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PREPARATORY EXAMINATION

2019

MARKING GUIDELINES

PHYSICAL SCIENCES: CHEMISTRY (PAPER 2) (10842)

13 pages

QUESTION 1

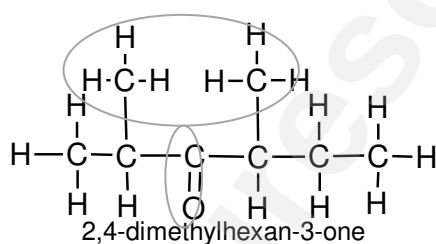
- 1.1 A ✓✓
 1.2 D ✓✓
 1.3 D ✓✓
 1.4 B ✓✓
 1.5 D ✓✓
 1.6 C ✓✓
 1.7 D ✓✓
 1.8 A ✓✓
 1.9 C ✓✓
 1.10 C ✓✓

[20]

QUESTION 2

- 2.1 2.1.1 A ✓
 2.1.2 A ✓
 2.1.3 C ✓
 2.1.4 B ✓
 2.1.5 D ✓

2.2

**Marking guidelines:**

- Correct ketone functional group ✓
- Both side chains / branches correct on correct carbon atom ✓
- Whole structure correct ✓

(3)

- 2.3 2,3-dichloro-3-fluorobutanal

(3)

[11]

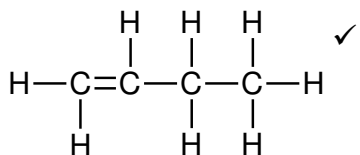
QUESTION 3

3.1 3.1.1 Esters ✓ **OR** carboxylic acids (1)

3.1.2 Ketones ✓ (1)

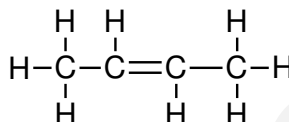
3.2 3.2.1 Chain isomers: Same molecular formula, but different types of chains ✓✓ (2)

3.2.2



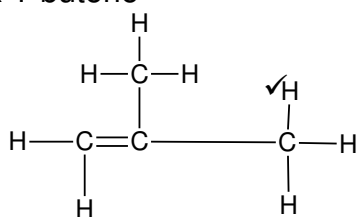
but-1-ene ✓

OR 1-butene



but-2-ene ✓

OR 2-butene



2-methylprop-1-ene ✓

OR methylpropene

OR 2-methyl-1-propene

Marking guideline:

One mark for whole structure

One mark for correct IUPAC name
for each of the isomers

3.3 3.3.1 Butan-1-ol ✓ and pentanoic acid ✓ (2)

3.3.2 Condensation ✓ **OR** esterification (1)

3.4	If answered as: Butyl pentanoate has a higher boiling point than butyl butanoate. Both esters have the same type of intermolecular forces (London forces). ✓ Butyl pentanoate has a longer chain therefore stronger forces between the molecules. ✓ More energy is required to overcome the intermolecular forces between butyl pentanoate ✓ therefore the boiling point is higher.	If answered as: Butyl butanoate has a lower boiling point than butyl pentanoate. Both esters have the same type of intermolecular forces (London forces). Butyl butanoate has a shorter chain therefore weaker intermolecular forces between the molecules. Less energy is required to overcome the intermolecular forces between butyl butanoate.
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Marking criteria

- same intermolecular forces must be mentioned. Their names need not be mentioned. ✓
- comparison chain length / molecular mass ✓
- energy required ✓

(3)

- 3.5.1 *Addition polymerisation*: A reaction in which small molecules join to form very large molecules by adding on at double bonds. ✓✓
Condensation polymerisation: Molecules of two monomers with different functional groups undergo condensation reactions with the loss of small molecules, usually water. ✓✓ (4)
- 3.6.1 Polythene or Polyethene ✓ (1)
- 3.6.2 Ethene ✓ (1)
- [22]

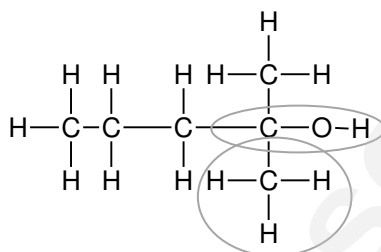
QUESTION 4

- 4.1 Elimination / dehydrohalogenation / dehydrobromination ✓ (1)
- 4.2
- heat ✓
 - Concentrated sodium hydroxide (NaOH) / Concentrated potassium hydroxide (KOH) / Concentrated strong base ✓

