KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

NATIONAL SENIOR CERTIFICATE

PHYSICAL SCIENCES P2 (CHEMISTRY)

JUNE 2023

COMMON TEST

MARKING GUIDELINES

MARKS: 150

This memorandum consists of 11 pages.

QUESTION 1

1.1 D ✓✓ (2)

1.2 C ✓✓ (2)

1.3 A ✓✓ (2)

1.4 B ✓✓ (2)

1.5 A ✓✓ (2)

1.6 B ✓✓ (2)

1.7 C ✓✓ (2)

1.8 D ✓✓ (2)

1.9 B ✓✓ (2)

1.10 B ✓✓ (2)

[20]

QUESTION 2

2.1.1 4,5,5 – trimethylhexa – 1,3 - diene

REMOVED

Marking criteria:
- correct stem i.e. hexadiene✓
- all substituents trimethyl correctly identified✓
- IUPAC name completely correct including numbering, sequence and hyphen and commas✓

(3)

2.1.2 2 – methylbutan – 2 – ol **OR** 2 – methyl -2-butanol

Marking criteria:
- correct stem i.e. butanol✓
- substituent methyl correctly identified✓
- IUPAC name completely correct including numbering, sequence and hyphen and commas✓

(3)

2.2.1 F✓ (1)

2.2.2 E✓ (1)

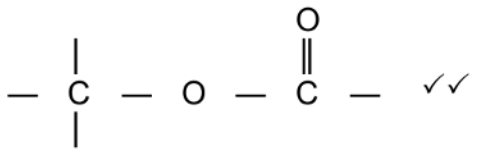
2.3.1 A bond/an atom/a group of atoms that determine(s) the (physical and) chemical properties of a group of organic compounds.

Marking criteria:
If any one of the underlined key phrases in the correct context is omitted, deduct 1 mark

(2)

2.3.2 carboxyl✓✓ (1)

2.3.3



✓✓

Marking criteria:
Whole structure correct
2 or zero

(2)

2.3.4 $C_2H_4O_2$ ✓ + C_2H_6O ✓ → $C_4H_8O_2$ ✓ + H_2O ✓ balancing ✓

Marking criteria:
- 1 for each correct reactant and product
- 1 for correct balancing
- If structural formulae are used Max 4/5
- Any additional reactant or product: -1 mark

(5)

2.3.5 Sulphuric acid/H_2SO_4 ✓ (1)

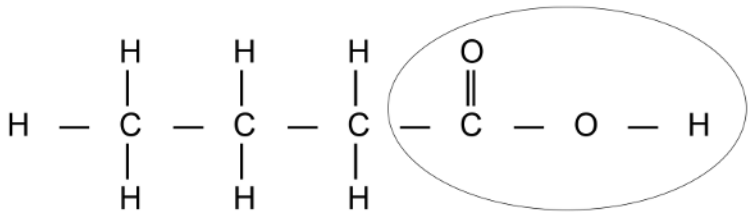
2.3.6 ethanol✓✓ (2)

2.4 Compounds with the same molecular formula ✓ but different functional groups/homologous series. ✓

Marking criteria:
If any one of the underlined key phrases in the correct context is omitted, deduct 1 mark

(2)

2.5



Marking criteria:
- Only Functional group correctly drawn✓ ½
- Whole structure correct ✓ 2/2

(2)

[25]

QUESTION 3

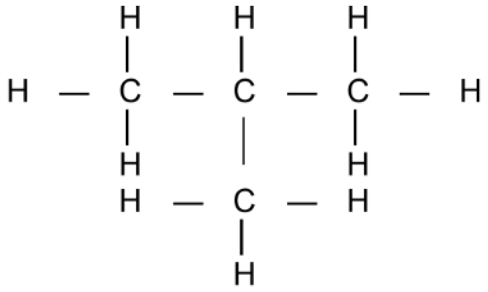
3.1.1 The temperature at which the vapour pressure of a substance equals atmospheric pressure ✓✓

Marking criteria:
If any one of the underlined key phrases in the correct context is omitted, deduct 1 mark

(2)

3.1.2 Compound X / methylpropane Is branched / has a smaller surface area / is less spherical while compound Y / butane has a straight chain / is unbranched / has a bigger surface area / is more spherical✓
The intermolecular forces in compound Y are stronger than the intermolecular forces in comnpound X. ✓
More energy is required to overcome the intermolecular forces in compound Y. ✓ (3)

