

Mark schemes

Q1.

B

It can form hydrogen bonds.

[1]

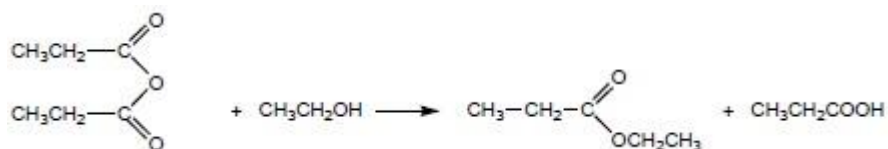
Q2.

D

[1]

Q3.

(a)



Ethyl propanoate only

M1 Structure of ester (allow $\text{C}_2\text{H}_5\text{CO}_2\text{C}_2\text{H}_5$)

1

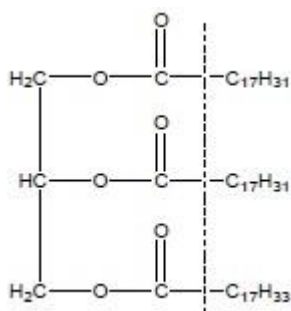
M2 propanoic acid formula (allow $\text{C}_2\text{H}_5\text{CO}_2\text{H}$) and correctly balanced equation

1

M3 Ethyl propanoate only

1

(b)

**M1** for all except $\text{C}_{17}\text{H}_{3x}$ (i.e. all to the left of the dotted line)Allow $-\text{O}_2\text{C}-$, $-\text{OOC}-$, $-\text{OCO}-$ Not $-\text{CO}_2-$, $-\text{COO}-$

1

M2 for two $\text{C}_{17}\text{H}_{31}$ and one $\text{C}_{17}\text{H}_{33}$ in any order top to bottom

1

(c)



M1 for skeleton

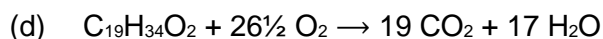
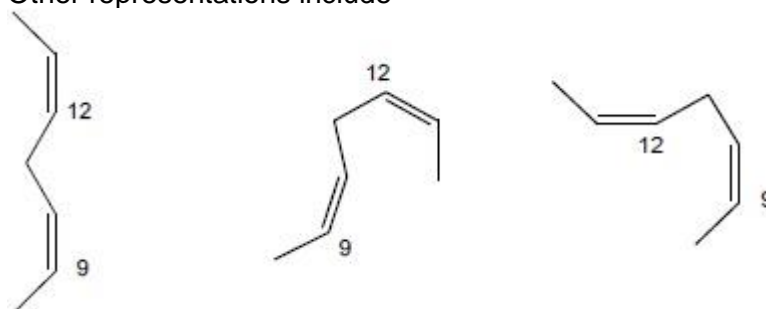
1

M2 for both Z correct
Independent marks

1

*C9 – C14 shown with double bonds in the correct place
Ignore structure beyond carbon 14
If hydrogens shown or not skeletal can only score **M2***

Other representations include



Allow 53/2 or all doubled

1

- (e) Absorption in spectrum at 2350 cm^{-1} does not correspond to data booklet value of $1680 - 1750\text{ cm}^{-1}$ or for C=O bonds in organic compounds)

Allow would expect a peak at $1680 - 1750\text{ cm}^{-1}$

1

- (f) C=O Bonds in CO_2 absorb infrared radiation (of 2350 cm^{-1})

1

IR radiation emitted by the earth does not escape (from the atmosphere)

OR

This energy is transferred to other molecules in the atmosphere by collisions (so all atmosphere is warmed)

Ignore IR reflected

1

[11]

Q4.

A

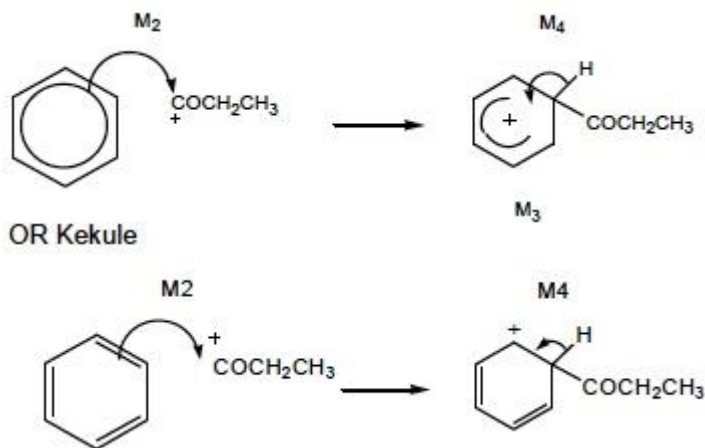
[1]

Q5.