OR

Hot ethanolic concentrated sodium hydroxide / potassium hydroxide / KOH / NaOH (2)

4.3



Marking guidelines:

- Correct hydroxyl functional group on C-2 ✓
- Side chains / branch correct on correct carbon atom ✓
- Whole structure correct ✓
- If condensed structural formula given -1

- 4.4 H₂O / water ✓ (1)
- 4.5 Addition / Hydration ✓ (1)
- [8]

QUESTION 5

5.1 To prevent loss of any solution / acid from the flask ✓

OR

To allow gas to escape

OR

To prevent any solids / liquids getting in / out

OR

To prevent spurting

NOTE: Answer must not be given in terms of preventing evaporation or condensation. (1)

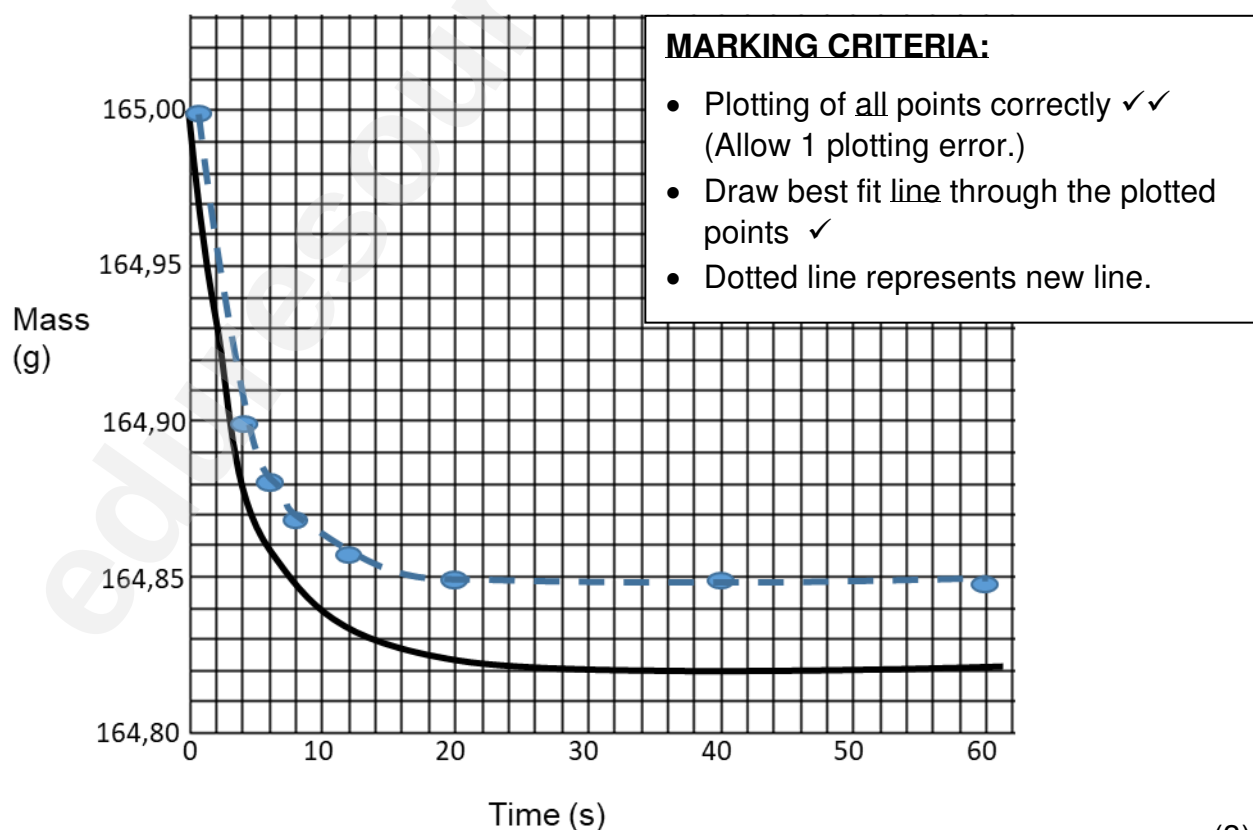
5.2
$$\text{Reaction rate} = \frac{\text{change in mass}}{\text{change in time}} = \frac{164,84 - 165,00}{10,0} \frac{\checkmark}{0 \checkmark} = -0,016 \text{ g} \cdot \text{s}^{-1} \checkmark$$

Accept positive sign or no sign in the answer.

