OCR A-Level Chemistry A

Carbon–carbon bond formation and synthesis mark scheme · goes with “Carbon–carbon bond formation and synthesis” · whiteboardchemistry.com/revision/exam-questions/ocr-a-level-chemistry/

Mark schemes

Carbon–carbon bond formation and synthesis · 5 questions

Q1 · June 2018 · Paper 2 (Synthesis and analytical techniques) · Q14 · [1 mark]

Answer: **B**

Only 1 and 2

Q2 · June 2018 · Paper 2 (Synthesis and analytical techniques) · Q15 · [1 mark]

Answer: **B**

Only 1 and 2

Q3 · June 2018 · Paper 3 (Unified chemistry) · Q4 · [11 marks]

OCR MARK SCHEME

4(a)(i)

+2

Sign required

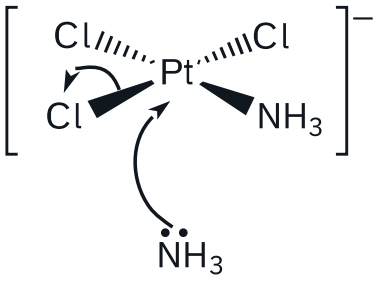
[1 mark]

EXAMINER GUIDANCE

ALLOW *2+* ***OR*** *+II*

ALLOW *Pt^{2+}*

4(a)(ii)



Curly arrow from lone pair on NH_3 to Pt ✓

$[PtCl_3(NH_3)]^-$ drawn with 1 Pt, 3 Cls and 1 NH_3

AND

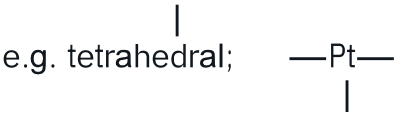
Curly arrow from **any** Pt–Cl bond in the complex ✓

ALLOW *S_N1 mechanism:*

For $[PtCl_3(NH_3)]^-$:

- **IGNORE** dipoles
- **IGNORE** absence of – charge
- **IGNORE** – charge shown on atoms

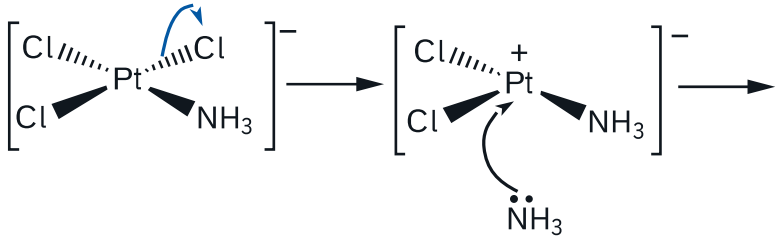
ALLOW *any 4 coordinate shape for $[PtCl_3(NH_3)]^-$,*

e.g. tetrahedral; 

1st curly arrow must

- go to Pt

AND

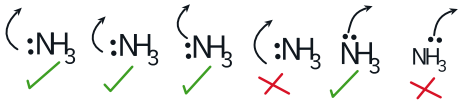


Mark curly arrows as above for S_N2

Requires + on platinum intermediate

[2 marks]

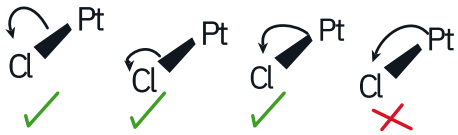
start from, **OR** be traced back to **any point across width** of lone pair on N of NH_3



DO NOT ALLOW *charge on NH_3 nucleophile,*

e.g. NH_3^-

2nd curly arrow must start from, **OR** be traced back to, **any part of** Pt–Cl bond and go to one of the 3 Cl atoms



4(b)(i)

Phenol ✓

Amide ✓

- **IGNORE** attempt to classify amide, e.g. secondary

[2 marks]

IF > 2 *functional groups are shown,*

- Mark 2 groups **ONLY**
- Mark incorrect groups **first**

Treat carbonyl with aldehyde **OR** with ketone as one functional group, i.e.

- carbonyl, aldehyde
- carbonyl, ketone
- carbonyl

IGNORE *aryl **OR** alkyl group*

e.g. benzene, phenyl, aryl, arene, methyl

IGNORE *hydroxyl/hydroxy*

4(b)(ii)

Level 3 (5-6 marks)

A correct calculation of the mass of 4-nitrophenol.

AND

Identifies the reagents **AND** intermediate.

AND

A **detailed** description of most purification steps.

Indicative scientific points may include:

Calculation of mass of 4-nitrophenol

Using moles

- n(paracetamol) $= \frac{5.00}{151} = 0.0331$ (mol)

There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.

Level 2 (3-4 marks)

Calculates the mass of 4-nitrophenol with some errors **AND** suggests reagents and intermediate with some omissions.

OR

Calculates the mass of 4-nitrophenol with some errors **AND** describes some purification steps, with some detail.

