OCR A-Level Chemistry A

Carbonyls, carboxylic acids and esters mark scheme · goes with “Carbonyls, carboxylic acids and esters” · whiteboardchemistry.com/revision/exam-questions/ocr-a-level-chemistry/

Mark schemes

Carbonyls, carboxylic acids and esters · 9 questions

Q1 · June 2022 · Paper 2 (Synthesis and analytical techniques) · Q10 · [1 mark]

Answer: **B**

$C_3H_5O_2Na$

Q2 · June 2023 · Paper 2 (Synthesis and analytical techniques) · Q12 · [1 mark]

Answer: **D**

Q3 · June 2023 · Paper 2 (Synthesis and analytical techniques) · Q14 · [1 mark]

Answer: **D**

Only 1

Q4 · June 2023 · Paper 2 (Synthesis and analytical techniques) · Q2 · [1 mark]

Answer: **A**

$C_6H_5COCOOH$

Q5 · June 2024 · Paper 2 (Synthesis and analytical techniques) · Q17 · [8 marks]

OCR MARK SCHEME

17(a)

Reagent and/or catalyst:

H_2SO_4 OR H_3PO_4 OR H^+ OR acid (catalyst) ✓

Organic product: (mark independently)

$CH_3CH_2CHCH_2$ ✓

[2 marks]

EXAMINER GUIDANCE

DO NOT ALLOW *other named acids e.g. HCl / hydrochloric acid as can be used for substitution reaction*

DO NOT ALLOW *other additional reagents e.g. H_2O / steam, H_2 / hydrogen*

ALLOW suitable non-specification alternatives e.g. Al_2O_3 OR Pumice stone

ALLOW names of reagents e.g. sulfuric or phosphoric acid, if no formulae given

IGNORE *concentration e.g. dilute/concentrated*

IGNORE *(aq) state symbol*

IGNORE *conditions e.g. temperature/pressure/reflux*

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

IGNORE *names unless no structure is given then accept but-1-ene*

17(b)

Reagent and/or catalyst:

$K_2Cr_2O_7$ **AND** H_2SO_4

OR $Cr_2O_7^{2-}/H^+$ ✓

ALLOW $Na_2Cr_2O_7$ *for* $K_2Cr_2O_7$

ALLOW names for reagents e.g. acidified dichromate, if no formulae given

IGNORE *Roman numerals e.g. (VI), unless incorrect*

Organic product: (mark independently)

$CH_3CH_2COCH_3$ ✓

IGNORE *[O]*

[2 marks]

DO NOT ALLOW *other named acids e.g. HCl / hydrochloric acid*

DO NOT ALLOW *other additional reagents e.g.* H_2O*, steam*

ALLOW suitable non-specification alternative oxidising agents e.g. $KMnO_4/H^+$ *OR* CrO_3/H^+ *OR* H_2CrO_4 *(chromic acid)*

IGNORE *concentration e.g. dilute/concentrated*

IGNORE *conditions e.g. reflux/distillation*

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

IGNORE *names unless no structure is given then accept butanone*

17(c)

Mark organic product first:

$(CH_3)_2CHCH_2X$

where X is identified as Cl, Br, I ✓

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

IGNORE *names unless no structure is given then accept 1-halo-2-methylpropane, where halo is chloro, bromo or iodo (ignore alphabetical order for prefixes)*

Reagent and/or catalyst:

Reagent to match organic product

$NaX / KX / X^-$

AND

H_2SO_4 / H^+ / acid

Where X is identified as Cl, Br, I ✓

[2 marks]

For 2 marks, the reagent must be consistent with the product given e.g. $(CH_3)_2CHCH_2Cl$ then correct reagent is NaCl / H_2SO_4

ALLOW 1 mark if correct reagents given but no or incorrect organic product shown

ALLOW 1 mark if organic product is given with X i.e. $(CH_3)_2CHCH_2X$ ***AND*** *reagent is consistent e.g. NaX / H^+ OR just states 'halide with acid'*

ALLOW HX where X is identified as Cl, Br, I

ALLOW names of reagents e.g. sodium bromide and sulfuric acid, if no formulae given