(Negative value indicates loss in mass during reaction.) (3)

5.3.1

Graph of mass versus time



- 5.3.3 The reaction will be faster. ✓
Increasing the temperature, increases the kinetic energy so that more particles have kinetic energy that is higher than the activation energy. ✓
More collisions with correct orientation ✓
More successful or effective collisions per unit time take place. ✓ (4)
- 5.4.1 2 ✓ (1)
- 5.4.2 State of division changed – Size of the zinc particles increased / surface area increased – originally lumps were used. ✓
Exp 1 powder and exp 2 lumps
Accept: removed catalyst. (1)
- 5.4.3 0,5 g / half of the amount as in experiment 1. ✓ (1)
[14]

QUESTION 6

6.1 A catalyst was used in the experiment that produced the graph for experiment C. ✓ (1)

6.2 The concentration of the products in both graphs at equilibrium are the same and the concentration of the reactants at equilibrium are the same, ✓ but equilibrium was reached faster in Experiment C than in Experiment A. ✓

OR

Equilibrium concentration is the same, equilibrium was not disturbed.

OR

Accept:

A catalyst was added and the rate of both forward and reverse reactions were increased. (2)

6.3 EXOTHERMIC ✓ (1)

6.4 – negative marking from QUESTION 6.3

In experiment C the concentration of the reactants is higher than the concentration of the reactants in Experiment A when equilibrium is established. ✓

∴ The reverse reaction is favoured, ✓

Endothermic reaction is favoured when the temperature is increased. ✓

Therefore reverse reaction is endothermic OR the forward reaction is exothermic. (3)

6.5 Use the data given to calculate the equilibrium constant at 500°C.

	H ₂ (g)	I ₂ (g)	2HI(g)
Initial mol	0,5	0,5	0
Change in mol	-0,2	-0,2	0,4 ✓
Mol at equilibrium	0,3 ✓	0,3	0,4 ratio used ✓
Concentration at equilibrium	0,3	0,3	0,4

$$K_c = \frac{[HI]^2}{[H_2][I_2]} \quad \checkmark$$

$$= \frac{(0,4)^2}{(0,3)(0,3)} \quad \checkmark \text{ (positive marking)}$$

$$= 1,78 \quad \checkmark$$

MARKING CRITERIA:

- Change in mol of HI ✓
- Using ratio 1:1:2 ✓
- Addition and subtraction to get the correct mol at equilibrium / concentration at equilibrium ✓
- Correct K_c expression ✓
- Correct substitution of concentration at equilibrium values from this table ✓
- Correct final answer ✓

No K_c expression, correct substitution Max 5/6

Wrong K_c expression Max 3/6

(6)

OPTION 2

Concentration of I_2 at equilibrium is $0,3 \text{ mol} \cdot \text{dm}^{-3}$.

$$\begin{aligned}
 c(I_2) \text{ initial} &= \frac{n}{V} & c(H_2) \text{ initial} &= \frac{n}{V} \\
 &= \frac{0,5}{1} & &= \frac{0,5}{1} \\
 &= 0,5 \text{ mol} \cdot \text{dm}^{-3} & \text{and} &= 0,5 \text{ mol} \cdot \text{dm}^{-3}
 \end{aligned}$$

	$H_2(g)$	$I_2(g)$	$2HI(g)$
Initial concentration	0,5	0,5	0
Change in concentration	-0,2	-0,2	0,4 ✓
concentration at equilibrium	0,3 ✓	0,3	0,4 ratio used ✓

$$\begin{aligned}
 K_c &= \frac{[HI]^2}{[H_2][I_2]} \quad \checkmark \\
 &= \frac{(0,4)^2}{(0,3)(0,3)} \quad \checkmark \text{ (positive marking)} \\
 &= 1,78 \quad \checkmark
 \end{aligned}$$

No K_c expression, correct substitution Max 5%

Wrong K_c expression Max 3/6

(6)

6.6 Lower than ✓ positive marking from QUESTION 6.3.

answer would then be: higher than

(1)

6.7 +

$$\begin{aligned}
 K_c &= \frac{[HI]^2}{[H_2][I_2]} \\
 &= \frac{(0,38)^2}{(0,3)(0,3)} \quad \text{(re-calculate equilibrium concentrations)} \\
 &= 1,6
 \end{aligned}$$

Note: may use calculation or use explanation.

