Province of the EASTERN CAPE EDUCATION

AMATHOLE WEST DISTRICT

GRADE 11

PHYSICAL SCIENCES

CONTROLLED TEST

12 SEPTEMBER 2023

MARKS: 100

TIME: 2 HOURS

This question paper consists of 11 pages including Data Sheet

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.
2. Number your answers correctly according to the numbering system used in this question paper.
3. Leave ONE line between two sub-questions, e.g., between QUESTION 2.1 and QUESTION 2.2.
4. A non-programmable calculator may be used.
5. Appropriate mathematical instruments may be used.
6. Show ALL formulae and substitutions in ALL calculations.
7. Round off your FINAL numerical answers to a minimum of TWO decimal places.
8. Give brief motivations, discussions, etc. where required.
9. You are advised to use the attached data sheets.
10. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various 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 (i.e 1.1 D) in the ANSWER BOOK.

1.1 The minimum amount of energy needed for a reaction to start is called……

A Activation energy

B Catalyst

C Heat of reaction

D Bond energy

(2)

1.2. Which ONE of the following statements about a chemical reaction is CORRECT?

The actual yield of a chemical reaction is usually…….

A Equal to the percentage yield

B Greater than the percentage yield

C Less than the theoretical yield

D Greater than the theoretical yield

(2)

1.3. Which ONE of the following statements is CORRECT for an endothermic reaction?

A The temperature of the surroundings increases

B The enthalpy change for the reaction is negative

C Heat flows from the surroundings into the system

D The enthalpy of products is less than the enthalpy of reactants

(2)

1.4 Consider an incomplete chemical equation below:

$$\mathbf{X} + 2HNO_3 \rightarrow Zn(NO_3)_2 + H_2O + CO_2$$

Which ONE of the following is represented by **X** in the above equation?

A $ZnCO_3$

B $ZnHCO_3$

C $ZnCO_2$

D $Zn(OH)_2$

(2)

1.5 The number of ions present in 3 moles of $MgCl_2$ is……….

A $3,612 \text{ X } 10^{24}$

B $5,418 \text{ x } 10^{24}$

C $1,08 \text{ x } 10^{24}$

D $7,22 \text{ x } 10^{24}$

(2)

1.6 According to the kinetic-molecular theory, molecules of different gases at the same temperature always have the same….

A Pressure
B Volume
C Kinetic energy
D Average kinetic energy

(2)

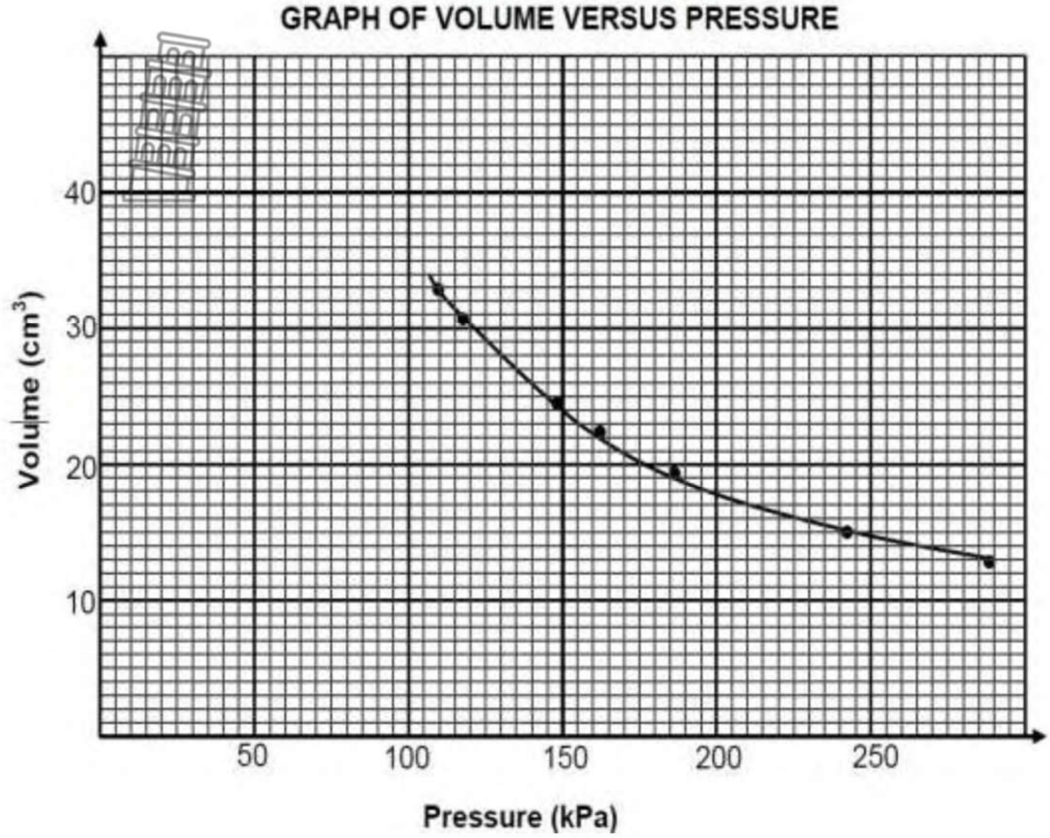
1.7 Two different gases of the same volume at STP will have the same……