Allow + on C or O in equation –
But must be on C in mechanism

M1



M2 Arrow from inside hexagon to C or + on C

1

M3 Structure of intermediate

- horseshoe centred on C1 and must not extend beyond C2 and C6, but can be smaller

- + in intermediate not too close to C1 (allow on or "below" a line from C2 to C6)

1

M4 Arrow from bond into hexagon (Unless Kekule)

- Can allow M4 arrow independent of wrong M3 structure

- + on H in intermediate loses M3 not M4

- Ignore Cl⁻ and AlCl₄⁻

- used in M4

1

(b) Either...

1-phenylpropan-1-ol

1

NaBH₄ / LiAlH₄

1

Nucleophilic addition

1

Or...

1-phenylpropan-1-ol

1

H₂ with Ni/Pd/Pt

1

Addition/hydrogenation

1

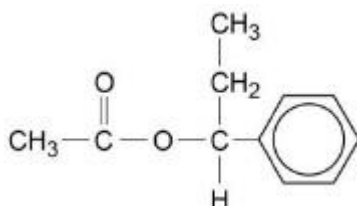
Both numbers needed for names
Ignore solvents

- (c) Misty fumes / steamy fumes
Allow sweet/fruity smell / white fumes
Not smoke

1

(Nucleophilic) addition-elimination

1



1

[10]

Q6.

- (a) M1 NaOH
Only score M2 if M1 gained, but mark on from hydroxide. Mention of acid loses M1 & M2

1

M2 Aqueous/(warm)
Ignore alcoholic / conc / dil.

1

M3 (Fractional) distillation or described
Not just evaporation; not reflux
Allow chromatography

1

- (b) M1 S is $\text{CH}_3\text{CH}(\text{CN})\text{CH}_2\text{CH}_3$
Allow without brackets

1

Step 3

M2 KCN (mark on from CN^-)
Not HCN, not KCN with acid

1

M3 Alcoholic / (aqueous)
Allow ethanolic
Can only score M3 if M2 gained

1

Step 4

M4 H₂LiAlH₄

Na

Can only score M5 if M4 gained

1

M5 Ni or Pt or Pd

Ethoxyethane or ether

LiAlH₄ with acid loses both M4 and M5

Ignore 'followed by acid'

Na

Ethanol

*NOT NaBH₄ OR Sn/HCl**Penalise other extras as list**Ignore pressure or temperature*

1

[8]

Q7.(a) CH₂OHCH(OH)CH₂OH

1

(Potassium) Carboxylate salt

*Allow fatty acid salt / salt**Salt of a carboxylic acid*

1

Soap

Allow detergent / surfactant

1

(b) 638 = 173 + 3(15 + 14n)

M_r ester fragment = 173

M1

Show subtract 638 – (M1 + 45)

M2

Division of M2 by 42

n = 10

n must be an integer

M3

(c) Amount HCl = 0.100 × 0.01565 = 1.565 × 10⁻³ mol

M1

Initial amount KOH = $\frac{0.421}{56.1} = 7.50 \times 10^{-3}$ mol

M2

$$\text{Amount KOH used} = M2 - M1 = 5.939 \times 10^{-3} \text{ mol}$$

M3

$$\text{Amount ester} = \frac{5.935 \times 10^{-3}}{3} = 1.980 \times 10^{-3} \text{ mol (M3 / 3)}$$

M4

$$\text{Mass ester} = (1.980 \times 10^{-3}) \times 638 = 1.263 \text{ g (M4 x 638)}$$

M5

$$\% \text{age by mass} = \frac{1.263}{1.45} \times 100 = 87.1 \% \text{ ((M5 / 1.45) x 100)}$$

Allow 87.0 to 87.1

Allow 2 sf

Don't allow M6 for an answer >100%

M6

- (d) Allow to dissolve both oil and KOH

*To act as a mutual solvent **OR** To ensure reactants are miscible*

M1

Precaution must be linked to heating
e.g. Use a water bath for heating mixture

Allow electrical heater / mantle

Allow sand bath

M2

Prevents risk of fire / Ethanol is flammable

Allow KOH is corrosive/caustic/damages eyes if matches alternative precaution given

M3

[15]

Q8.

