 (Start on a new page.)

Four different substances, W, X, Y and Z are represented in the table below.



2.1 Is Substance X an ELEMENT or a COMPOUND?
Give a reason for the answer. (2)

2.2 Write down the LETTER of the substance that represents a mixture. (1)

2.3 Write down the COMMON NAME of Substance Y. (1)

2.4 Draw the Lewis structure of Substance Y. (2)

2.5 Identify the type of chemical bond between atoms in Substance W. (1)

2.6 Hydrogen gas and Nitrogen gas reacts to produce Substance Y.

2.6.1 Write down a BALANCED chemical equation for the reaction that takes place. (3)

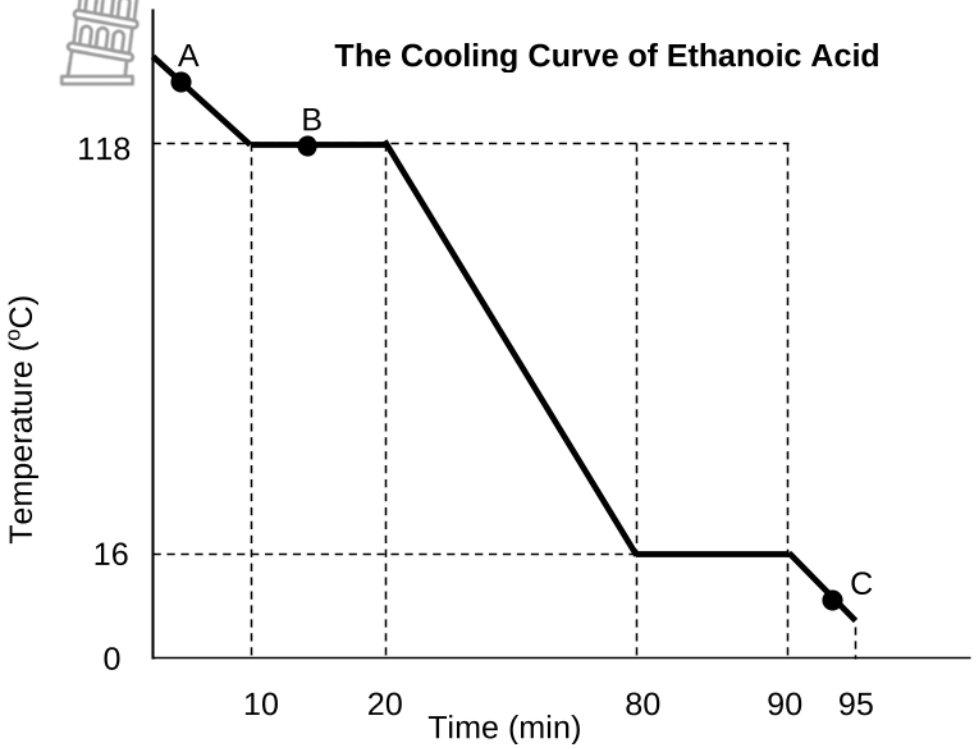
2.6.2 Is this a synthesis or decomposition reaction?
Give a reason for the answer. (2)

2.6.3 Use the balanced chemical equation from Question 2.6.1 to prove the law of conservation of mass in this reaction. (3)

[15]

QUESTION 3 (Start on a new page.)

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



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

3.2 What is the melting point of ethanoic acid? (1)

3.3 Are the forces between particles stronger in ETHANOIC ACID or in WATER? Give a reason for the answer. (2)

3.4 Write down the phase of ethanoic acid at 5 minutes. (1)

3.5 Write down the name given to the phase change occurring between 10 and 20 minutes. (1)

3.6 Explain why the change referred to in QUESTION 3.5 is a Physical Change. (2)

3.7 At which points, A, B or C are the following statements applicable?

3.7.1 The forces between particles are the strongest. (1)

3.7.2 The spaces between the particles are the largest (1)

3.7.3 The kinetic energies of the particles remain constant. (1)

[12]

QUESTION 4 (Start on a new page.)

Some information for the substances IRON and the SULPHIDE ION are given in the table below.