A Mass
B Density
C Molar mass
D Number of molecules

(2)

[14]

Q UESTION 2 (Start on a new page)



A fixed mass of oxygen is used to verify one of the gas laws. The results obtained are shown in the graph below.

2.1 Write down a mathematical expression, in symbols, for the relationship between the variables shown in the graph. (1)

2.2. Give the name and state the gas law investigated. (3)

2.3 Explain the relationship in QUESTION 2.1 in terms of the kinetic theory of gases. (2)

2.4 Write down TWO variables that must be kept constant during this investigation and briefly describe how this is done. (4)

2.5 From the graph, write down the volume of oxygen, in cm^3, when the pressure is 120 kPa. (2)

2.6 Using the graph and the information provided, calculate the pressure, in kPa, exerted on the gas when it is compressed to 5 cm^3. (4)

2.7 Write down TWO conditions under which oxygen gas will deviate from ideal gas behaviour. (2)

[18]

QUESTION 3 (start on a new page.)

Consider the reaction represented by the equation below.

$$CO_{2(g)} + 2H_2O_{(l)} \rightarrow CH_{4(g)} + 2O_{2(g)}$$

During the reaction the temperature of the reaction mixture **DECREASES**

Bond energies (D) in ($kJ.mol^{-1}$):

C=O D = 602	H-O D = 459	C-H D = 411	O=O D = 494

(2)

3.1 Define the term enthalpy change.

3.2 Does the enthalpy change (ΔH) for this reaction have a positive or negative value? Explain the answer by referring to the energy involved. (3)

3.3 Sketch a labelled potential energy versus course of reaction graph for this reaction. On the graph, show the position of the reactants, products, ΔH and activation energy. (6)

[11]

QUESTION 4 (Start on a new page)

The chemical reaction for the production of the drug, aspirin, from two compounds, **X** and **Y**, is represented by the balanced equation below.

$$2C_7H_6O_3 + C_4H_6O_3 \rightarrow 2C_9H_8O_4 + H_2O$$

X **Y** aspirin

A chemist reacts 14 g of compound **X** with 10 g of compound **Y.**

4.1 Define the term *limiting reagent* in a chemical reaction. (2)

4.2 Perform the necessary calculations to determine which one of compound X or compound Y is the limiting reagent. (5)

The actual mass of aspirin obtained is 11, 5 g.

4.3 Calculate the percentage yield of aspirin (5)

[12]

QUESTION 5 (Start on a new page)

In order to determine the empirical formula and molecular formula of a compound, C_xH_y, a certain mass of the compound is burnt completely in excess oxygen to produce 47, 1 g CO_2 and 19, 35 g H_2O as the only products.

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

5.1.2 Use relevant calculations to determine the empirical formula of the compound. (8)

5.1.3 The molar mass of the compound is 28 $g.mol^{-1}$. Determine by using calculations the value of **x** and **y.** (3)

A sample of IMPURE calcium carbonate (limestone) of unknown mass required a continuous supply of strong heat to decompose according to the following equation:

$$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$$

After the completion of reaction, 11, 76 g CaO was produced.
The percentage purity of calcium carbonate is found to be 80%.

5.2 Calculate the mass of the impure calcium carbonate. (6)

5.3. In an experiment, a learner added 1, 5 g of sodium carbonate (Na_2CO_3) to hydrochloric acid (HCl). A volume of 306 cm^3 of carbon dioxide gas was formed and collected under standard pressure at room temperature. Take the molar gas volume at room temperature (V_m) as 24,45 dm^3. The unbalanced equation for the reaction is:

$$Na_2CO_{3(s)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

5.3.1 Calculate the mass of sodium carbonate that reacted (6)

5.3.2 Calculate the percentage of sodium carbonate in excess (4)

[29]

QUESTION 6 (Start on a new page)

A solution of potassium hydroxide (KOH) is prepared by dissolving 3, 36 g crystals of KOH in 250 cm^3 of solution.

