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HILTON COLLEGE
GRADE 12 TRIAL EXAMINATIONS
SEPTEMBER 2024

**TOTAL
MARKS**

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PHYSICAL SCIENCES: PAPER II

EXAMINATION NUMBER

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Examiner: Mr MJ van Wyk
Moderator: Mrs K McNeil & Mr K Mgozeli

Time: 3 hours
200 Marks

MARKING GUIDELINES

QUESTION 1 MULTIPLE CHOICE QUESTIONS

A	B	~~C~~	D
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Here the option C has been marked as an example.

1.1	A	B	C	~~D~~
1.2	~~A~~	B	C	D
1.3	A	B	~~C~~	D
1.4	A	~~B~~	C	D
1.5	A	~~B~~	C	D
1.6	A	B	C	~~D~~
1.7	~~A~~	B	C	D
1.8	A	B	~~C~~	D
1.9	~~A~~	B	C	D
1.10	A	B	C	~~D~~

QUESTION 2

2.1

2.1.1 SiO_2 ✓2.1.2 PH_3 ✓2.1.3 C_6H_{12} ✓

2.1.4 Kr ✓

2.1.5 KBr ✓

2.1.6 NH_4Cl ✓

2.1.7 Pt ✓

2.1.8 H_2O OR SiO_2 ✓

(8)

2.2

2.2.1 A force of attraction between molecules or between atoms of noble gases. ✓

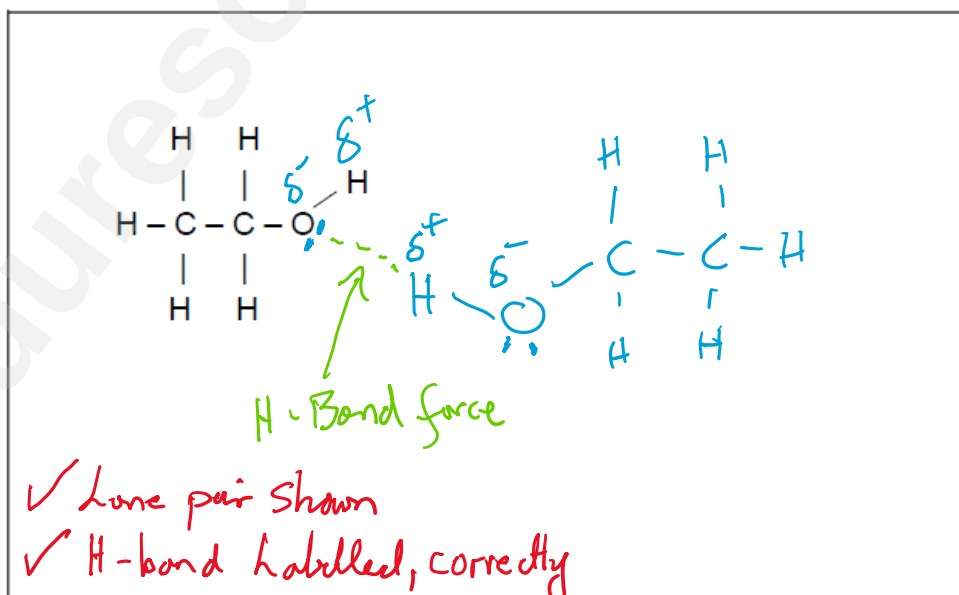
(2)

2.2.2 - Random **electron movement** create temporary dipoles. ✓- Temporary dipoles **induce dipoles** in neighboring molecules. ✓

- Electrostatic attraction between delta positive and delta negative (poles) on neighboring molecules. ✓

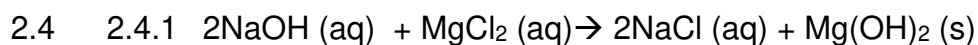
(3)

2.2.3



(3)

2.3 The mass in grams of one mole of that substance. (2)



$$\begin{aligned}n_{\text{NaOH}} &= cV \\&= 0,8 \times 0,03 \quad \checkmark \text{ Conversion} \\&= 0,024 \text{ moles}\end{aligned}$$

$$\begin{aligned}n_{\text{MgCl}_2} &= 0,5 \times 0,025 \\&= 0,0125 \text{ mol} \quad \checkmark\end{aligned}$$

$$2 \text{ NaOH} : 1 \text{ MgCl}_2 \quad \checkmark \text{ Ratio}$$

Therefore, 0,0125 mole MgCl_2 requires 0,025 NaOH moles

Thus $\text{NaOH} = \text{LR}$ (4)

$$\begin{aligned}2.4.2 \quad M_{\text{Mg(OH)}_2} &= n \times M \\&= 0,012 \quad \checkmark \text{ COE} \times 58 \quad \checkmark \text{ molar mass} \\&= 0,696 \text{ g} \quad \checkmark \\ \text{Or } &= 0,70 \text{ g}\end{aligned}$$