3.1.3



Marking criteria:
- 3 carbons in the longest chain✓
- substituent methyl on the second carbon and everything else correct✓

(2)

3.2.1 Butanoic acid ✓✓
The compounds must be of comparable molecular mass OR butanoic acid has the same molecular mass as pentan – 1 - ol✓

OR

Pentanoic acid ✓✓
The compounds must be of comparable chain length OR butanoic acid has the same chain length as pentan – 1 - ol✓ (3)

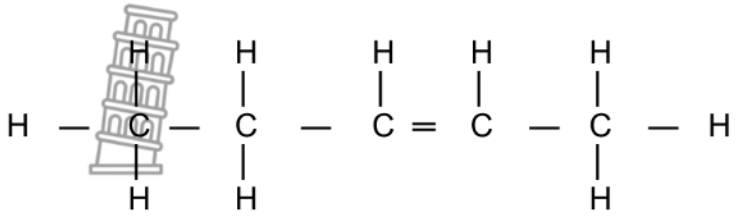
3.2.2 GREATER THAN✓ (1)

3.2.3 The carboxylic acid has 2 sites for hydrogen bonding while the alcohol has only 1 site for hydrogen bonding. ✓
The intermolecular forces will therefore be stronger between the molecules of the carboxylic acid. ✓
More energy will therefore be required to overcome the intermolecular forces between the molecules of the acid. ✓ (3)
[14]

QUESTION 4

4.1.1 Elimination. ✓ (1)

4.1.2



Marking criteria:
- Double bond on second carbon✓ ½
- Whole structure correct ✓ 2/2

(2)

4.1.3 concentrated sulphuric acid ✓✓ (If concentrated is not mentioned, then 1/2) (2)

4.2.1 Hydrogenation✓ (1)

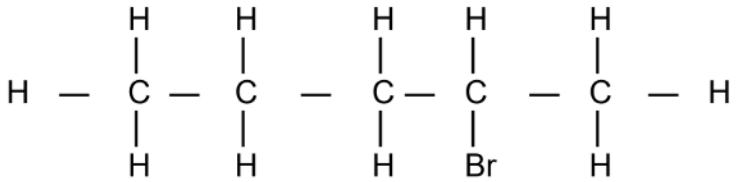
4.2.2 Hydrogen/H_2✓ (1)

4.2.3 Platinum/Pt catalyst✓ (1)

4.3.1 Halogenation/bromination/substitution✓ (1)

4.3.2 Require uv light. Or heat✓ (1)

4.3.3



Marking criteria:
- Br on second carbon✓ ½
- Whole structure correct ✓ 2/2

(2)

4.4.1 Dilute strong base/KOH/NaOH/H_2O✓ (1)

4.4.2 $CH_3CH_2CH_2CHBrCH_3 + KOH \rightarrow CH_3CH_2CH_2CHOHCH_3 + KBr$ **OR**
$CH_3CH_2CH_2CHBrCH_3 + NaOH \rightarrow CH_3CH_2CH_2CHOHCH_3 + NaBr$ **OR**
$CH_3CH_2CH_2CHBrCH_3 + H_2O \rightarrow CH_3CH_2CH_2CHOHCH_3 + HBr$

Marking criteria:
- Correct reactants✓
- Correct products✓
- Balancing✓

(3)

4.5 Dehydrohalogenation/dehydrobromination✓ (1)
[17]

QUESTION 5

5.1

Marking criteria:
Give the mark for per unit time only if in context of reaction rate.

ANY ONE
- Change in concentration ✓of products/reactants per (unit) time. ✓
- Change in amount/number of moles/volume/mass✓ of products or reactants per (unit) time. ✓
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time. ✓✓
- Rate of change in concentration/amount of moles/number of moles/volume/mass. ✓✓ (2 or 0) (2)

5.2 Change in the mass of the flask and contents✓ decreases per unit time / per second / every 30 seconds. ✓ (2)

5.3 Mass of $CaCO_3$ decreases or is used up. ✓
A decrease in the exposed surface area. ✓
The number of effective collisions per unit time decreases. ✓

OR

HCl is used up. ✓
Concentration of the HCl decreases. ✓
The number of effective collisions per unit time decreases. ✓ (3)

NOTE: If no mention made of $CaCO_3$ or HCl used up, award 2 marks to second bullet.