- (a) Dehydration

Allow (acid catalysed) Elimination

M1

Conc H₂SO₄

Allow Conc H₃PO₄

M2

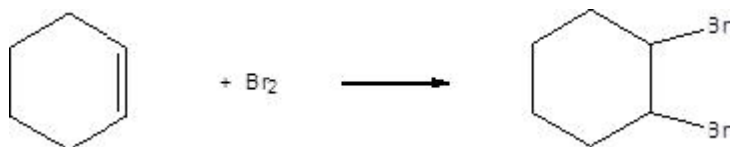
- (b) Br₂

Allow bromine (water)

Allow Cl₂ or I₂

Allow O₂ if epoxide route used

M1



allow consequ equation to H_2 , H_2O , HBr , HCl . HI and H_2SO_4

An epoxide is a feasible alternative that could score here and consequentially M3 and M4

M2

NaOH

Or KOH or other suitable strong alkali

M3



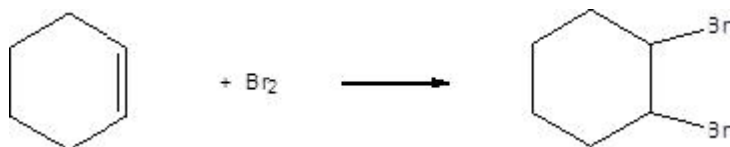
Allow this equation with molecular formulae

M4

(c) M1 (nucleophilic)addition-elimination

Note lone pair required for M5

M1



M2

M3

M4

M5

(d) Less energy used OR Better yield

OR reduces practical losses, simpler plant,

M1

Less waste OR Less pollution

OR maximises the use of raw materials in the process into useful products, saves resources

M2

[13]

Q9.

(a) M1 (Re)weigh the empty boat

1

M2 In order to calculate the (exact) mass of salicylic acid added to the reaction mixture

1

(b) 10 cm³ measuring cylinder (if volume given – allow between 10 to 50 cm³)
Or a 10 cm³ pipette

- Or burette / graduated pipette
- Or 10 cm³ syringe 1
- (c) Corrosive 1
Allow skin burn / permanent eye damage
Ignore irritant / toxic
- (d) LHS + (CH₃CO)₂O RHS + CH₃COOH 1
- (e) **M1** Amount salicylic acid = $\frac{6.01}{138} = 4.36 \times 10^{-2}$ mol 1
Allow conseq from wrong mole ratio in (d)
Must show and state that ethanoic anhydride is in excess
- M2** Mass (CH₃CO)₂O = 10.5 × 1.08 = 11.34 g 1
- M3** Amount (CH₃CO)₂O = $\frac{11.34}{102} = 1.11 \times 10^{-1}$ mol 1
For M4/M5 ecf from M1/M3
- M4** (CH₃CO)₂O is in excess 1
- M5** Mass aspirin = M1 × 0.841 × 180 = 6.59 g 1
Allow 2 sf or more.
- (f) **M1** Value lower 1
- M2** Range of values 1
For M2 allow mpt not sharp or a larger range of melting points
- (g) **M1** (Ethanol is flammable so) use a water bath to heat / do not use a Bunsen burner 1
Must give practical step, not just state hazard
- M2** Heat to temp below bp (so ethanol does not boil away) 1
Allow use min vol solvent
- (h) To remove any soluble impurities 1
Allow To avoid aspirin dissolving (small amount cold solvent used)
Allow To remove/(wash away) any ethanolic solution on the product.

1

- (i) Pure product will have (larger) crystals / needle-like crystals / lighter in colour

Allow whiter, less grey, more crystalline, less powdery, shinier, single colour

Must be tied to pure product

Allow opposite points tied to the crude product

1

[16]**Q10.****B****[1]**