[25]

QUESTION 3

- 3.1 3.1.1 EXOTHERMIC ✓ (1)
- 3.1.2 Temperature increases during reaction. ✓ (1)
- 3.2 3.2.1 NO ✓ (1)
- 3.2.2 There is more than one independent variable ✓ (1)
- OR Changing more than one variable in one test (1)
- 3.3 3.3.1 Surface area / State of division ✓ (1)
- 3.3.2 Time / Reaction rate ✓ (1)
- 3.4 3.4.1 FASTER THAN ✓ (1)
- 3.4.2 Catalyst was used in Exp. 5. ✓ (1)
- 3.5
- There was an increase in temperature. ✓
 - This increased the average kinetic energy of particles and more molecules have sufficient kinetic energy, equal or greater than E_A . ✓
 - More **effective** collisions **per unit time**. ✓ (have to have bold to get mark)
 - The rate of reaction has increased in Experiment **4** compared to Experiment **1**. ✓ (4)
- 3.6 The change in amount or concentration per unit time of either a reactant or product. (2)

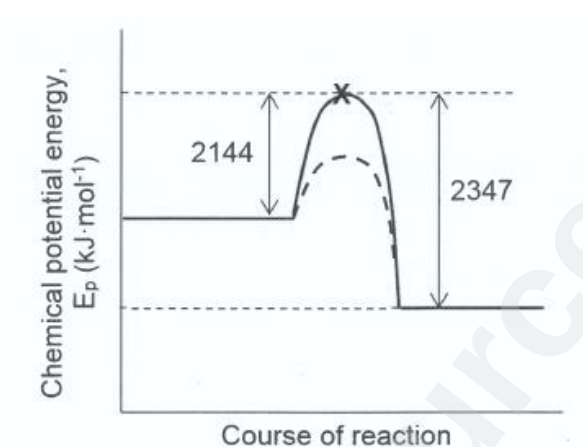
3.7 $n(\text{Zn}) = \frac{m}{M}$
 $= \frac{1,2}{65}$
 $= 0,018 \text{ mol} \checkmark$
 $n(\text{HCl}_{\text{reacted/gerageer}}) = 2(0,018) \checkmark = 0,037 \text{ mol}$

Ratio

Rate $= \frac{\Delta n}{\Delta t}$
 $= \frac{0,037}{8} \checkmark$
 $= 4,63 \times 10^{-3} \checkmark (\text{mol} \cdot \text{s}^{-1})$

(5)

3.8



3.8.1 X marked at top of energy peak. $\checkmark$ (1)

3.8.2 Curve starts and ends at same point as original curve. $\checkmark$
 Peak is lower. $\checkmark$ (2)

3.8.3 The (amount) of energy taken in / absorbed (to break bonds). $\checkmark$
 OR E_A for the forward reaction. (1)

3.8.4 $\Delta H = E_{in} - E_{out} = 2144 - 2347 \checkmark = -203 \text{ kJ} \cdot \text{mol}^{-1} \checkmark$
 (0 marks if positive answer) (2)

[25]

QUESTION 4

4.1

$$K_c = \frac{[H_2]^2 [CO_2]}{[H_2O]^2}$$

(2)

4.2

- $\Delta n(CO_2) = \Delta n(C) = 0,225$ mol. ✓
- Use mole ratio/Gebruik $n(C) : n(H_2O) : n(CO_2) : n(H_2) = 1 : 2 : 1 : 2$ ✓
- Equilibrium/Ewewig $n(H_2O) = \text{initial/aanvanklike } n(H_2O) - \Delta n(H_2O)$ ✓
- Equilibrium/Ewewig $n(H_2) = \text{initial/aanvanklike } n(H_2) + \Delta n(H_2)$ ✓
- Equilibrium/Ewewig $n(CO_2) = \text{initial/aanvanklike } n(CO_2) + \Delta n(CO_2)$ ✓
- Divide equilibrium moles of H_2O , H_2 AND/EN CO_2 by/deur 2 dm^3 . ✓
- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c uitdrukking (formules in vierkantige hakies).
- Substitution of concentrations into correct K_c expression. ✓
Vervanging van konsentrasies in korrekte K_c -uitdrukking.
- Final answer/Finale antwoord: 0,00948 ✓
Range/Gebied: 0,00948 to/tot 0,01 ($9,48 \times 10^{-3}$ to/tot 1×10^{-2})

