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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]**

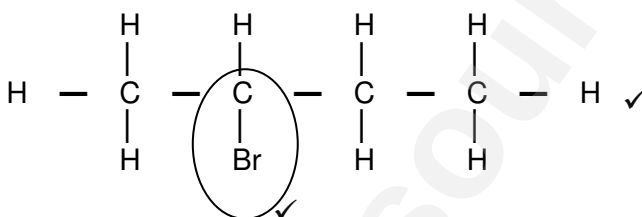
QUESTION 3

- 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 CH₂ 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 °C✓ (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

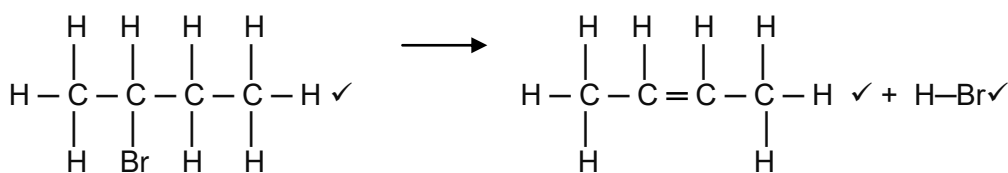


2-bromobutane✓

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

(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 $n(\text{CO}_2) = n(\text{CaCO}_3)$ ✓

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

$$= \left(\frac{86 - 40}{100} \right) \checkmark$$

$$= 0,46 \text{ mols}$$

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

$$0,46 \checkmark = \frac{V}{22,4} \checkmark$$

$$V = 10,304 \text{ dm}^3 \checkmark$$

Marking criteria

- Use mol ratio: $n(\text{CO}_2) = n(\text{CaCO}_3) = 1:1$ ✓
- Substitute $\frac{86 - 40}{100}$ in $n = \frac{m}{M}$ ✓
- Substitute 0,46 ✓ mols and
- Substitute $22,4 \text{ dm}^3$ ✓ in $n = \frac{V}{V_m}$
- Final answer: $V = 10,304 \text{ dm}^3$

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 amount✓
- Correct mol ratio✓
- Calculating in terms of x the quantity(mol) at equilibrium of all three substances ✓
- Substitute $V = 4 \text{ dm}^3$ 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 K_c ✓
- 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
Quantity at equilibrium(mol)	2-x	2-x	2x
Equilibrium concentration(mol.dm ⁻³)	$\frac{2-x}{4}$	$\frac{2-x}{4}$	$\frac{x}{2}$

Ratio ✓

✓

Divide by 4✓

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

x = 1,56 mol

m(HI) = nM✓

= $\frac{(2)(1,56)(128)}{399,36 \text{ g}} \checkmark$

(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 $\text{pH} = -\log [\text{H}_3\text{O}^+]$ ✓ / $\text{pOH} = -\log [\text{OH}^-]$ ✓
- Substitute 13,45 for pH ✓ / 0,55 for pOH ✓
- $c(\text{OH}^-) = 0,282 \text{ mol.dm}^{-3}$ ✓
- Using ratio of 1: 2 to calculate $c((\text{Ba}(\text{OH})_2))$ ✓
- Formula $m = cVM$ ✓
- Substituting into the above formula ✓
- Answer ✓

Option 1:

$$\begin{aligned}\text{pH} &= -\log [\text{H}_3\text{O}^+] \quad \checkmark \\ 13,45 \checkmark &= -\log [\text{H}_3\text{O}^+] \\ \therefore [\text{H}_3\text{O}^+] &= 3,54 \times 10^{-14} \text{ mol.dm}^{-3} \\ [\text{H}_3\text{O}^+][\text{OH}^-] &= 1 \times 10^{-14} \\ c(\text{OH}^-) &= 0,282 \text{ mol.dm}^{-3} \checkmark \\ c((\text{Ba}(\text{OH})_2)) &= 0,141 \text{ mol.dm}^{-3} \checkmark \\ m &= cVM \checkmark \\ &= \frac{(0,141)(0,25)(171)}{1} \checkmark \\ &= 6,03 \text{ g} \checkmark\end{aligned}$$

Option 2:

$$\begin{aligned}\text{pOH} &= -\log [\text{OH}^-] \quad \checkmark \\ 0,55 \checkmark &= -\log [\text{OH}^-] \\ \therefore [\text{OH}^-] &= 0,282 \text{ mol.dm}^{-3} \checkmark \\ c((\text{Ba}(\text{OH})_2)) &= 0,141 \text{ mol.dm}^{-3} \checkmark \\ m &= cVM \checkmark \\ &= \frac{(0,141)(0,25)(171)}{1} \checkmark \\ &= 6,03 \text{ g} \checkmark\end{aligned}$$