Name	Symbol	Number of protons	Number of electrons	Number of neutrons
IRON	Fe	**4.1.1**	26	**4.1.2**
SULPHIDE ION	**4.1.3**	16	**4.1.4**	16

4.1 Complete the table by providing the answers to questions 4.1.1 to 4.1.4. Do not redraw the table. Write the numbers (4.1.1– 4.1.4) down and the correct answer next to it. (4)

4.2 Draw the aufbau diagram and write down the electronic configuration (sp-notation) for the sulphide ion. (3)

4.3 How many valence electrons does the sulphide ion have? (1)

4.4 Iron (Fe) has three common isotopes as indicated below

Isotope	Percentage Abundance
Fe - 54	5,8 %
Fe - 56	91,7%
Fe - 57	REMAINDER

4.4.1 Define the term *isotope* in words. (2)

4.4.2 Determine the relative atomic mass of Iron (Fe). (3)

[13]

QUESTION 5 (Start on a new page.)

5.1 The table below shows the first and second ionisation energies of elements in PERIOD 2 of the periodic table.

	FIRST IONISATION ENERGY ($kJ.mol^{-1}$)	SECOND IONISATION ENERGY ($kJ.mol^{-1}$)
Li	520	7 297
Be	899	1 757
B	801	2 427
C	1 086	2 352
N	1 402	2 854
O	1 214	3 391
F	1 681	3 381
Ne	2 080	3 964

5.1.1 Explain why there is a general increase in the first ionisation energy on going from left to right across the period. (2)

5.1.2 It is observed that the second ionisation energy of Li (Lithium) is considerably higher than Be (Beryllium). Explain this observation. (2)

5.1.3 Write down the NAME of the group whose elements have the highest first ionisation energy in the period. (1)

5.2 Write down the CHEMICAL FORMULA for:

5.2.1 Sodium oxide (1)

5.2.2 Calcium phosphate (1)

5.2.3 Copper (II) carbonate (1)

5.3 Write down the CHEMICAL NAME for:

5.3.1 $MgBr_2$ (1)

5.3.2 $(NH_4)_2SO_4$ (1)

[10]

QUESTION 6 (Start on a new page)

Sulphur dioxide (SO_2) reacts with oxygen (O_2) to form sulphur trioxide (SO_3), as shown in the balanced equation below.

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

In one such reaction 2450 cm^3 sulphur trioxide (SO_3), is formed at STP.

6.1 State *Avogadro's law* in words. (2)

6.2 Calculate the:

6.2.1 Number of moles of SO_3 that formed. (4)

6.2.2 Mass of SO_2 that reacted. (4)

6.2.3 Number of oxygen (O_2) molecules that reacted (4)

[14]

QUESTION 7 (Start on a new page)

7.1 The analysis of a compound made up of the elements sodium (Na), sulphur (S) and oxygen (O) provides the following percentage composition, by mass.

Element	Percentage Composition
Sodium (Na)	29,11%
Sulphur (S)	40,51%
Oxygen (O)	30.38%

7.1.1 Define the term *empirical formula* in words. (2)

7.1.2 Determine the empirical formula of this compound (5)

7.2 Determine the percentage composition of water (H_2O) in hydrated copper sulphate ($CuSO_4 \cdot 5H_2O$). (4)

[11]

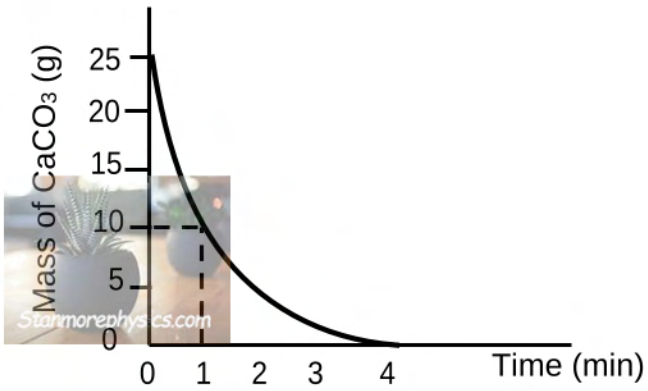
QUESTION 8 (Start on a new page)

Calcium carbonate ($CaCO_3$) reacts completely with excess phosphoric acid (H_3PO_4) of concentration 1,25 mol·dm^{-3}.

The reaction is represented by the following balanced equation:

$$3CaCO_3(s) + 2H_3PO_4(aq) \rightarrow Ca_3(PO_4)_2(aq) + 3CO_2(g) + 3H_2O(\ell)$$

The graph below (not drawn to scale), shows the **mass of the calcium carbonate ($CaCO_3$)** as the reaction progresses



8.1 Determine the number of moles of $Ca_3(PO_4)_2$ FORMED AFTER 1 MINUTE. (5)

The reaction is thereafter allowed to reach completion.

