



education

DEPARTMENT: EDUCATION
MPUMALANGA PROVINCE

GERT SIBANDE DISTRICT

GRADE 11

PHYSICAL SCIENCES TOPIC TEST
TOPIC: QUANTITATIVE ASPECTS OF CHEMICAL CHANGE
AUGUST 2023

MARKS: 50

TIME: 1 hour

This question paper consists of 6 pages including the data sheets

INSTRUCTIONS AND INFORMATION

1. This question paper consists of FOUR 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

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 (1.1–1.3) in the ANSWER BOOK, for example 1.4 D

1.1 The molecular formula of Compound Y is $C_2H_4Cl_2$. Which ONE of the following is the EMPIRICAL FORMULA of Y?

A $CHCl$

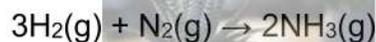
B CH_2Cl

C $CHCl_2$

D $C_4H_8Cl_4$

(2)

1.2 10 moles of hydrogen gas (H_2) and 2,5 moles of nitrogen gas (N_2) are mixed and allowed to react to form ammonia (NH_3) according to the following balanced equation:



If 4 moles of $NH_3(g)$ is formed during the reaction, the number of moles of $H_2(g)$ and $N_2(g)$ that remain in the container are respectively:

	Moles of $H_2(g)$	Moles of $N_2(g)$
A	0	0
B	7	1,5
C	4	0,5
D	4	2

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

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

A greater than the theoretical yield.

B equal to the percentage yield.

C greater than the percentage yield.

D less than the theoretical yield.

(2)

[6]

QUESTION 2

Compound **X** is composed of carbon (C), hydrogen (H) and oxygen (O).

During combustion of a 9,984 g sample of **X**, it is found that 28,160 g of $\text{CO}_2(\text{g})$ and 11,520 g of $\text{H}_2\text{O}(\text{g})$ is produced.

- 2.1 Calculate the mass of carbon (C) in CO_2 . (3)
- 2.2 Use relevant calculations to determine the empirical formula of compound **X**. (7)
- 2.3 The molar mass of menthol is $156 \text{ g} \cdot \text{mol}^{-1}$. Determine the molecular formula of compound **X**. (2)

[12]

QUESTION 3

Leaners demonstrated how a limiting reagent is used in chemical industries to determine the percentage yield of the industrial products. They carried out two experiments in which the reactions that took place are summarised in the tables below.

EXPERIMENT	QUANTITY OF REACTANTS
1	20 g of Iron (Fe) is heated with 10 g of sulphur (S)
2	14 cm^3 of $0,125 \text{ mol} \cdot \text{dm}^{-3}$ $\text{HBr}(\text{aq})$ is reacted with 0,2 mol $\text{Ba}(\text{OH})_2(\text{aq})$

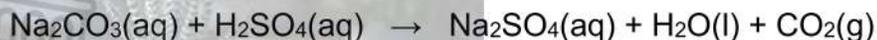
EXPERIMENT	BALANCED CHEMICAL EQUATION
1	$\text{Fe}(\text{s}) + \text{S}(\text{s}) \rightarrow \text{FeS}(\text{s})$
2	$\text{Ba}(\text{OH})_2(\text{aq}) + 2\text{HBr}(\text{aq}) \rightarrow \text{BaBr}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$

- 3.1 Define the term *limiting reactant*. (2)
- 3.2 Consider EXPERIMENT 1 :
 - 3.2.1 Use a calculation to show that sulphur (S) is a limiting reagent. (4)
 - 3.2.2 How many grams of Iron (Fe) are in excess? (4)
- 3.3 Consider EXPERIMENT 2 :
 - 3.3.1 Calculate the mass of BaBr_2 formed, if HBr is the limiting reagent in the reaction. (5)
 - 3.3.2 Calculate the actual yield of BaBr_2 if the percentage yield is 90 %. (3)

[18]

QUESTION 4

36 cm³ of 0,05 mol.dm⁻³ sulphuric acid (H₂SO₄) is reacted with 1,2 g of EXCESS IMPURE sodium carbonate crystals (Na₂CO₃). The balanced chemical equation for the reaction which takes place is as follows.