5.4 REMAINS THE SAME. ✓ (1)

5.5

$$\text{Average rate} = -\frac{\Delta m}{\Delta t}$$

$$6{,}58 \times 10^{-2} \checkmark = -\frac{X - 217{,}50}{180 - 0} \checkmark \checkmark$$

$$X = 205{,}66 \text{ g} \checkmark$$

Marking criteria:
- Substitute rate✓
- Substitute Δm✓
- Δt✓
- Final answer✓

(4)

5.6 203,95 g ✓
Reaction has reached completion. ✓ (2)

5.7 **Marking criteria:**

- Calculate mass of pure CO_2✓
- Formula: $n = \frac{m}{M}$
- Correct substitution of 44 ($\frac{13{,}55}{44}$ ✓) in the above formula
- Formula $n(CO_2)_{produced} = \frac{V}{V_m}$

✓Either equation

- Substitute n = 0,31 ✓
- Substitute V_m = 22,4 ✓
- Final answer = 6.944 dm^3 ✓

$m(CO_2)$ = 217,50 - 203,95 ✓ = 13,55 g

$n(CO_2) = \frac{m}{M}$

$= \frac{13{,}55}{44}$ ✓

= 0,31 mols

✓Either equation

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

$0{,}31$✓ $= \frac{V}{22{,}4}$ ✓

V = 6,944 dm^3 (6,90)✓ (6)

5.8 A catalyst provides an alternate pathway of lower activation energy / lowers the activation energy✓
More molecules will therefore have sufficient energy✓
The number of effective collisions per unit time increases ✓ (3)

5.9.1 REMAINS THE SAME✓ (1)

5.9.2 DECREASES✓ (1)

[25]

QUESTION 6

6.1.1 The reaction is in a state of (dynamic) equilibrium. ✓✓
OR The rate of forward reaction equals the rate of reverse reaction.
OR The concentrations of the reactants and products remain constant.

Note
IF: Forward reaction equals reverse reaction. $^{1}/_{2}$ (2)

6.1.2 Less than✓ (1)

6.1.3 **t_1**✓
The concentration of N_2 was increased./graph shows an increase in concentration of N_2✓ (2)

6.1.4

Marking criteria:
If any one of the underlined key phrases in the correct context is omitted, deduct 1 mark.

When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will cancel/oppose the disturbance. ✓✓ (2)

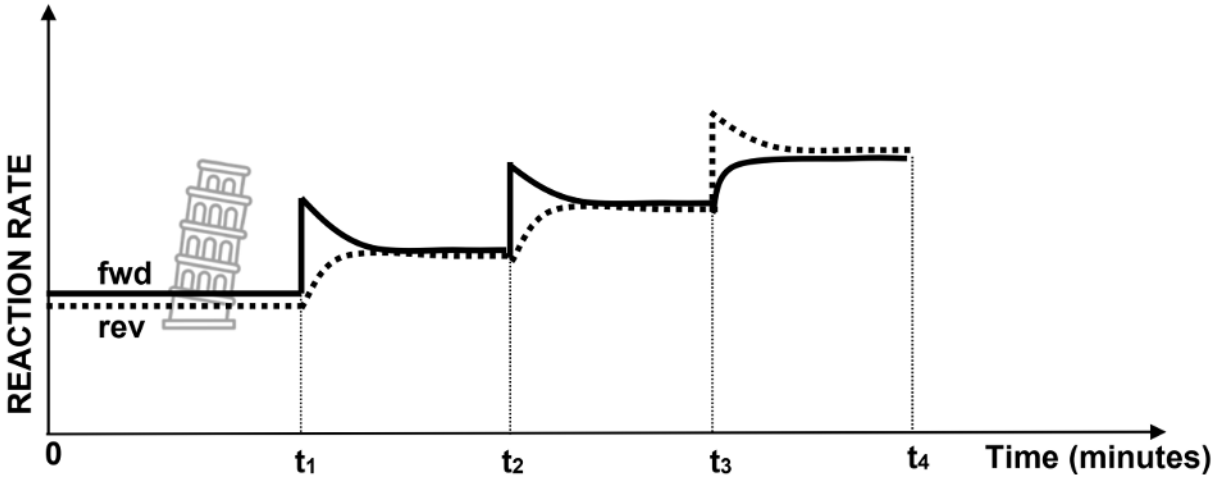
6.1.5 temperature✓ (1)

6.1.6 INCREASED✓
According to the graph the concentration of the reactants increases OR the concentration of the products decreases. ✓
Therefore the reverse reaction / endothermic reaction is favoured. ✓
(According to Le Chatelier's Principle) an increase in temperature favours the endothermic reaction. ✓ (4)