(7)

7.4 Positive marking from question 7.3: concentration of $\text{Ba}(\text{OH})_2$

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: $0,141 \times 60 / 0,141 \times 0,06$ ✓
- Use mol ratio: $n_a : n_b = 2 : 1$ ✓
- Final answer: $33,84 \text{ cm}^3 / 0,03384 \text{ dm}^3$ ✓

Option 1:

$$\begin{aligned}n(\text{HCl}) &= 2n((\text{Ba}(\text{OH})_2)) \\ &= 2cV \\ &= \frac{2(0,141)(0,06)}{1} \checkmark \\ &= 0,01692 \text{ mols} \\ c(\text{HCl}) &= n/V \checkmark \\ 0,5 \checkmark &= 0,01692/V \\ V &= 0,03384 \text{ dm}^3 / 33,84 \text{ cm}^3 \checkmark\end{aligned}$$

Option 2:

$$\begin{aligned}\frac{c_A}{c_B} \frac{V_A}{V_B} &= \frac{n_A}{n_B} \quad \checkmark \\ \frac{0,5}{0,141} \frac{V_A}{0,06} &= \frac{2}{1} \quad \checkmark \\ V_A &= 0,03384 \text{ dm}^3 \checkmark \\ \text{Accept } V_B &= 60 \text{ cm}^3 \\ V_A &= 33,84 \text{ cm}^3\end{aligned}$$

(4)
[14]

QUESTION 8

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

8.2 Temperature of 25 °C/298K ✓

Pressure 101,3 kPa ✓

Concentration of electrolyte of 1 mol.dm⁻³ ✓ (3)

8.3 Chlorine (molecule) ✓ ✓ (2)

8.4 **OPTION 1**

$$E^{\ominus}_{\text{cell}} = E^{\ominus}_{\text{cathode}} - E^{\ominus}_{\text{anode}} \checkmark$$

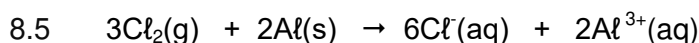
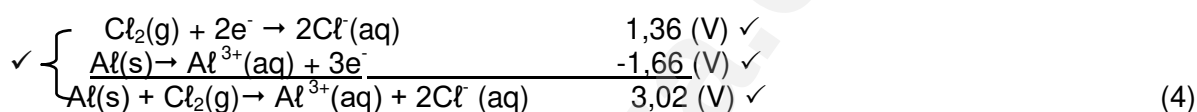
$$= 1,36 \checkmark - (-1,66) \checkmark$$

$$= 3,02 \text{ V} \checkmark$$

Notes

- Accept any other correct formula from the data sheet.
- Any other formula using unconventional abbreviations, e.g. $E^{\ominus}_{\text{cell}} = E^{\ominus}_{\text{OA}} - E^{\ominus}_{\text{RA}}$ followed by correct substitutions:

$$E^{\ominus}_{\text{sel}} = E^{\ominus}_{\text{OM}} - E^{\ominus}_{\text{RM}} \text{ Max.: } \frac{3}{4}$$

OPTION 2**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 ✓

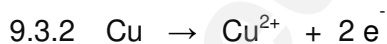
(1)

[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)

**Notes**

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

(2)

9.3.4

Marking criteria

- Calculate number of mols of cations: $2,259 \times 10^{24} = n(6,023 \times 10^{23})$ ✓
- 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 ✓

$$n_e = nNA$$

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

$$n = 3,75 \text{ mols}$$

$$m = nM \quad \checkmark$$

$$= (3,75)(63,5) \quad \checkmark$$

$$= 238,125 \text{ g.} \quad \checkmark$$

(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/H₂SO₄ ✓

(1)

10.2.2 H₂SO₄ + 2NH₃ → (NH₄)₂SO₄**Notes:**

- Reactants ✓ Products ✓ Balancing ✓
- Marking rule 6.3.10.

(3)

$$10.3 \quad \% N = 14/20 \times 36$$

$$= 25,2\% \quad \checkmark$$

$$\text{Mass of N} = 25,2/100 \times m$$

$$12,60 \checkmark = \frac{25,2}{100} \times m \quad \checkmark$$

$$m = 50 \text{ kg} \quad \checkmark$$

(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

