Education

KwaZulu-Natal Department of Education

PHYSICAL SCIENCES P2 (CHEMISTRY)

PREPARATORY EXAMINATION

SEPTEMBER 2018

MEMORANDUM

NATIONAL SENIOR CERTIFICATE

GRADE 12

MARKS : 150

This memorandum consists of 9 pages.

The marking guidelines as per 2014 Examination Guidelines, pages 34-37 must be applied when marking this Paper.

QUESTION 1

1.1	B ✓✓	(2)
1.2	C✓✓	(2)
1.3	C✓✓	(2)
1.4	A✓✓	(2)
1.5	B✓✓	(2)
1.6	B✓✓	(2)
1.7	D✓✓	(2)
1.8	A✓✓	(2)
1.9	A✓✓	(2)
1.10	C✓✓	(2) **[20]**

QUESTION 2

2.1.1	E ✓	(1)
2.1.2	B ✓	(1)
2.1.3	D✓	(1)
2.1.4	F✓	(1)
2.1.5	G✓	(1)
2.2.1	2,4,4-trimethylpent-2-ene✓✓	(2)
2.2.2	C_nH_{2n} ✓	(1)
2.3.1	ethanol✓	(1)
2.3.2	sulphuric acid✓	(1) **[10]**

QUESTION 3

3.1.1 a series of organic compounds that can be described by the same general formula✓ in which one member differs from the next with a CH_2 group. ✓ (2)

3.1.2 the temperature at which the vapour pressure equals atmospheric/external pressure. ✓✓ (2 or 0) (2)

3.2 C✓
As the boiling point increases the vapour pressure decreases. ✓
C has the highest boiling point. ✓ (3)

3.3 B✓ (1)

3.4.1 118,50 ºC✓ (1)

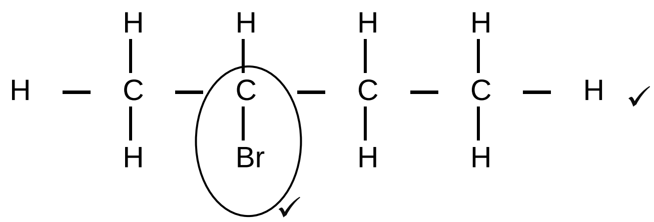
3.4.2 In addition to London forces and dipole-dipole forces, C has two sites for hydrogen bonding between the molecules✓ resulting in the strongest intermolecular forces occurring between molecules of C.✓
The intermolecular forces between molecules of C require the most amount of energy to overcome. ✓
C will therefore have the highest boiling point. ✓ (4)
[13]

QUESTION 4

4.1.1 Addition/hydrohalogenation✓ (1)

4.1.2 Substitution/hydrolysis✓ (1)

4.2



- Whole structure correct: 2/2
- Only functional group correct 1/2
- More than one functional group 0/2

2-bromobutane✓ (3)

4.3 Secondary✓
The carbon to which the —O—H✓ is bonded to, is bonded to TWO other carbon atoms. ✓ (3)

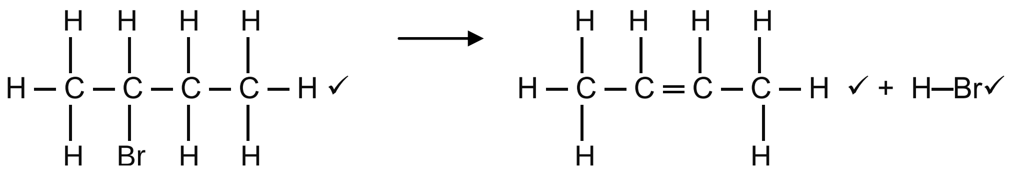
4.4 Dehydration✓✓ (1)

4.5 (Gentle) heat✓
Aqueous/dilute strong base (accept NaOH(dilute) or KOH(dilute) ✓ (2)

4.6.1 Compounds with the same molecular formula, ✓ but different positions of the side chain/substituents/functional groups on the parent chain.✓ (2)

4.6.2 Elimination✓ (1)

4.6.3



1 mark for each reactant and product

(3)
[17]

QUESTION 5

5.1.1 **ANY ONE**

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

5.1.2 60 - 61(s) ✓ (1)

5.1.3 $n(CO_2) = n(CaCO_3)$ ✓

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

$= (\frac{86 - 40}{100})$ ✓

$= 0,46$ mols

$n = \frac{V}{V_m}$

$0,46$ ✓ $= \frac{V}{22,4}$ ✓

$V = 10,304\ dm^3$ ✓ (5)

Marking criteria
- Use mol ratio: $n(CO_2) = n(CaCO_3) = 1:1$ ✓
- Substitute $\frac{86 - 40}{100}$ in $n = \frac{m}{M}$ ✓
- Substitute 0,46✓ mols and
- Substitute $22,4\ dm^3$✓ in $n = \frac{V}{V_m}$
- Final answer: $V = 10,304\ dm^3$