4.1 Define the term *concentration*. (2)

4.2 Calculate:

4.2.1 The number of moles of sulphuric acid that reacts with sodium carbonate. (3)

4.2.2 The percentage of sodium carbonate in impure sodium carbonate crystals. (6)

4.2.3 The volume of CO₂ (g) that is formed if the reaction takes place at STP. (3)

[14]

TOTAL: 50

DATA FOR PHYSICAL SCIENCES GRADE 11 PAPER 2 (CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS

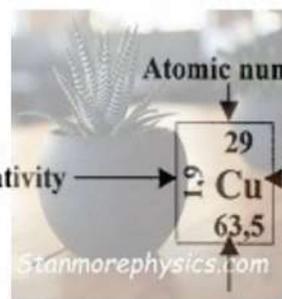
NAME	SYMBOL	VALUE
Standard pressure	p ^θ	1,013 x 10 ⁵ Pa
Molar gas volume at STP	V _m	22,4 dm ³ ·mol ⁻¹
Standard temperature	T ^θ	273 K
Avogadro's' number	N _A	6,02×10 ²³

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

I																									0											
1	II																	III	IV	V	VI	VII	2													
2,1																		2,0	2,5	3,0	3,5	4,0	4													
1																		5	6	7	8	9	10													
1																		11	12	14	16	19	20													
3																		13	14	15	16	17	18													
1,0																		1,5	1,8	2,1	2,5	3,0	40													
7																		27	28	31	32	35,5														
11																		19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
0,9																		0,8	1,0	1,2	1,5	1,6	1,6	1,5	1,8	1,8	1,8	1,9	1,6	1,6	1,8	2,0	2,4	2,8	84	
23																		39	40	45	48	51	52	55	56	59	59	63,5	65	70	73	75	79	80	84	
																		11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
																		23	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
																		37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
																		86	88	89	91	92	96	101	103	106	108	112	115	119	122	128	127	131	131	
																		0,8	1,0	1,2	1,4	1,6	1,8	1,9	2,2	2,2	2,2	1,9	1,7	1,7	1,8	1,9	2,1	2,5	86	
																		86	88	89	91	92	96	101	103	106	108	112	115	119	122	128	127	131	131	
																		55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	
																		133	137	139	179	181	184	186	190	192	195	197	201	204	207	209				
																		0,7	0,9	1,0	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6
																		87	88	89	179	181	184	186	190	192	195	197	201	204	207	209				
																		0,7	0,9	1,0	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6	1,6
																		87	88	89	179	181	184	186	190	192	195	197	201	204	207	209				
																		Fr	Ra	Ac																
																		226	226	226																
																		58	59	60	61	62	63	64	65	66	67	68	69	70	71					
																		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu					
																		140	141	144		150	152	157	159	163	165	167	169	173	175					
																		90	91	92	93	94	95	96	97	98	99	100	101	102	103					
																		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr					
																		232		238																



Electronegativity → ← Symbol

Relative atomic mass (approximately)



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Stanmorephysics.com

**TOPIC: QUANTITATIVE ASPECTS OF CHEMICAL CHANGE
AUGUST 2023
MARKING GUIDELINES**

MARKS: 50

Stanmorephysics.com

These marking guidelines consist of 5 pages

QUESTION 1

- 1.1 B ✓✓ (2)
 1.2 C ✓✓ (2)
 1.3 D ✓✓ (2)

[6]