6.1 Define the term *concentration.* (2)

6.2 Calculate the concentration of potassium hydroxide solution. (4)

25 cm^3 of a potassium hydroxide solution of concentration 0, 25 $mol.dm^{-3}$ completely neutralises a dilute solution of sulphuric acid (H_2SO_4) in a flask.

The incomplete equation below represents the reaction that takes place:

$$2KOH + H_2SO_4 \rightarrow K_2SO_4 + H_2O$$

6.3.1 Define the term *standard solution* (2)

6.3.2 Calculate the number of moles potassium hydroxide (KOH) (3)

6.3.3 Calculate the mass of sulphuric acid in the flask (5)

[16]

TOTAL: 100

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*

$\frac{p_1V_1}{T_1}=\frac{p_2V_2}{T_2}$	$pV=nRT$
$n=\frac{m}{M}$	$n=\frac{N}{N_A}$
$n=\frac{V}{V_m}$	$c=\frac{n}{V}$ OR/*OF* $c=\frac{m}{MV}$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

KEY/*SLEUTEL*: Atomic number/*Atoomgetal* (29); Electronegativity/*Elektronegatiwiteit* (1,9); Symbol/*Simbool* (Cu); Approximate relative atomic mass/*Benaderde relatiewe atoommassa* (63,5)

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

Province of the
EASTERN CAPE
EDUCATION

AMATHOLE WEST DISTRICT

GRADE 11

PHYSICAL SCIENCES

MARKING GUIDELINE

12 SEPTEMBER 2023

MARKS: 100

This MARKING GUIDELINE consists of 7 pages including cover page

QUESTION 1

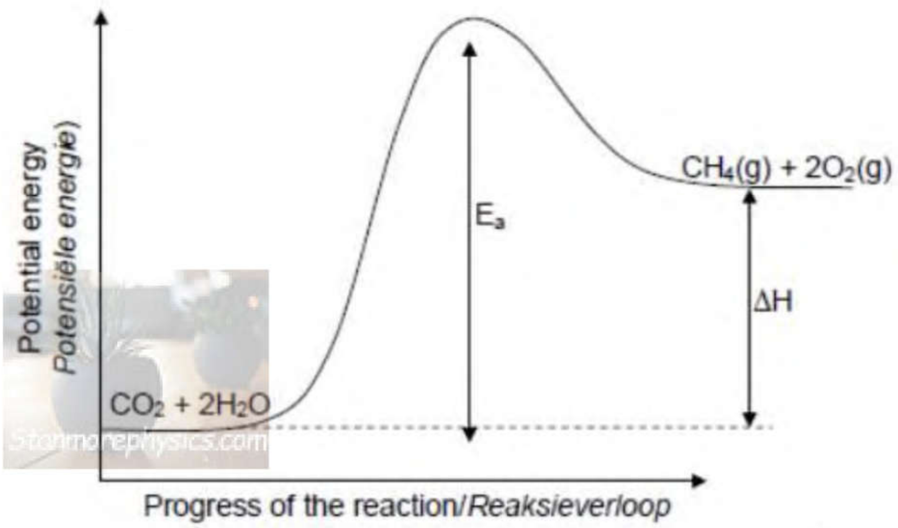
1.1 A √√
1.2 C √√
1.3 C √√
1.4 A √√
1.5 A √√
1.6 D √√
1.7 D √√

[14]

QUESTION 2		
2.1	$p \propto \frac{1}{V}$ **OR/*OF*** $V \propto \frac{1}{p}$ ✓	(1)
2.2	Boyle's law √, The pressure of an enclosed gas is inversely proportional to the volume it occupies at constant temperature √√	(3)
2.3	When the volume of the container is decreased, the particles will be closer together √, hence the particles will collide more with each other and the wall of the container leading to increase in the pressure. √	(2)
2.4	Mass of the gas√ – ensure there's no leakage.√ Temperature √ – gradually increase the pressure without having much effect on the temperature.√	(2)
2.5	30 cm^3 √√	(2)
2.6	$P_1v_1 = p_2v_2$ √ 120(30) √ = p2(5) √ P2 = 720 kPa √ **<u>Note</u>** May use any set of values from the graph that gives the correct answer	(4)
2.7	High pressures √ Low temperatures √	(2)

[18]

QUESTION 3		
3.1	The amount of heat/energy released or absorbed in a chemical reaction.	(2)
3.2	Positive √ The energy of the products is greater than energy of the reactants √√	(3)
3.3		(6)



Marking criteria/*Nasienriglyne*:
Labelled axes/*Benoemde asse* ✓
Shape/*Vorm* ✓
Position of reactants/*Posisie van reaktanse* ✓
Position of products/*Posisie van produkte* ✓
ΔH ✓
Activation energy / *Aktiveringsenergie*

[11]