OPTION 1/OPSIE 1

$$n(H_2O)_{\text{initial/aanvanklik}} = \frac{m}{M} = \frac{36}{18} = 2 \text{ mol}$$

	H_2O	H_2	CO_2
Initial amount (moles) Aanvangs hoeveelheid (mol)	2		
Change in amount (moles) Verandering in hoeveelheid (mol)	0,45	0,45	0,225 ✓
Equilibrium amount (moles) hoeveelheid (mol)	1,55	0,45	0,225 ✓
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	0,775	0,225	0,1125 ✓

ratio ✓
verhoudingDivide by/
Deel deur
 2 dm^3 ✓

$$\begin{aligned}
 K_c &= \frac{[H_2]^2 [CO_2]}{[H_2O]^2} \checkmark \\
 &= \frac{[0,225]^2 [0,1125]}{[0,775]^2} \checkmark \\
 &= 0,00948 \checkmark
 \end{aligned}$$

(6)

4.3

- For a K_c value of 1 it indicates that the concentration of the products formed too the concentration of the reactants used is equal. ✓ (comparing answer (COE) to 1)
- The K_c value calculated in Q.4.2 is much lower than 1, the extent the reactants has

turned into products (when equilibrium is established) is incomplete. There is a low yield.

✓ (Valid conclusion) (2)

- 4.4 4.4.1 - Refers to a reversible reaction ✓
- in which the forward and reverse reactions are taking place at the same rate, ✓
- and hence the concentrations of reactants and products are constant. ✓ (3)
- 4.4.2 Steam is used up / Amount of steam decreases / Concentration of steam decreases / Reactants are used up. ✓ (1)
- 4.4.3 Dynamic Chemical Equilibrium is reached / Rate of the forward reaction is equal to the rate of reverse reaction / Concentration of reactants and concentration of products remains constant. ✓ (1)
- 4.4.4 i. Catalyst was added. ✓ (1)
ii. NO EFFECT ON ✓ (1)
- 4.4.5 When an external stress (change in pressure, temperature or concentration) is applied to a system in dynamic chemical equilibrium, the equilibrium point will change in such a way as to counteract the stress. ✓✓ (2)
- 4.4.6 ENDOTHERMIC ✓ (1)
- 4.4.7 - The temperature of the system was increased. ✓
- The forward reaction was favoured at t_2 . ✓
- According to LCP the system will react to counteract the increase of temperature by lowering the temperature by favouring the ENDOTHERMIC reaction.
- Therefore, MORE GAS IS FORMED. ✓ (3)
- 4.4.8 DECREASE ✓✓ (2)

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QUESTION 5

5.1 5.1.1 Diprotic ✓ (1)

5.1.2 $(\text{COO})_2^{2-}$ ✓ (1)

5.1.3 $\text{H}(\text{COO})_2^-$ ✓ (2)

5.2

OPTION 1	OPTION 2
$c = \frac{m}{MV} \therefore 0,2 = \frac{m}{0,25 \times 90} \checkmark$ $\therefore m = 4,5 \text{ g} \checkmark$	$c = \frac{n}{V} \therefore 0,2 = \frac{n}{0,25} \therefore n = 0,05 \text{ mol}$ $n = \frac{m}{M} \therefore 0,05 = \frac{m}{90} \therefore m = 4,5 \text{ g} \checkmark$

(3)

5.3 5.3.1 i $V_b = 38,8 - 2,8 = 36 \text{ cm}^3$ or $0,036 \text{ dm}^3$ (accept both) (1)

ii

OPTION 1	OPTION 2
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b} \checkmark$ $\frac{0,2 \times 25}{c_b \times 36} = \frac{1}{2} \checkmark \therefore c_b = 0,28 \text{ mol} \cdot \text{dm}^{-3} \checkmark$	$n((\text{COOH})_2) = cV \checkmark = (0,2)(0,025) \checkmark$ $= 0,005 \text{ mol}$ $n(\text{NaOH}) = 2(0,005) \checkmark = 0,01 \text{ mol}$ $\bullet c = \frac{n}{V} = \frac{0,01}{0,036} = 0,28 \text{ mol} \cdot \text{dm}^{-3} \checkmark$