OR

Suggests reagents and intermediate with some omissions **AND** describes some purification steps, with some detail.

There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.

Level 1 (1-2 marks)

Attempts to calculate the mass of 4-nitrophenol

OR

Suggests reagents **OR** intermediate but may be incomplete

OR

Describes few purification steps.

There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.

0 marks *No response or no response worthy of credit.*

[6 marks]

- n(4-nitrophenol) $= \frac{0.0331 \times 100}{40} =$ 0.0828 (mol)
- Mass of 4-nitrophenol = 139 × 0.0828 = 11.5 g

ALLOW *11.4–11.6 for small slip/rounding*

Using mass

- Theoretical mass paracetamol $= \frac{5.00 \times 100}{40} = 12.5$ g
- Theoretical n(4-nitrophenol) $= \frac{12.5}{151} = 0.0828$ (mol)
- Mass of 4-nitrophenol = 139 × 0.0828 = **11.5** g

NOTE*: Incorrect inverse ratio of 100 / 40 gives:*

- $\frac{0.0331 \times 40}{100} = 0.0132$ (mol)
- Mass = 139 × 0.0132 = 1.84 g

Reagents and intermediate

- **Reagents:** Sn + (conc) HCl (then NaOH)
- **Intermediate**: 4-aminophenol or structure

Purification

- Dissolve impure solid in **minimum volume of** hot solvent
- **Cool** solution and filter solid
- **Scratch with glass rod**
- **Wash** with cold solvent/solvent and **dry**

Examples of detail in **bold (NOT INCLUSIVE)**

NOTE*: 'Recrystallisation' on its own is **NOT** a detailed description*

Q4 · June 2022 · Paper 2 (Synthesis and analytical techniques) · Q21 · [6 marks]

OCR MARK SCHEME

21

Level 3 (5–6 marks)

Describes, in detail, reactions of two aliphatic compounds that form a C–C bond

AND mechanisms for the two aliphatic reactions.

There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.

Level 2 (3–4 marks)

Describes a reaction of one aliphatic compound that forms a C–C bond with few omissions/errors.

AND mechanism for one aliphatic reaction.

OR

Describes reactions of two compounds that forms a C–C bond

AND attempts a mechanism for one of the reactions

There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.

Level 1 (1–2 marks)

Selects suitable reagents for reactions of two compounds that form a C–C bond.

OR

Attempts to describe a reaction and mechanism of one compound that forms a C–C bond, with omissions/errors.

There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.

0 marks No response or no response worthy of credit.

[6 marks]

EXAMINER GUIDANCE

Indicative scientific points may include:

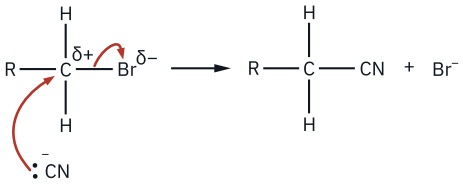
Reactions of aliphatic compounds and mechanisms

- Haloalkane, RX and CN^- → RCN + X^-

Reagents: NaCN and ethanol

Reaction: Nucleophilic substitution

Mechanism:



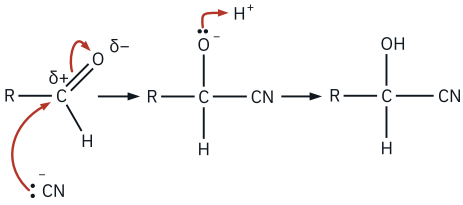
- Aldehyde or ketone and HCN

e.g. RCHO + HCN → RCH(OH)CN

Reagents: NaCN and H^+

Reaction: Nucleophilic addition

Mechanism:



OR H_2O instead of H^+ for 2nd stage

Q5 · November 2021 · Paper 2 (Synthesis and analytical techniques) · Q19 · [14 marks]

OCR MARK SCHEME

EXAMINER GUIDANCE

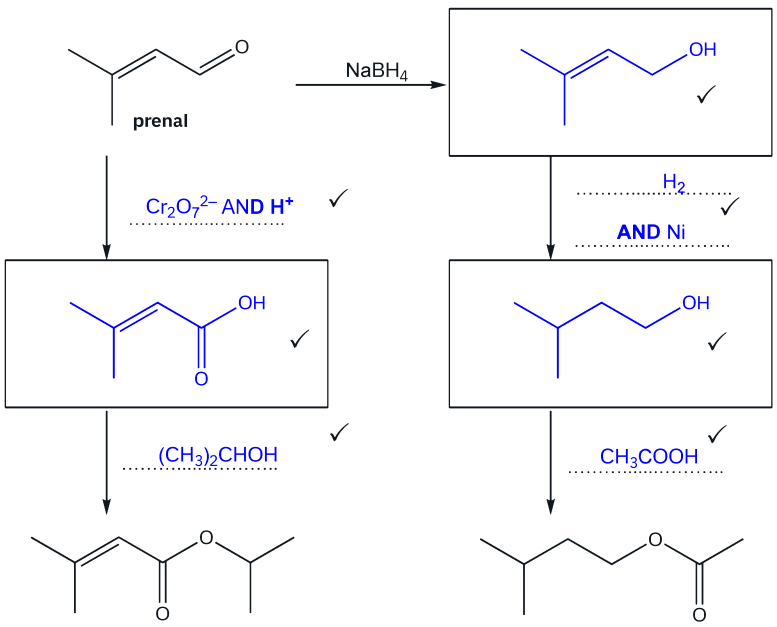
19(a)(i)