QUESTION 4

4.1 Limiting reagent is the substance that is totally used up in a chemical reaction. √√ (2)

4.2 From the balanced equation;

$n(C_7H_6O_3)/n(C_4H_6O_3) = 2/1 = 2$ √

From the data supplied;

$n(C_7H_6O_3) = m/M$

$= 14/138$

$= 0{,}1014$ mol √

$n(C_4H_6O_3) = m/M$

$= 10/102$

$= 0{,}098$ mol √

$n(C_7H_6O_3)/n(C_4H_6O_3) = 0{,}1014/0{,}098$

$= 1{,}034$ √

Therefore, $C_4H_6O_3$ **(Y)** is the limiting reagent. √ (5)

4.3 $C_4H_6O_3 : C_9H_8O_4$

1 : 2

0, 098 : x

$n(C_9H_8O_4) = 0{,}196$ mol √

m = nM

m = 0, 196 x 180 √

m = 35, 28g

$$percentage\ yield = \frac{actual\ yield}{theoretical\ yield} x\ 100\%$$ √

$$= \frac{11{,}5}{35{,}28}\ x\ 100\%$$ √

$$= 32{,}60\ \%$$ √

(5)

[12]

QUESTION 5			
	5.1.1	Empirical formula: Smallest whole number ratio of elements that make up the substance. √√	(2)
	5.1.2	**OPTION 1** $n(H_2O)$ = m/M √ = 19,35/18 √ = 1, 075 mol n(H) = 2(H_2O) = 2 x 1,075 = 2, 15 mol √ n (CO_2) = m/M = 47,1/44 √ = 1, 07 mol n(C) = n (CO_2) = 1, 07 mol √ mol C: mol H 1, 07: 2, 15 √ 1: 2 √ **OPTION 2** %H in H_2O = 2/18 x 100 √ = 11,11% m(H) in H_2O = 11,11% of 19,35 g √ = 2,15 g $n_{(H)}$ = 2,15 ÷ 1 = 2, 15 mol √ %C in CO_2 = 12/44 x 100 √ = 27,27% m(C) in CO_2 = 27,27% of 47,1 g √ = 12,84 g (to 12,85 g) $n_{(C)}$ = 12,84 ÷ 12 = 1, 07 mol √ mol C: mol H 1, 07: 2,15 √ 1: 2 Empirical formula: CH_2 √	(8)
	5.1.3	**POSTIVE MARKING FROM QUESTION 5.1.2** $M(CH_2)$ = 1(12) + 2(1) = 14g.mol^{-1} (14)n = 28 √ n = 2 molecular formula: $(CH_2)2$ C_2H_4 √ $x = 2; y = 4$ √	(3)
5.2		n(CaO)=m/M √ 11,76/56=0,21 mol ($CaCO_3$) : (CaO) 1 : 1 $n_{(CaCO_3)}$ = 0, 21 mol √ m ($CaCO_3$) = nM = (0,21) (100) √ =21g √ $\% \ purity = \frac{pure\ sample}{impure\ sample} x\ 100\%$ $= \frac{21}{80}\ x\ 100\%$ √ = 26,25% √	(6)

5.3.1	V = 306 cm^3 = 0,306 dm^3 n (CO_2) = V/V_m = 0,306/24,45 √ = 0,0125 mol N(CO_2) = n(Na_2CO_3) = 0,0125 mol √ (mole ratio 1:1) m (Na_2CO_3) = nM √ = 0,0125 √ x (23(2) + 12 +3(16)) √ = 1,33 g √	(6)
5.3.2	Mass (Na_2CO_3) excess = 1,5 – 1,33√ = 0,17 g √ % excess = (0,17/1,5) x 100 √ = 11, 33%√	(4)

[30]

QUESTION 6		
6.1	Concentration is the amount of solute per litre of solution.	(2)
	OR Concentration is the number of moles of a substance per dm^3 of solution	
6.2	**OPTION 1** C = m/MV √ = 3,36 √/ (56) (0,25) √ = 0,24 $mol.dm^{-3}$ √ **OPTION 2** n = m/M = 3,36/56√ = 0,06 mol c = n/V √ = 0,06/ 0,25 √ = 0,24 $mol.dm^{-3}$ √	(4)
6.3.1	Solution of known concentration √√	(2)
6.3.3	n = CV √ n(KOH) = (0,25) (0,025) √ = 6,25 x 10^{-3} mol √	(3)
6.3.4	$n(H_2SO_4)$ = 0,5n(KOH) √ (mole ratio 1:2) = 0,5 (6,25x10^{-3}) = 3,125 x 10^{-3}mol $m(H_2SO_4)$ = nM √ = 3,125 x10^{-3} (98) √ = 0,31 g √	(4)

[15]

Total = [100]