DO NOT ALLOW *other additional reagents e.g. $AlCl_3$*

ALLOW suitable non-specification alternative e.g. PCl_3, PCl_5, (red) phosphorus ***AND*** *bromine OR iodine, $SOCl_2$*

IGNORE *concentration e.g. dilute/concentrated*

IGNORE *conditions e.g. reflux/distillation*

17(d)

Mark organic product first:

A correct ester of $(CH_3)_3COH$ ✓

e.g. $(CH_3)_3COOCCH_3$

Reagent and/or catalyst:

Reagent to match ester shown

suitable carboxylic acid **AND** acid / H^+ catalyst, e.g. CH_3COOH/H_2SO_4

OR

suitable acyl chloride e.g. CH_3COCl

OR

suitable acid anhydride e.g. $(CH_3CO)_2O$ ✓

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

IGNORE *additional byproducts e.g. H_2O, HCl or carboxylic acid (from acid anhydride)*

For 2 marks, the reagent must be consistent with the product given e.g. $(CH_3)_3COOCCH_3$ then correct reagent is CH_3COOH / H_2SO_4

ALLOW 1 mark if correct reagents given but no or incorrect organic product shown

[2 marks]

ALLOW 1 mark if ester is given with an R group i.e. $(CH_3)_3COOCR$ ***AND*** *reagent is consistent e.g. RCOOH OR just states 'carboxylic acid and acid'*

ALLOW names of reagents e.g. ethanoic acid and sulfuric acid.

DO NOT ALLOW *other additional reagents e.g. $Cr_2O_7^{2-}$*

IGNORE *concentration e.g. dilute/concentrated*

IGNORE *conditions e.g. reflux/distillation*

IGNORE *use of acid catalyst with acyl chloride or acid anhydride*

Q6 · June 2024 · Paper 2 (Synthesis and analytical techniques) · Q20 · [13 marks]

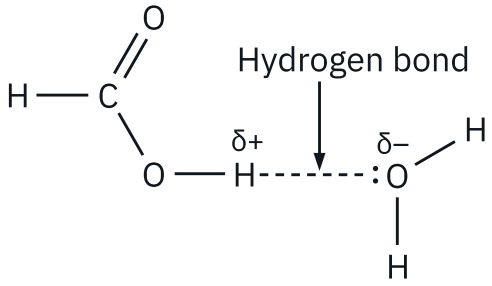
OCR MARK SCHEME

20(a)

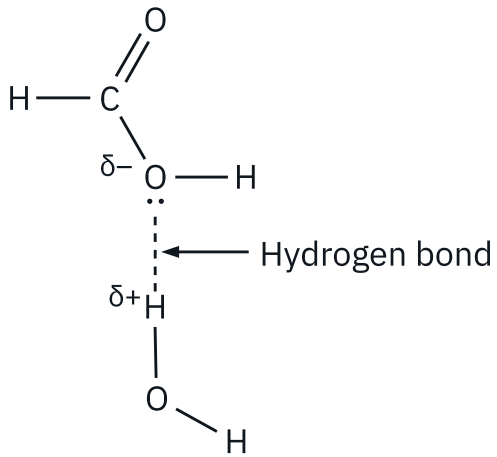
Diagram showing a hydrogen bond between a water molecule and a HCOOH (dipoles and lone pairs not required)

AND

Hydrogen bonding / H-bond stated **OR** labelled on diagram ✓



OR



EXAMINER GUIDANCE

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

ALLOW hydrogen bond to $HCOO^-$ (methanoate ion)

DO NOT ALLOW *H bond from H–C*

DO NOT ALLOW *any marks for a diagram containing O_2H*

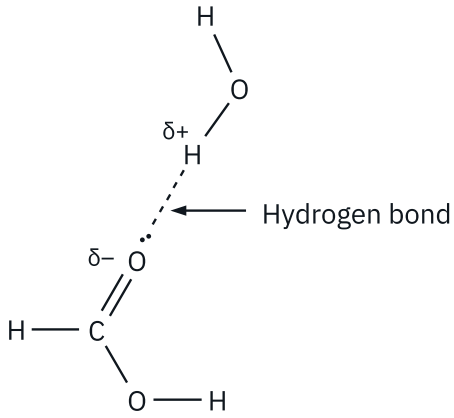
Hydrogen bond does **NOT** need to be labelled but it must be different from the covalent bond if it is not labelled.