(4)

5.3.2

INDICATOR	pH RANGE
A	3,1 - 4,4
B	6,0 - 7,6
C	8,3 - 10,0

(1)

5.3.3 - $(\text{COONa})_2 \rightarrow 2\text{Na}^+ + 2 \text{COO}^-$ ✓ Ionisation reaction
 - COO^- from WEAK ACID, will undergo hydrolysis. ✓ (Statement)
 - $\text{H}_2\text{O} + \text{COO}^- \leftrightarrow 2\text{COOH} + \text{OH}^-$ ✓ (Hydrolysis equation)
 - Increase in concentration of OH^- ions. ✓ (statement)
 - Thus, expected pH > 7. ✓ (5)

5.4 STRONG ✓ COMPLETELY ✓ DISSOCIATES ✓ (3)

5.5 - NaOH is a giant ionic **solid**. ✓
 - Many electrostatic forces between cations and anions in ionic crystal lattice. ✓
 - Large amount of energy to overcome forces (break the bonds). ✓ (3)

[24]

QUESTION 6

- 6.1 Completes the circuit and ✓
Maintains electrical neutrality in the half cells ✓ (underlined required) (2)
- 6.2 Mn to Ni ✓ (1)
- 6.3
$$E_{\text{cell}}^{\ominus} = E_{\text{reduction}}^{\ominus} - E_{\text{oxidation}}^{\ominus}$$
 ✓

$$= -0,25 - (-1,18)$$
 ✓

$$= 0,93 \text{ V}$$
 ✓ (3)
- 6.4 The voltage reading would be **ZERO**. ✓
REASON: The galvanic cell has reached chemical equilibrium. ✓ (2)
- 6.5 $\text{Ni}^{2+} + \text{Mn} \rightarrow \text{Mn}^{2+} + \text{Ni}$ ✓ Bal. ✓ (3)
- 6.6 A substance that can conduct electricity due to the presence of free (mobile) ions ✓
when molten or dissolved in solution. ✓ (2)
- 6.7 INCREASE ✓ (1)
- 6.8 - Increase in Ni^{2+} ion concentration.
- According to LCP the system will react to counteract the stress by lowering the concentration of Ni^{2+} ions, ✓
- by favouring the forward reaction. ✓
- Any factor favouring the forward reaction increases the voltage. ✓ (make link) (3)
- 6.9.1 - INCREASE ✓ (1)
- By lowering the internal resistance. ✓
- This increases the maximum current the cell can deliver. ✓ (2)
- 6.9.2 - REMAINS THE SAME ✓ (1)

[21]

QUESTION 7

7.1 Q ✓ (1)

7.2 ELECTRICAL ✓ NON-SPONTANEOUS ✓ (2)

7.3 7.3.1 $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$ ✓✓ (2)

7.3.2 $2\text{NaCl} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{Cl}_2 + \text{H}_2$ ✓ r ✓ p ✓ b (3)

7.3.3 Concentrated solution of sodium chloride. (2)

- 7.3.4
- H_2O has a more negative electrode potential than Cl^- (OR H_2O is a stronger reducing agent than Cl^-) ✓
 - Therefore, H_2O would be more likely to be oxidised under standard conditions ✓
 - However, the high concentration of Cl^- ions increases the rate of its oxidation (OR makes its electrode potential more negative), making the oxidation of Cl^- predominant ✓ (3)

7.3.5 Oxygen / O_2 ✓ (1)

7.4 7.4.1 H_2 ✓ (Formula) (1)

7.4.2 Titanium ✓ (Name) (1)

- 7.5
- Both chlorine and hydrogen have London forces only ✓
 - Chlorine has more electrons } ✓
 - producing larger temporary dipoles } ✓
 - Therefore, chlorine has stronger London forces ✓
 - resulting in more energy required to overcome the intermolecular forces and separate the particles in chlorine } ✓
 - thus, chlorine has a higher boiling point } (4)

[20]

QUESTION 8

8.1 A compound in which there is at least one double and/or triple bond between carbon atoms. ✓✓ (2 or 0) (2)

8.2 Write down the:

8.2.1 D ✓ (1)

8.2.2 2,4-dimethylhexane ✓✓✓ (3)