The [product] is smaller and the [reactant] is higher at the higher temperature. ✓

This results in a lower K_c value at a higher temperature. ✓

Or

Equilibrium is to the left and reverse reaction is favoured.

(2)

[16]

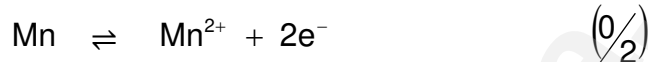
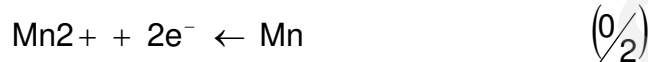
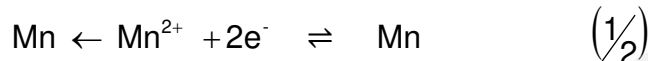
QUESTION 7

- 7.1 Temperature = 25°C / 298 K ✓
 Pressure = 101,3 kPa / 1,013 x 10⁵ / 1 atm) ✓
 [Cl⁻] = 1 mol·dm⁻³ ✓ (3)

7.2

- 7.2.1 $\text{Mn} \rightarrow \text{Mn}^{2+} + 2\text{e}^-$ ✓✓ (2)

Marking criteria:



Ignore if charge is omitted on electron.

If charge (+) is omitted on Mn²⁺ Max. ½

- 7.2.2 $\text{Mn} + \text{Cl}_2 \rightarrow 2\text{Cl}^- + \text{Mn}^{2+}$

Marking criteria:

✓ Reactants ✓ Products ✓ Balancing (3)

- 7.3 $\text{Mn(s)} / \text{Mn}^{2+}(\text{aq})(1 \text{ mol·dm}^{-3}) // \text{Cl}_2(\text{g})(1 \text{ atm}) / \text{Cl}^-(\text{aq})(1 \text{ mol·dm}^{-3}) / \text{Pt}$ ✓✓✓

NOTE:

Do not penalise if phases and conditions are not included. (3)

- 7.4 $\text{MnCl}_2 / \text{Mn}(\text{NO}_3)_2 / \text{MnSO}_4$ ✓ (1)

- 7.5 Chlorine gas ✓ OR Cl_2 (1)

- 7.6 $E_{\text{cell}}^{\theta} = E_{\text{reduction}}^{\theta} - E_{\text{oxidation}}^{\theta}$ ✓
 $= +1,36 - (-1,18)$ ✓
 $= +2,54 \text{ V}$ ✓

Note:

Accept any other correct formula from the data sheet.

Any other formula using unconventional abbreviations, e.g. $E_{\text{cell}} = E_{\text{OA}} - E_{\text{RA}}$

Followed by correct substitutions: Max 2/3

(3)
[16]

QUESTION 8

8.1 8.1.1 P ✓ (1)

8.1.2 P is connected to the positive terminal of the battery. ✓ (1)

8.2 8.2.1 $\text{Ni}_{2+}(\text{aq})$ ✓ Note: (aq) may be omitted. (1)

8.2.2 Q ✓ (1)

8.2.3 Q ✓ (1)

8.2.4 $\text{Ni}_{2+} + 2\text{e}^- \rightarrow \text{Ni}$ ✓✓

Marking criteria:



Ignore if charge is omitted on electron.

If charge (+) is omitted on Ni_{2+} Max. $\frac{1}{2}$

8.2.5 Remains the same ✓ (1)

8.2.6 For each mole or atom of nickel oxidised at the anode, a mole or atom of nickel is reduced at the cathode. ✓✓

Or

Rate of oxidation equals the rate of reduction.