IF *more than one hydrogen bond is shown they must ALL be correct to award each mark.*

ALLOW H bond between C=O and H_2O, i.e.

H bond originates from lone pair on δ- O and goes to δ+ H (on another molecule) ✓

[2 marks]



DO NOT ALLOW *δ+ on H atom of C-H*

All Hydrogen bonds must hit a lone pair

ALLOW only one lone pair on O atom

DO NOT ALLOW *more than 2 lone pairs on O atom*

20(b)(i)

ethyl 4-methylpentanoate ✓

[1 mark]

ALLOW one word: ethyl4-methylpentanoate

OR more words, e.g. ethyl 4-methyl pentanoate

DO NOT ALLOW *1-ethyl-4-methylpentanoate*

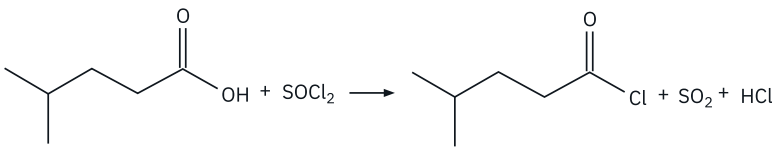
IGNORE *lack of hyphens, extra hyphens, full stops instead of commas, extra spaces*

DO NOT ALLOW *the following for methyl: methy, meth, methly, methanyl*

DO NOT ALLOW *the following for ethyl: ethy, eth, ethly, ethanyl*

20(b)(ii)

Step 1



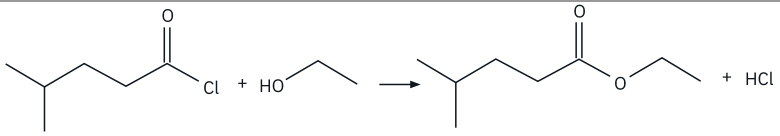
Step 2

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

e.g. $(CH_3)_2CHCH_2CH_2COOH + SOCl_2 \rightarrow (CH_3)_2CHCH_2CH_2COCl + SO_2 + HCl$

$(CH_3)_2CHCH_2CH_2COCl + C_2H_5OH \rightarrow (CH_3)_2CHCH_2CH_2COOC_2H_5 + HCl$

DO NOT ALLOW *incorrect connectivity on OH*



$SOCl_2$ used in Step 1 ✓

Acyl chloride: $(CH_3)_2CHCH_2CH_2COCl$ correct ✓

Seen anywhere

Step 1 correct equation ✓

Step 2 correct equation ✓

[4 marks]

BUT **ALLOW ECF** on subsequent structures

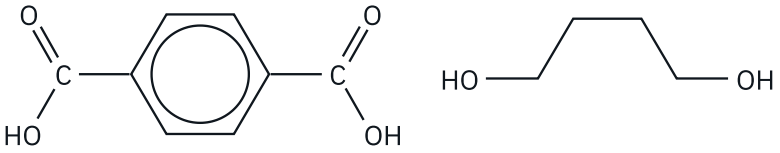
ALLOW suitable non-specification alternatives for step 1 e.g. PCl_3, PCl_5, $COCl_2$

e.g. $3(CH_3)_2CHCH_2CH_2COOH + PCl_3 \rightarrow 3(CH_3)_2CHCH_2CH_2COCl + H_3PO_3$

$(CH_3)_2CHCH_2CH_2COOH + PCl_5 \rightarrow (CH_3)_2CHCH_2CH_2COCl + POCl_3 + HCl$

$(CH_3)_2CHCH_2CH_2COOH + COCl_2 \rightarrow (CH_3)_2CHCH_2CH_2COCl + HCl + CO_2$

20(c)

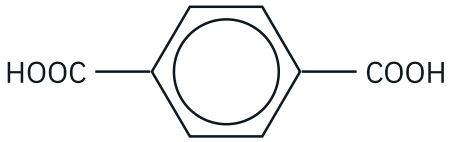


✓ ✓

[2 marks]

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

e.g. ALLOW



✓

$HO–CH_2CH_2CH_2CH_2–OH$ ✓

ALLOW Diacyl chloride:



✓

ALLOW a diacid anhydride of benzene-1,4-dicarboxylic acid, e.g.