8.2 Determine the number of moles of calcium carbonate ($CaCO_3$) used. (2)

8.3 Calculate the volume of phosphoric acid that reacts with the calcium carbonate after 4 MINUTES. (4)

8.4 Calculate the percentage yield of carbon dioxide (CO_2), if 4 dm^3 of CO_2 was formed at STP. (4)

[15]

TOTAL: 100

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)
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	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 55 Cs 133	0,9 56 Ba 137	57 La 139	1,6 72 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 81 Tℓ 204	1,8 82 Pb 207	1,9 83 Bi 209	2,0 84 Po	2,5 85 At	86 Rn
0,7 87 Fr	0,9 88 Ra 226	89 Ac															

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 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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GRADE 10

PHYSICAL SCIENCES P2

FINAL EXAMINATION
MARKING MEMORANDUM

NOVEMBER 2023

MARKS: 100

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QUESTION 1:

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

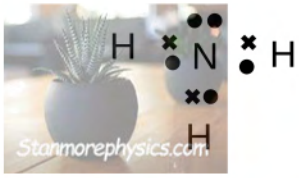
QUESTION 2

2.1 Element. ✓
It consists of one type of atom only. ✓ (2)

2.2 (Substance) Z ✓ (1)

2.3 Ammonia ✓ (1)

2.4 (2)



✓✓

2.5 Ionic bond ✓ (1)

2.6

2.6.1 $N_2 + 3H_2 \rightarrow 2NH_3$
LHS ✓
RHS ✓
Balancing ✓ (3)

2.6.2 Synthesis. ✓
Smaller elements are combining to form a larger compound ✓ (2)

2.6.3 **POSITIVE MARKING FROM 2.6.1**
Mass of reactants = 14x2+ 3 (1x2) ✓
= 34 $g.mol^{-1}$
Mass of products = 2(14 + 1x3) ✓
= 34 $g.mol^{-1}$
Mass of reactants is equal to the mass of products. Therefore mass is conserved. ✓ (3)

[15]

QUESTION 3

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

3.2 16 °C ✓ (1)

3.3 Ethanol ✓
It has a higher boiling point/melting point than water. ✓ (2)

3.4 Gas ✓ (1)

3.5 Condensation ✓ (1)

3.6 No new substance is formed / No chemical bonds are broken. ✓✓ (2)

3.7 3.7.1 C ✓ (1)
3.7.2 A ✓ (1)
3.7.3 B ✓ (1)

[12]

QUESTION 4

4.1

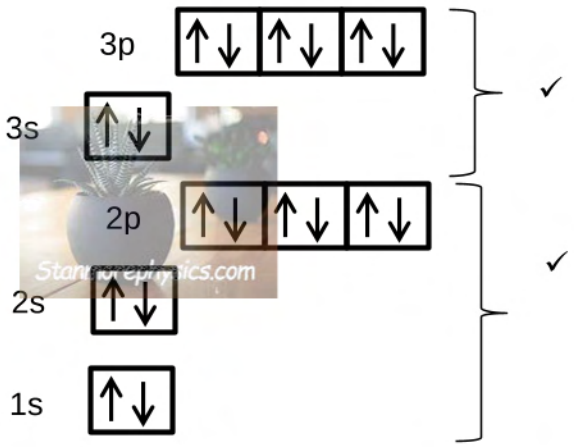
4.2.1 26 ✓ (1)

4.2.2 30 ✓ (1)

4.2.3 S^{2-} ✓ (1)

4.2.4 18 ✓ (1)

4.2



sp-notation: $1s^2 2s^2 2p^6 3s^2 3p^6$ ✓ (3)

4.3 8 ✓ (1)

4.4

4.4.1 Atoms of the same element having the same number of protons but different numbers of neutrons. ✓✓ (2)

4.4.2 % Fe-57 = 100 – 5,8 – 91,7 = 2,5% ✓

$$\text{Relative atomic mass} = 54\times\frac{5,8}{100} + 56\times\frac{91,7}{100} + 57\times\frac{2,5}{100} \quad ✓$$

$$= 55,91 \text{ AMU} ✓$$

(3)

[13]

QUESTION 5

5.1

5.1.1 As you move from left to right across a period the effective nuclear charge increase ✓
The force of attraction between the nucleus and the electrons in the outer orbital increases. ✓ (2)