3-methylbut-2-enal ✓

[1 mark]

IGNORE *lack of hyphens, or addition of commas*

19(a)(ii)



[7 marks]

ALLOW *any combination of skeletal* ***OR*** *structural* ***OR*** *displayed formula as long as unambiguous*

ALLOW *names of reagents and catalyst*

For oxidation,

ALLOW $K_2Cr_2O_7$ *for* $Cr_2O_7^{2-}$

ALLOW H_2SO_4 *for* H^+

For left hand side esterification

IGNORE C_3H_7OH

19(b)

Level 3 (5-6 marks)

Correct calculation of the mass of $C_6H_5CH_2Cl$

AND

Planned synthesis to form the intermediate $C_6H_5CH_2CN$ followed by hydrolysis to form A with most of the reagents identified and equations are mostly correct.

There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.

Level 2 (3-4 marks)

Correct calculation of the mass of $C_6H_5CH_2Cl$

AND

Planned synthesis to form the intermediate $C_6H_5CH_2CN$ with most of the reagents identified and equation is mostly correct

OR

Calculation of the mass of $C_6H_5CH_2Cl$ is partly correct

AND

Indicative scientific points may include:

Calculation of mass of $C_6H_5CH_2Cl$

Using moles

- $n(A) = \frac{5.44}{136} = 0.04(00)$ (mol)
- $n(C_6H_5CH_2Cl) = \frac{0.0400 \times 100}{25} =$ 0.16(0) (mol)
- Mass of $C_6H_5CH_2Cl = 126.5 \times 0.16 = 20.2(4)$ g

Using mass

- Theoretical mass of ester $= \frac{5.44 \times 100}{25} = 21.76$ (g)
- Theoretical $n(C_6H_5CH_2Cl) = \frac{21.76}{136} = 0.16(0)$ (mol)

Planned synthesis includes formation of the intermediate $C_6H_5CH_2CN$ followed by hydrolysis to form A with some of the reagents identified

OR

Attempts to calculate mass of $C_6H_5CH_2Cl$ but makes little progress

AND

Planned synthesis includes formation of the intermediate $C_6H_5CH_2CN$ followed by hydrolysis to form A with most of the reagents identified and equations are mostly correct

There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.

Level 1 (1-2 marks)

Calculation of the mass of $C_6H_5CH_2Cl$ is partly correct

OR

Attempts to calculate mass of $C_6H_5CH_2Cl$ but makes little progress

AND

Planned synthesis includes formation of the intermediate $C_6H_5CH_2CN$ with the reagent identified

OR

Planned synthesis includes both steps with some of the reagents identified

OR

Attempts equations for both steps but these may contain errors

OR

Describes one step of the synthesis with reagent(s) and equation mostly correct

There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.

0 marks

No response or no response worthy of credit.

[6 marks]

- Mass of $C_6H_5CH_2Cl = 126.5 \times 0.160 = 20.2(4)$ g

***ALLOW** small slip/rounding errors such as errors in M_r e.g. use of 137 instead of 136 for $C_6H_5CH_2COOH$*

Examples of partly correct calculations

Mass = 1.265 g from $\frac{0.0400 \times 25}{100} \times 126.5$

(% yield inverted)

Mass = 5.06 g from 0.0400×126.5

(% yield omitted)

Synthesis: reagents and conditions

Stage 1: Formation of intermediate, $C_6H_5CH_2CN$

- Reagents: CN^-(/ethanol)
- Equation:

$C_6H_5CH_2Cl + CN^- \rightarrow C_6H_5CH_2CN + Cl^-$

OR $C_6H_5CH_2Cl + NaCN \rightarrow C_6H_5CH_2CN + NaCl$

(**OR** use of KCN)

Stage 2: Formation of A, $C_6H_5CH_2COOH$

- Reagents: H^+/H_2O (**ALLOW** 'acid hydrolysis'
- Equation:

$C_6H_5CH_2CN + 2H_2O + H^+ \rightarrow C_6H_5CH_2COOH + NH_4^+$

OR $C_6H_5CH_2CN + 2H_2O + HCl \rightarrow C_6H_5CH_2COOH + NH_4Cl$

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