✓

***DO NOT ALLOW** incorrect connectivity on OH*

BUT **ALLOW ECF** on subsequent structures

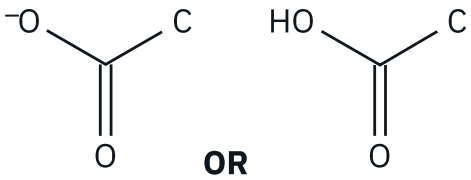
ALLOW correct Kekulé representation of benzene

20(d)

Hydrolysis of ester:

Methanol / CH_3–OH ✓

Formation of carboxylate / carboxylic acid from hydrolysis of ester or amide:

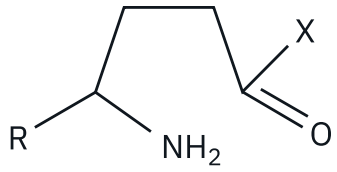


✓

C=O of Carboxylate or carboxylic acid group must be attached to a C But ignore rest of molecule

Hydrolysis of amide:

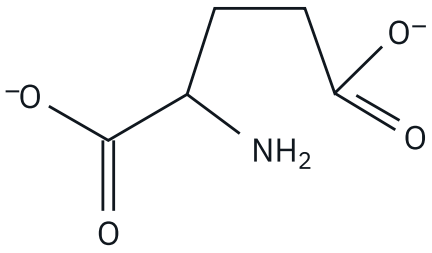
Breaks amide bond in ring to give: ✓



Where R can be H or any other structure

For X, ignore group attached to C=O

Correct hydrolysis product:



✓

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

***DO NOT ALLOW** incorrect connectivity on OH*

...BUT **ALLOW ECF** on subsequent structures

***DO NOT ALLOW** CH_3O^- (Na^+) **OR** sodium methoxide*

*ALLOW $–COO^-Na^+$ **OR** –COONa*

***DO NOT ALLOW** esters or amides*

ALLOW NH_3^+

***IGNORE** missing Hs on carbon chain*

Must be completely correct structure

*ALLOW $–COO^-Na^+$ **OR** –COONa*

[4 marks]

Q7 · June 2025 · Paper 2 (Synthesis and analytical techniques) · Q13 · [1 mark]

Answer: **B**

Only 1 and 2

Q8 · June 2025 · Paper 2 (Synthesis and analytical techniques) · Q21 · [17 marks]

OCR MARK SCHEME

21(a)

An atom/ group of atoms/part of molecule responsible for the characteristic reactions (of a compound) ✓

[1 mark]

EXAMINER GUIDANCE

ALLOW *'part of an organic compound' for 'part of molecule'*

ALLOW *'chemical properties'* ***OR*** *'reactions* ***OR*** *'reactivity' for 'characteristic reactions'*

IGNORE *references to physical properties*

21(b)

2,4-DNP ✓

Red/orange/yellow precipitate ✓

[2 marks]

ALLOW *2,4-dinitrophenylhydrazine* ***OR*** *2,4-DNPH*

OR Brady's (Reagent)

ALLOW *ppt* ***OR*** *solid* ***OR*** *crystals as an alternative for precipitate*

Mark second point independently of response for first marking point

21(c)

	Expected observations		
Chemical test	**Pyruvic acid**	**Methylglyoxal**	**Acetol**
Tollens' reagent	no change	Silver mirror	no change **OR** Silver mirror
Na_2CO_3(aq)	Effervescence **OR** Bubbles **OR** Fizzing	no change	no change
$Cr_2O_7^{2-}$(aq) / H^+(aq)	no change (orange solution)	(Orange to) Green (solution)	(Orange to) Green (solution)