(2)
[10]

QUESTION 9

9.1.1 A substance that can act as either an acid or a base ✓✓ (2)

9.1.2 H_2O ✓ (1)

9.1.3 $n = cV$ ✓
 $= (0,05)(0,036)$ ✓
 $= 1,8 \times 10^{-3} \text{ mol H}_2\text{SO}_4$ ✓
 $1,8 \times 10^{-3} \text{ mol H}_2\text{SO}_4$ neutralised $1,8 \times 10^{-3} \text{ mol Na}_2\text{CO}_3$ in 25 cm^3
 + positive marking from QUESTION 9.1.3 (3)

9.1.4 $m = nM$ ✓
 $= 1,8 \times 10^{-3} \times 106$ ✓
 $= 0,1908 \text{ g}$ ✓

Marking criteria:
 ✓ formula
 ✓ ratio of mol
 ✓ 106
 ✓ correct answer

Also accept:

$$\frac{n_b}{n_a} = \frac{c_b V_b}{c_a V_a}$$

$$\frac{1}{1} = \frac{c_b \cdot 25}{0,05 \times 36}$$

$$c_b = 0,072 \text{ mol} \cdot \text{dm}^{-3}$$

$$c = \frac{m}{MV} \quad \checkmark$$

$$\checkmark 0,072 = \frac{m}{106 \times 0,025} \quad \checkmark$$

$m = 0,1908 \text{ g}$ ✓ (4)

9.1.5 Positive marking from Question 9.1.2

$$\% \text{Na}_2\text{CO}_3 = \frac{\text{Actual mass}}{\text{Original mass}} \times 100$$

$$= (10)(0,0018)(106) = 1,908 \text{ g Na}_2\text{CO}_3 \quad \checkmark$$

$$= \frac{1,908}{5,13} \times 100 \quad \checkmark$$

$$= 37,19 \% \quad \checkmark$$

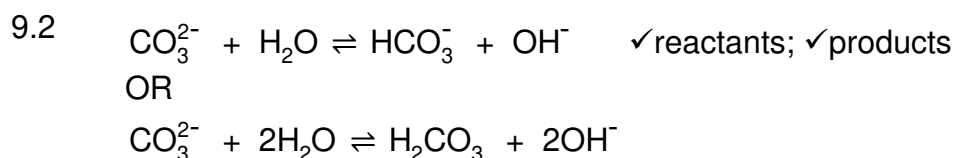
Marking criteria:
 ✓ correct calculation of mass
 ✓ substitution of 5,13
 ✓ correct answer

Or

25 cm^3 has $0,1908 \text{ g}$ ✓

250 cm^3 has $10 \times 0,1908 \text{ g} = 1,908 \text{ g}$ ✓

$$\% \text{Na}_2\text{CO}_3 = \frac{1,908}{5,13} \times 100 \quad \checkmark = 37,19 \% \quad \checkmark \quad (3)$$



(2)
[15]

QUESTION 10

- 10.1 10.1.1 Total percentage mass fertiliser in the bag ✓ (1)
- 10.1.2 Nitrogen, ✓ phosphorous ✓ **OR** potassium (Any two) (2)
- 10.1.3 $\% \text{N} = \frac{2}{11} \times 40$ ✓
 $= 7,27 \%$ ✓ (3)
- 10.2 10.2.1 Ammonium nitrate or NH_4NO_3 ✓ (1)
- 10.2.2 Haber process (1)
- 10.2.3 $(\text{NH}_4)_2\text{SO}_4$ ✓ (1)
- 10.2.4 Ostwald process ✓ **OR** catalytic oxidation of ammonia (1)
- 10.2.5 So that plants can absorb them from the soil ✓ (1)
- 10.2.6 Eutrophication ✓
 Any given examples that apply to rivers and dams.
 Note: do not accept red tide. (1)
- 10.2.7 Nitrogen ✓ and hydrogen ✓ (2)
- 10.2.8 Sulphur dioxide ✓ (1)
- 10.2.9 Enhance growth of crops / plants to produce more food for humans ✓
 Production of fertiliser results in job creation. ✓
 Selling of fertilisers stimulates the economy. ✓
 (Any relevant positive impact) (3)
[18]

TOTAL: 150