QUESTION 2

2.1

<p>Marking criteria:</p> <ul style="list-style-type: none"> Substitute $44 \text{ g} \cdot \text{mol}^{-1}$. ✓ Substitution $12 \text{ g} \cdot \text{mol}^{-1}$. ✓ Final answer $7,68 \text{ g}$ ✓ 	<p>OPTION 1</p> $m(\text{C}) = \frac{12}{44} \times 28,16$ $\therefore m(\text{C}) = 7,68 \text{ g} \checkmark$
<p>OPTION 2</p> $n = \frac{m}{M}$ $\therefore n(\text{CO}_2) = \frac{28,16}{44} = 0,64 \text{ mol}$ $n(\text{C}) = n(\text{CO}_2) = 0,64 \text{ mol}$ $m(\text{C}) = nM$ $= (0,64)(12) \checkmark$ $= 7,68 \text{ g} \checkmark$	<p>OPTION 3</p> $\% \text{C in CO}_2 = \frac{12}{44} \times 100$ $= 27,27\%$ $m(\text{C}) \text{ in CO}_2 = 27,27\% \text{ of } 28,16 \text{ g}$ $m(\text{C}) = 7,68 \text{ g} \checkmark$

(3)

2.2 **POSITIVE MARKING FROM Q 2.1**

<p>Marking criteria:</p> <ul style="list-style-type: none"> Substitute $M(\text{H}_2\text{O})$ to calculate $n(\text{H}_2\text{O})$. ✓ $n(\text{H}) = 2n(\text{H}_2\text{O})$. ✓ Substitution $M(\text{H})$ to calculate $m(\text{H})$. ✓ $m(\text{O}) = m(\text{menthol}) - (m(\text{C}) + m(\text{H}))$. ✓ Substitution $M(\text{O})$ to calculate $n(\text{O})$. ✓ Ratio: mol C : mol H : mol O = 10 : 20 : 1 ✓ Empirical formula: $\text{C}_{10}\text{H}_{20}\text{O}$ ✓

OPTION 1	OPTION 2															
<u>n(H) and m(H)</u>																
$n = \frac{m}{M}$	$\%H \text{ in } H_2O = \frac{2}{18} \times 100$															
$\therefore n(H_2O) = \frac{11,52}{18} = 0,64 \text{ mol}$	$= 11,11\%$ $m(H) \text{ in } H_2O = 11,11\% \text{ of } 11,52 \text{ g} = 1,28 \text{ g}$															
$n(H) = 2n(H_2O) = 2(0,64) = 1,28 \text{ mol}$	$m(O) = 9,984 - (7,68 + 1,28) = 1,024 \text{ g}$															
$m(H) = nM = (1,28)(1) = 1,28 \text{ g}$	<table border="0"> <tr> <td>C</td> <td>:</td> <td>H</td> <td>:</td> <td>O</td> </tr> <tr> <td>7,68</td> <td>:</td> <td>1,28</td> <td>:</td> <td>1,024</td> </tr> <tr> <td>12</td> <td>:</td> <td>1</td> <td>:</td> <td>16</td> </tr> </table>	C	:	H	:	O	7,68	:	1,28	:	1,024	12	:	1	:	16
C	:	H	:	O												
7,68	:	1,28	:	1,024												
12	:	1	:	16												
<u>n(O) and m(O)</u>	0,64 : 1,28 : 0,064															
$m(O) = 9,984 - (7,68 + 1,28) = 1,024 \text{ g}$	10 : 20 : 1															
$n(O) = \frac{1,024}{16} = 0,064 \text{ mol}$	Empirical Formula: $C_{10}H_{20}O$															
Ratio:																
mol C : mol H : mol O																
0,64 : 1,28 : 0,064																
10 : 20 : 1																
Empirical formula: $C_{10}H_{20}O$																

(7)

2.3 POSITIVE MARKING FROM Q 2.2

OPTION 1

$M(C_{10}H_{20}O) = 10 \times 12 + 20 + 16 = 156 \text{ g} \cdot \text{mol}^{-1}$