One row correct ✓

Two rows correct ✓✓

Three rows correct ✓✓✓

ALLOW *alternatives for 'no change' such as 'no observation', 'no reaction', 'nothing' or 'X'*

For Tollen's

ALLOW *Silver/Grey/Black* ***AND*** *precipitate/ppt/solid*

ALLOW *acetol to give a positive result (it is an alpha hydroxy ketone so can tautomerize to give an aldehyde, not covered in the specification)*

For Na_2CO_3

IGNORE *gas / CO_2 formed i.e. must be an observable change*

IGNORE *test with limewater* ***BUT DO NOT ALLOW*** *other gas tests*

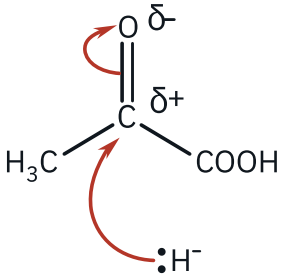
If no other marks awarded, ***ALLOW*** *1 mark for a correct column*

[3 marks]

21(d)

***NOTE**: curly arrows can be straight, snake-like, etc. but **NOT** double headed or half headed arrows*

Nucleophilic attack 2 marks



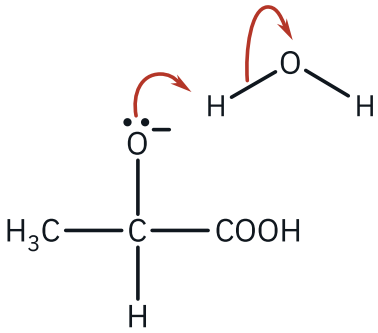
Curly arrow from H^- to C of C=O ✓

Correct dipole shown on C=O

AND

curly arrow showing breaking of C=O ✓

Intermediate 1 mark



Correct intermediate

AND curly arrow from O^- to H in H_2O ✓

***DO NOT ALLOW** δ– on O of intermediate*

***IGNORE** attempt to draw curly arrow showing breaking of H–O in H_2O*

***IGNORE** lack of dipole on H_2O*

***IGNORE** absence of OH^- as 2nd product*

***IGNORE** connectivity of H_3C–*

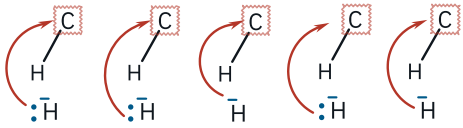
Product 1 mark

1st curly arrow must

- go to the C atom of C=O

AND

- start from, **OR** be traced back to any point across width of lone pair on $^-$:H
- **OR** start from – charge on $^-$H (then lone pair on H^- does not need to be shown)



✓ ✓ ✓ ✓ ✗

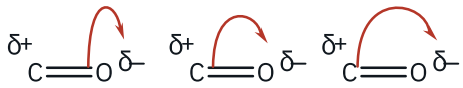
***IF** the carboxylic acid is attacked, in addition to the ketone, then **ALLOW** first two marks provided all arrows and dipoles are correct*

2nd curly arrow must

- start from, **OR** be traced back to any part of $^{\delta+}C{=}O^{\delta-}$ bond

AND

- go to $O^{\delta-}$ (across width of $O^{\delta-}$)