5.1.2 Losing a second electron will result in an unstable electron state in Li ✓, whilst losing a second electron results in a stable electron state in Be ✓

OR

The second electron in Li is removed from the energy level very close to the nucleus, compared to Be. ✓ Therefore the force of attraction between the nucleus and the outer electron is stronger in Li. Hence more energy is needed to remove the second electron in Li compared to Be ✓ (2)

5.1.3 Noble gas ✓ (1)

5.2

5.2.1 Na_2O ✓ (1)

5.2.2 $Ca_3(PO_4)_2$ ✓ (1)

5.2.3 $CuCO_3$ ✓ (1)

5.3

5.3.1 Magnesium bromide ✓ (1)

5.2.2 Ammonium sulphate ✓ (1)

[10]

QUESTION 6

6.1 One mole of a gas occupies the same volume at the same temperature and pressure. ✓✓ (2)

6.2

6.2.1 $n(SO_3) = \frac{V}{V_m}$ ✓

$n(SO_3) = \frac{2,45}{22,4}$ ✓

$n(SO_3) = 0,11$ mol ✓ (3)

6.2.2 **POSITIVE MARKING FROM 6.2.1**

$SO_2 : SO_3$

2 : 2 ✓

$n(SO_2) = 0,11$ mol

$n(SO_2) = \frac{m}{M}$ ✓

$0,11 = \frac{m}{64}$ ✓

$m(SO_2) = 7,04$ g ✓ (4)

6.2.3 **POSITIVE MARKING FROM 6.2.1**

$O_2 : SO_3$

1 : 2 ✓

$n(O_2) = 0,055$ mol

$n(O_2) = \frac{N}{N_A}$ ✓

$0,055 = \frac{N}{6,02 \times 10^{23}}$ ✓

$N(O_2) = 3,31 \times 10^{22}$ O_2 molecules ✓ (4)

[13]

QUESTION 7

7.1 7.1.1 The simplest whole number ratio of elements in a compound. ✓✓ (2)

7.1.2 Consider 100g

Element	mass (g)	$n = \frac{m}{M}$	Simplest Ratio	
Na	29,11	$\frac{29,11}{23} = 1,27$ ✓	$\frac{1,27}{1,27} = 1 \times 2 = 2$	✓ (Obtaining all simplest ratios)
S	40,51	$\frac{40,51}{32} = 1,27$ ✓	$\frac{1,27}{1,27} = 1 \times 2 = 2$	
O	30,38	$\frac{30,38}{16} = 1,9$ ✓	$\frac{1,9}{1,27} = 1,5 \times 2 = 3$	

Empirical Formula: $Na_2S_2O_3$ ✓ (5)

7.2 M ($CuSO_4.5H_2O$). = 63,5 + 32 + 4x16 + 5(2+16) ✓

= 249,5 g.mol^{-1}

$$\% H_2O = \frac{5 \times 18}{249,5} \times 100$$ ✓

= 36,07 % ✓ (4)

[11]

QUESTION 8

8.1 $m(CaCO_3) = 25 - 10$ ✓

= 15 g

$n(CaCO_3) = \frac{m}{M}$ ✓

$= \frac{15}{100}$ ✓

= 0,15 mol

$CaCO_3$: $Ca_3(PO_4)_2$

3 : 1 ✓

n $[Ca_3(PO_4)_2]$ = 0.05 mol ✓ (5)

8.2 $n(CaCO_3) = \frac{m}{M}$

$= \frac{25}{100}$ ✓

= 0,25 mol ✓ (2)

8.3 **POSITIVE MARKING FROM 8.2**

$CaCO_3 : H_3PO_4$

3 : 2 ✓

$n(H_3PO_4) = 0,17$ mol

$c(H_3PO_4) = \frac{n}{V}$

$1,25$ ✓ $= \frac{0,17}{V}$ ✓

V (H_3PO_4) = 0,136 dm^3 ✓ (4)

8.4 **POSITIVE MARKING FROM 8.2**

$CaCO_3 : CO_2$

3 : 3 ✓

$n(CO_2) = 0,25$ mol

$n(CO_2) = \frac{V}{V_m}$

$0,25 = \frac{V}{22,4}$ ✓

V (CO_2) = 5,6 dm^3

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

$\%\ yield = \frac{4}{5,6} \times 100$ ✓ ✓

% yield = 71,43% ✓ (5)

[16]

TOTAL: 100