5.1.4 40 g✓ (1)
5.1.5 INCREASES✓ (1)
5.1.6 See attached graph. (3)

- Curve starts at 86 g and ends at 40g✓
- The completion time is above 60 or 61s✓
- The curve above the original✓

5.2.1 Collision theory ✓ (1)

5.2.2 The shaded areas in the distribution curves represent the number of molecules with sufficient kinetic energy to overcome the activation energy ✓. An increase in the temperature of the system results in a greater number of particles with sufficient kinetic energy to overcome the activation energy of the reaction ✓. This results in more effective collisions per unit time OR a higher chance of an effective collision occurring✓, resulting in a higher reaction rate. (3)
[17]

QUESTION 6

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

6.2.1 REMAINS THE SAME✓ (1)

6.2.2 INCREASES✓ (1)

6.2.3 REMAINS THE SAME ✓ (1)

6.2.4 INCREASES✓ (1)

Apply negative marking from 6.2.4

6.3 According to Le Chatelier's Principle a decrease in temperature favours the exothermic reaction✓ A decrease in temperature increases the equilibrium constant✓.Therefore the forward reaction is favoured✓ (3)

6.4

Marking criteria:

- Indicating that the number of mols of H_2 decreases by an unknown amout✓
- Correct mol ratio✓
- Calculating in terms of x the quantity(mol) at equilibrium of all three substances ✓
- Substitute V = 4 dm^3 in $c = \frac{n}{V}$ to determine concentration at equilibrium of H_2/I_2 and HI.✓
- K_c expression✓
- Substitution of concentrations in K_c expression ✓
- Substitution of 49 for Kc✓
- Equation: $n = \frac{m}{M}$ ✓
- Substituting in the above equation✓
- Final answer: 399,36 g✓

No K_c expression, correct substitution: Max. $\frac{9}{10}$

Wrong K_c expression : Max. $\frac{6}{10}$

	H_2	I_2	HI	
Initial quantity(mol)	2	2	0	
Change(mol)	-x✓	-x	+2x	Ratio ✓
Quantity at equilibrium(mol)	2-x	2-x	2x	✓
Equilibrium concentration(mol.dm^{-3})	$\frac{2-x}{4}$	$\frac{2-x}{4}$	$\frac{x}{2}$	Divide by 4✓

$$K_c = \frac{[HI]^2}{[H_2][I_2]} ✓ = \frac{(\frac{x}{2})^2}{(\frac{2-x}{4})(\frac{2-x}{4})} ✓ = 49 ✓$$

x = 1,56 mol

m(HI) = nM✓
= (2)(1,56)(128) ✓
= 399,36 g✓ (10)

[19]

QUESTION 7

7.1 It dissociates/ionises completely in water to form a high concentration of OH^- ions. ✓ (1)

7.2 It contains a small amount (number of moles) of base✓ in proportion to the volume of water✓ (2)

7.3

- Formula pH = - log [H_3O^+] ✓/ pOH = - log [OH^-] ✓
- Substitute 13,45 for pH✓/0,55 for pOH✓
- c(OH^-) = 0,282 mol.dm^{-3}✓
- Using ratio of 1: 2 to calculate c(($Ba(OH)_2$) ✓
- Formula m = cVM✓
- Substituting into the above formula✓
- Answer✓

Option 1:

pH = - log [H_3O^+] ✓

13,45✓ = - log [H_3O^+]

∴ [H_3O^+] = 3,54 x 10^{-14} mol.dm^{-3}

[H_3O^+][OH^-] = 1 x 10^{-14}

c(OH^-) = 0,282 mol.dm^{-3}✓

c(($Ba(OH)_2$) = 0,141 mol.dm^{-3}✓

m = cVM✓

= (0,141)(0,25)(171) ✓

= 6,03 g✓

Option 2:

pOH = - log [OH^-] ✓

0,55✓ = - log [OH^-]

∴ [OH^-] = 0,282 mol.dm^{-3}✓

c(($Ba(OH)_2$) = 0,141 mol.dm^{-3}✓

m = cVM✓

= (0,141)(0,25)(171) ✓

= 6,03 g✓

(7)

7.4 **Positive marking from question 7.3: concentration of $Ba(OH)_2$**

Marking guidelines

- Formulae: $c = \frac{n}{V}$ /n = cV/ $\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$ ✓
- Substitution of: 0,141 x 60 /0,141 x 0,06 ✓
- Use mol ratio: $n_a : n_b = 2 : 1$ ✓
- Final answer: 33,84 cm^3 / 0,03384 dm^3 ✓

Option 1:

n(HCℓ) = 2n(($Ba(OH)_2$)