6.1.7

MARKING CRITERIA

- At t_1, forward reaction is favoured (vertical upward climb of solid line) ✓
- At t_2, forward reaction is favoured (vertical upward climb of solid line) ✓
- At t_3, reverse reaction is favoured (vertical upward climb of broken line) ✓
- Vertical upward increase in rates at t_2, t_3 and t_4. ✓
- Equilibrium rate at t_4 .> equilibrium rate at t_3 > equilibrium rate at t_2✓



(5)

6.2.1 Products can be converted back to reactants. ✓✓ (2)

6.2.2 REVERSE✓ (1)

6.3

Marking criteria:

- Change in no. of mol of C =1✓
- Using the correct ratio✓
- Subtraction: initial mol X – change in mol of X AND initial mol Y – change in mol of Y. ✓
- Equilibrium mol of X and Y; divide by 2✓
- Correct Kc expression (formulae in square brackets) ✓
- Substitution of equilibrium concentrations into Kc expression. ✓
- Final answer 0,71✓

	X	Y	C	
Ratio	2	1	2	
Initial quantity (mol)	2,5	1,75	0	
Change (mol)	1	0,5 ✓	1✓	Using ratio ✓
Quantity at equilibrium (mol)	1,5	1,25	1	✓
Equilibrium concentration (mol·dm^{-3})	0,75	0,625	0,5	✓ Divide by 2

$$K_c = \frac{[C]^2}{[X]^2[Y]} \checkmark$$

$$\therefore = \frac{[0,5]^2}{[0,75]^2[0,625]} \checkmark$$

$$= 0,71 \checkmark$$

No K_c expression, correct substitution. $^6/_7$
Wrong K_c expression $^4/_7$

(7)

[27]

QUESTION 7

7.1.1 acids produce hydrogen ions (H^+/H_3O^+/hydronium ions) in aqueous solutions. ✓✓

Marking criteria:
If any one of the underlined key phrases in the correct context is omitted, deduct 1 mark. (2)

7.1.2 Hydrogen sulphate ion/ HSO_4^- ✓
Acts as an acid and a base✓ (2)

7.2.1 H_2O✓
$(COO)_2^{2-}$ ✓ (2)

7.2.2 Oxalic acid. ✓
Has a higher Ka value. ✓
Ionises to a greater extent / more completely. OR has a higher ion concentration. ✓ (3)

7.3.1 REMAINS THE SAME✓ (1)

7.3.2 DECREASES✓ The volume increases while number of moles is constant /
The number of moles of acid decreases in proportion to the volume of water ✓ (2)

7.4.1 The point at which the acid has completely reacted with the base /
The point at which the base has completely reacted with the acid ✓✓ (2)

7.4.2

Marking criteria:

- Formula $\frac{C_A V_A}{C_B V_B} = \frac{n_A}{n_B}$ / n = cV✓
- Substitute for C_A, V_A and V_B in the above formula/cV✓
- Ratio $n_A : n_B$✓
- Final answer: 0,365 mol.dm^{-3}✓

$\frac{C_A V_A}{C_B V_B} = \frac{n_A}{n_B}$ ✓

$\frac{0,29 \times 12,58}{C_B \times 20}$ ✓ $= \frac{1}{2}$ ✓

C_B = 0,365 mol.dm^{-3} ✓

OR

$n(NaHCO_3) = 2\, n(H_2SO_4)$

$= 2\, cV$✓

$= 2(0,29)(0,01258)$

$= 7,2964 \times 10^{-3}$ mols

$c(NaHCO_3) = \frac{n}{V}$ ✓

$= \frac{7,2964 \times 10^{-3}}{0,02}$ ✓

$= 0,365$ mol.dm^{-3} ✓

(4)

7.4.3 **POSITIVE MARKING FROM QUESTION 7.4.2**

Marking criteria:

- Any Formula: n = CV / m = nM / m = CMV Formula: m = nM✓
- Substitute 0,365 from 7.3.1 and 0,25✓
- Substitute M = 84✓ in any of the above formulae
- Final answer: 7,665 g ✓

OPTION1

$n(NaHCO_3)$ in 250cm^3 = cV✓

= (0,365)(0,25) ✓

= 0,09125 mols

$m(NaHCO_3)$ in 250cm^3 = nM

= 0,09125 x 84✓

= 7,67 g✓

OPTION2

m = CMV✓

= (0,365) (0,25) ✓ (84) ✓

= 7,67 g✓

(4)

[22]

TOTAL: 150