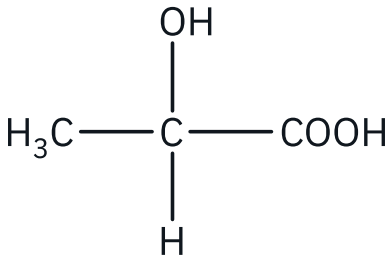
✓ ✓ ✗

3rd curly arrow must

- go to H of H_2O

AND

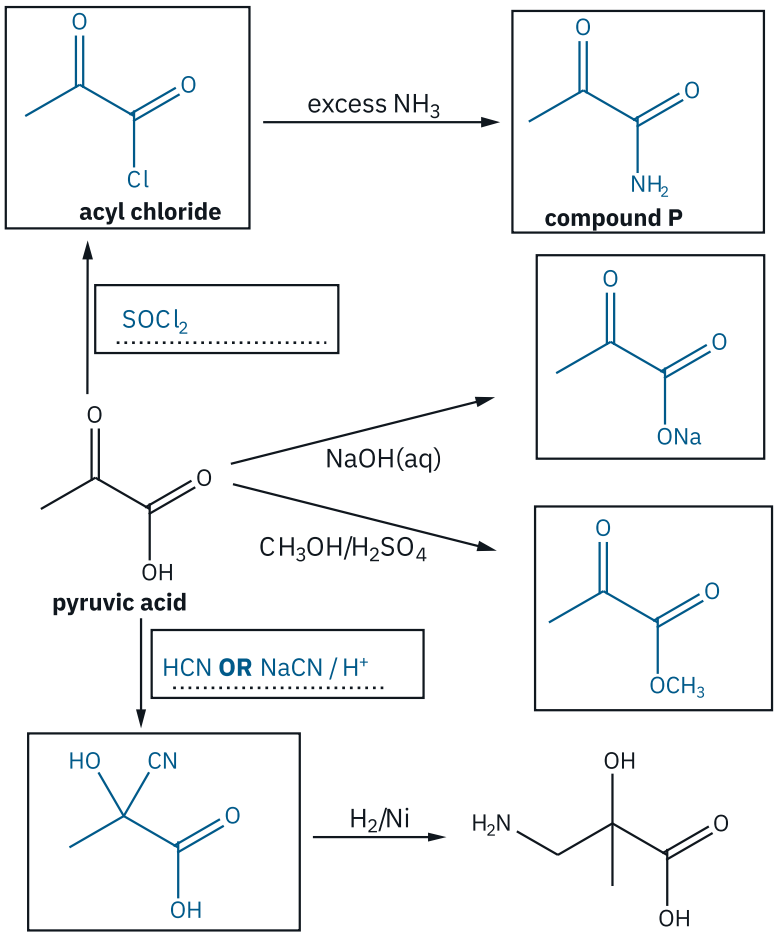
- start from, **OR** be traced back to any point across width of lone pair on $:O^-$
- **OR** start from – charge of O^- of intermediate



Correct product ✓

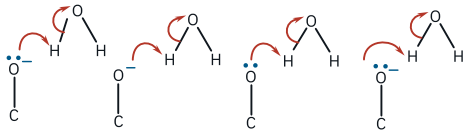
[4 marks]

21(e)



✓✓✓✓✓✓

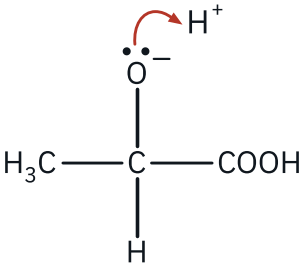
[7 marks]



✓ ✓ ✗ ✗

***NOTE: For arrow to** H of H_2O*

***ALLOW** curly arrow from O^- of intermediate to H^+*



***IGNORE** Connectivity*

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

***ALLOW** names for reagents if no formulae given*

***IGNORE** connectivity*

***IGNORE** conditions*

***IGNORE** inorganic products*

***DO NOT ALLOW** $-CONH_3^+$ in compound P*

For $SOCl_2$, **ALLOW** PCl_3 **OR** PCl_5 **OR** $COCl_2$

***IGNORE** additional H^+ **OR** HCl **OR** H_2SO_4*

***DO NOT ALLOW** H_2O or (aq)*

***ALLOW** carboxylate ion, COO^- (Na^+)*

ALLOW

NaCN **OR** KCN **OR** CN^-

AND

H^+ **OR** H_2SO_4 **OR** HNO_3 **OR** HCl

Acid is required for mark

***IGNORE** solvent **OR** (aq)*

ALLOW *any vertical bond to the OH or CN*

e.g. **ALLOW**



BUT DO NOT ALLOW -HO **OR** -NC

Q9 · June 2025 · Paper 2 (Synthesis and analytical techniques) · Q9 · [1 mark]

Answer: **D**

ALLOW *A*

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