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 $C_2H_4C\ell_2$ Which ONE of the following is the EMPIRICAL FORMULA of **Y**?

A $CHC\ell$

B $CH_2C\ell$

C $CHC\ell_2$

D $C_4H_8C\ell_4$ (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:

$$3H_2(g) + N_2(g) \rightarrow 2NH_3(g)$$

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 $CO_2(g)$ and 11,520 g of $H_2O(g)$ 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 $g \cdot mol^{-1}$. 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 $mol.dm^{-3}$ HBr(aq) is reacted with 0,2 mol $Ba(OH)_2(aq)$

EXPERIMENT	BALANCED CHEMICAL EQUESTION
1	$Fe(s) + S(s) \rightarrow FeS(s)$
2	$Ba(OH)_2(aq) + 2HBr(aq) \rightarrow BaBr_2(aq) + 2H_2O(l)$

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 cm^3 of 0, 05 $mol.dm^{-3}$ sulphuric acid (H_2SO_4) is reacted with 1, 2 g of EXCESS IMPURE sodium carbonate crystals (Na_2CO_3) .The balanced chemical equation for the reaction which takes place is as follows.

$$Na_2CO_3(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + H_2O(l) + CO_2(g)$$

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 CO_2 (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}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature	T^{θ}	273 K
Avogadro's' number	N_A	$6{,}02 \times 10^{23}$

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

KEY

Atomic number
29
Electronegativity 1,9 · Symbol Cu
63,5
Relative atomic mass (approximately)

I	II											III	IV	V	VI	VII	0
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

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AUGUST 2023
MARKING GUIDELINES

MARKS: 50

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

Marking criteria: • Substitute 44 $g \cdot mol^{-1}$.✓ • Substitution12 $g \cdot mol^{-1}$.✓ • Final answer 7,68 g ✓	**OPTION 1** m(C) = $\frac{12✓}{44✓} x 28,16$ $\therefore$ m(C) = 7,68 g✓
OPTION 2 $n = \frac{m}{M}$ $\therefore n(CO_2) = \frac{28,16}{44}$✓ = 0,64 mol $n(C) = n(CO_2)$ = 0,64 mol m(C) = nM = (0,64)(12)✓ = 7,68 g✓	**OPTION 3** %C in $CO_2 = \frac{12✓}{44✓} \times 100$ = 27,27% m(C)in CO_2 = 27,27% of 28,16 g m(C) = 7,68 g ✓

(3)

2.2 **POSITIVE MARKING FROM Q 2.1**

Marking criteria:
- Substitute $M(H_2O)$ to calculate $n(H_2O)$.✓
- $n(H) = 2n(H_2O)$.✓
- Substitution M(H) to calculate m(H).✓
- m(O) = m(menthol) – (m(C) + m(H))✓
- Substitution M(O) to calculate n(O).✓
- Ratio: mol C : mol H : mol O = 10 : 20 : 1✓
- Empirical formula: $C_{10}H_{20}O$✓

OPTION 1

n(H) and m(H)

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

$\therefore n(H_2O) = \frac{11,52}{18}$ ✓

= 0,64 mol

$n(H) = 2n(H_2O)$

= 2(0,64)✓

= 1,28 mol

m(H) = nM

= (1,28)(1)✓

= 1,28 g

n(O) and m(O)

m(O) = 9,984 – (7,68 + 1,28)✓

= 1,024 g

$n(O) = \frac{1,024}{16}$ ✓

= 0,064 mol

Ratio:

mol C : mol H : mol O

0,64 : 1,28 : 0,064

10 : 20 : 1✓

Empirical formula: $C_{10}H_{20}O$✓

OPTION 2

$\%H \text{ in } H_2O = \frac{2}{18} \times 100$ ✓✓

= 11,11%

$m(H) \text{ in } H_2O$ = 11,11% of 11,52 g✓

= 1,28 g

m(O) = 9,984 – (7,68 + 1,28)

= 1,024 g ✓

C	:	H	:	O
$\frac{7,68}{12}$	:	$\frac{1,28}{1}$	:	$\frac{1,024}{16}$ ✓

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

$M(C_{10}H_{20}O)$ = 10x12 + 20 + 16 = 156 g·mol^{-1}✓

Molecular formula: $C_{10}H_{20}O$✓

OPTION 2

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

$(12x10 + 20 + 16)_x = 156$

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

$n(Fe) = \frac{m}{M}$ ✓ Any formula

$= \frac{20}{56}$ ✓

$= 0{,}357$ mol Fe

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

$= \frac{10}{32}$ ✓

$= 0{,}313\ mol$

From balanced equation:
1 mol Fe reacts with 1 mol S / n(S) < n(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**

$n(Fe\ used) = \frac{m}{M}$ ✓

$0{,}313 = \frac{m}{56}$ ✓

$\therefore$ m(Fe used = 17,53 g

m(excess) = 20 – 17,53✓ = 2,47 g✓ (4)

3.3.1 n(HBr) = CV✓
n(HBr) = 0, 125 X 0,014 ✓ = 0, 0018 mol
n(HBr): n($BaBr_2$) = 2:1
n($BaBr_2$) = 0, 0018 ÷ 2 = 0, 0009 mol✓
m(($BaBr_2$) = nM
m(($BaBr_2$) = 0, 0009X 297✓ = 0,27 g✓ (5)

3.3.2 **POSITIVE MARKING FROM Q 3.3.1**

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

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

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 mol.✓ (3)

4.2.2 **POSITIVE MARKING FROM Q 4.2.1**

$n(H_2SO_4) : n(Na_2CO_3) = 1:1$✓

$n(Na_2CO_3) = 0,\ 0018$ mol

m = nM✓

m = 0, 0018 x 106✓ = 0,19 g✓

$\% \text{ of } Na_2CO_3 = \frac{\text{mass of Na2CO3}}{\text{impure mass}} x100$

$\% \text{ of } Na_2CO_3 = \frac{0{,}19}{1{,}2} x100$✓

$\% \text{ of } Na_2CO_3 = 15,\ 83\ \%$✓ (6)

4.2.3 **POSITIVE MARKING FROM Q 4.2.1**

$n(H_2SO_4) : n(CO_2) = 1:1$

$n(CO_2) = 0,\ 0018$ mol

$n(CO_2) = \frac{V}{V_M}$✓

$0,\ 0018 = \frac{V}{22{,}4}$✓

$V_{(CO2)} = 0{,}0403\ mol.dm^{-3}$✓

(3)

[14]

TOTAL:50