Molecular formula: $C_{10}H_{20}O$

OPTION 2

$(C_{10}H_{20}O)_x = 156$

$(12 \times 10 + 20 + 16)_x = 156$

$156x = 156$

$x = 1$

Molecular formula = $C_{10}H_{20}O$

(2)

[12]

QUESTION 3

3.1 A reagent/substance that is completely used up in a chemical reaction. ✓✓
 [2 or 0 MARK] (2)

3.2.1 $n(\text{Fe}) = \frac{m}{M}$
 $= \frac{20}{56}$ ✓
 $= 0,357 \text{ mol Fe}$ ✓ Any formula

$n(\text{S}) = \frac{m}{M}$
 $= \frac{10}{32}$ ✓
 $= 0,313 \text{ mol}$

From balanced equation:

1 mol Fe reacts with 1 mol S / $n(\text{S}) < n(\text{Fe})$ ✓
 (The limiting reactant is S.)

OR: Any other correct method used to determine the limiting reagent. (4)

3.2.2 **POSITIVE MARKING FROM Q 3.2.1**

$n(\text{Fe used}) = \frac{m}{M}$ ✓

$0,313 = \frac{m}{56}$ ✓

$\therefore m(\text{Fe used}) = 17,53 \text{ g}$

$m(\text{excess}) = 20 - 17,53$ ✓ = 2,47 g ✓ (4)

3.3.1 $n(\text{HBr}) = CV$ ✓

$n(\text{HBr}) = 0,125 \times 0,014$ ✓ = 0,0018 mol

$n(\text{HBr}): n(\text{BaBr}_2) = 2:1$

$n(\text{BaBr}_2) = 0,0018 \div 2 = 0,0009 \text{ mol}$ ✓

$m(\text{BaBr}_2) = nM$

$m(\text{BaBr}_2) = 0,0009 \times 297$ ✓ = 0,27 g ✓ (5)

3.3.2 **POSITIVE MARKING FROM Q 3.3.1**

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

90 ✓ = $\frac{\text{actual yield}}{0,27} \times 100$ ✓

Actual yield = 0,24 g ✓ (3) [18]

QUESTION 4

4.1 The amount of solute a given solution contains at a given temperature. ✓✓
[2 or 0 mark] (2)

4.2.1 $n = CV$ ✓
 $n = (0,05)(0,036)$ ✓
 $n = 0,0018 \text{ mol.}$ ✓ (3)

4.2.2 **POSITIVE MARKING FROM Q 4.2.1**

$$n(\text{H}_2\text{SO}_4) : n(\text{Na}_2\text{CO}_3) = 1:1 \quad \checkmark$$

$$n(\text{Na}_2\text{CO}_3) = 0,0018 \text{ mol}$$

$$m = nM \quad \checkmark$$

$$m = 0,0018 \times 106 \quad \checkmark = 0,19 \text{ g} \quad \checkmark$$

$$\% \text{ of } \text{Na}_2\text{CO}_3 = \frac{\text{mass of } \text{Na}_2\text{CO}_3}{\text{impure mass}} \times 100$$

$$\% \text{ of } \text{Na}_2\text{CO}_3 = \frac{0,19}{1,2} \times 100 \quad \checkmark$$

$$\% \text{ of } \text{Na}_2\text{CO}_3 = 15,83 \% \quad \checkmark \quad (6)$$

4.2.3 **POSITIVE MARKING FROM Q 4.2.1**

$$n(\text{H}_2\text{SO}_4) : n(\text{CO}_2) = 1:1$$

$$n(\text{CO}_2) = 0,0018 \text{ mol}$$

$$n(\text{CO}_2) = \frac{V}{V_M} \quad \checkmark$$

$$0,0018 = \frac{V}{22,4} \quad \checkmark$$

$$V_{(\text{CO}_2)} = 0,0403 \text{ mol.dm}^{-3} \quad \checkmark$$

TOTAL:50 (3)
[14]