= 2cV

= 2(0,141)(0,06) ✓

= 0.01692 mols

c(HCℓ) = n/V✓

0,5✓ = 0,01692/V

V = 0,03384 dm^3/33,84cm^3 ✓

Option 2:

$$\frac{c_A V_A}{c_B V_B} = \frac{n_A}{n_B}$$ ✓

$$\frac{0,5 \quad V_A}{0,141 \quad 0,06} = \frac{2}{1}$$ ✓ ✓

V_A = 0,03384 dm^3✓

Accept V_B = 60 cm^3

V_A = 33,84 cm^3

(4)

[14]

QUESTION 8

8.1 GALVANIC, ✓ converts chemical energy to electrical energy✓ or no dc power supply. (2)

8.2 Temperature of 25 ºC/298K✓
Pressure 101,3 kPa✓
Concentration of electrolyte of 1mol.dm^{-3}✓ (3)

8.3 Chlorine (molecule)✓ ✓ (2)

8.4 **OPTION 1**

$E^{\Theta}_{cell} = E^{\Theta}_{cathode} - E^{\Theta}_{anode}$ ✓
= 1,36 ✓ - (-1,66) ✓
= 3,02 V ✓

Notes
- Accept any other correct formula from the data sheet.
- Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:
  $E°_{sel} = E°_{OM} - E°_{RM}$ Max/: $\frac{3}{4}$

OPTION 2

✓ { $C\ell_2(g) + 2e^- \rightarrow 2C\ell^-(aq)$ 1,36 (V) ✓
$A\ell(s) \rightarrow A\ell^{3+}(aq) + 3e^-$ -1,66 (V) ✓
$A\ell(s) + C\ell_2(g) \rightarrow A\ell^{3+}(aq) + 2C\ell^-(aq)$ 3,02 (V) ✓ (4)

8.5 $3C\ell_2(g) + 2A\ell(s) \rightarrow 6C\ell^-(aq) + 2A\ell^{3+}(aq)$

Notes
- Reactants ✓ Products ✓ Balancing ✓
- Ignore phases.
- Marking rule 6.3.10
- Marking rule 3.9.
- Marking rule 3.4: One mark is forfeited when the charge of an ion is omitted per equation (not for the charge on the electron)

(3)

8.6.1 REMAINS THE SAME✓ (1)

8.6.2 DECREASES✓ (1)

[16]

QUESTION 9

9.1 A solution that conducts electricity through the movement of ions. ✓ (1)
9.2 Cu^{2+}✓ (1)

9.3.1 Decreases✓ (1)

9.3.2 $Cu \rightarrow Cu^{2+} + 2e^-$

Notes
- $Cu^{2+} + 2e^- \leftarrow Cu$ ($\frac{2}{2}$) $Cu^{2+} + 2e^- \rightleftharpoons Cu$ ($\frac{0}{2}$)
  $Cu \rightleftharpoons Cu^{2+} + 2e^-$ ($\frac{1}{2}$) $Cu^{2+} + 2e \rightarrow Cu$ ($\frac{0}{2}$)
- Ignore if charge on electron is omitted.
- If a charge of an ion is omitted e.g. $Cu \rightarrow Cu^2 + 2e^-$ *is* $Cu \rightarrow Cu^2 + 2e^-$ Max.: $\frac{1}{2}$

(2)

9.3.4

Marking criteria
- Calculate number of mols of cations: $\underline{2,259 \times 10^{24} = n(6,023 \times 10^{23})}$✓
- Formula: $n = \frac{m}{M}$ ✓
- Substitute calculated number of moles of cations and 63,5 in $n = \frac{m}{M}$ ✓
- Final answer 238,125 g✓

$n_e = nNA$

$\underline{2,259 \times 10^{24} = n(6,023 \times 10^{23})}$ ✓

n = 3,75 mols

m = nM✓

= $\underline{(3,75)(63,5)}$ ✓

= 238,125 g. ✓ (4)

[9]

QUESTION 10

10.1.1 Haber✓ (1)
10.1.2 Catalytic oxidation of ammonia✓ (1)
10.1.3 Nitrogen dioxide✓ (1)
10.1.4 Ammonium nitrate✓ (1)

10.2.1 Sulphuric acid/H_2SO_4✓ (1)

10.2.2 $H_2SO_4 + 2NH_3 \rightarrow (NH_4)_2SO_4$

Notes*:*
- Reactants ✓ Products ✓ Balancing ✓
- Marking rule 6.3.10.

(3)

10.3 % N = 14/20 x 36

= 25,2%✓

Mass of N = 25,2/100 x **m**

12,60✓= $\underline{25,2/100 \times \mathbf{m}}$✓

m = 50 kg ✓ (4)

10.4 Fertiliser A✓

Fertilizer A has a high percentage of Phosphorus compared to fertilizer B. ✓✓ (3)

[15]

TOTAL MARKS: 150

QUESTION 5.1.6