8.2.3 Propan-2-ol ✓✓ (2)

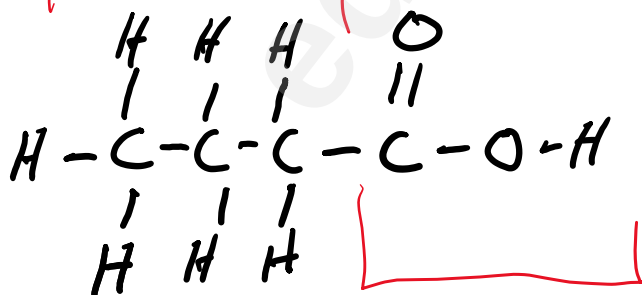
8.2.4 hept-1-ene ✓✓ (2)

8.2.5 $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ ✓ Bal ✓ (3)

8.3 8.3.1 Compounds with the same molecular formula but functional groups/homologous series. ✓✓ (2)

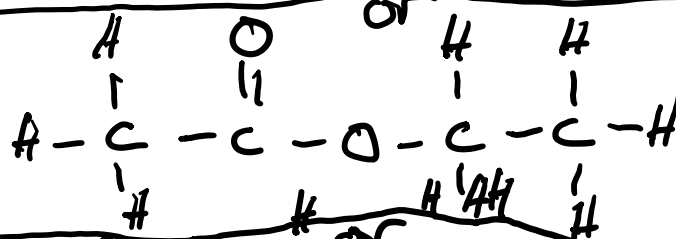
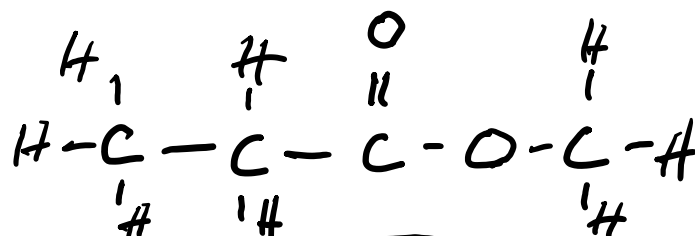
8.3.2

Carboxylic Acid
(4)



Esters

Alcohol
Carboxylic acid



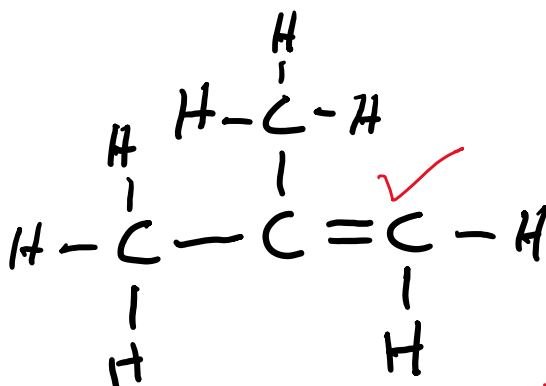
[19]

QUESTION 9

9.1 9.1.1 Halogenation ✓ (1)

9.1.2 Br₂ rapidly ✓ decolorizes ✓ (2)

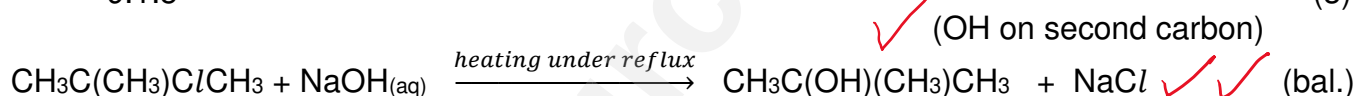
9.1.3



(2)

9.1.4 This will change possibilities of products, ✓
As water can react with Compound Q to form an alcohol. ✓ (2)

9.1.5 (3)



9.1.6 GENERAL: Substitution ✓
SPECIFIC: Hydrolysis ✓ (2)

9.1.7 A technique used to apply heat energy to a chemical mixture, ✓
over an extended period of time. ✓ (2)

9.1.8 Dehydration ✓ (1)

9.2 9.2.1 Esterification / Condensation ✓ (1)

9.2.2 Butyl ✓ propanoate ✓ (2)

9.2.3 H₂SO₄ ✓ (any appropriate acid catalyst's formula) (1)

9.2.4 gentle ✓ heating ✓ (2)

[21]