1. (a) (i) M1 (Yield) increases / goes up / gets more

*If **M1** is blank, mark on and seek to **credit the correct information in the explanation.***

*If **M1** is incorrect CE=0 for the clip.*

M2

The (forward) reaction / to the right is <u>exothermic</u> or <u>gives out / releases heat</u>

OR

The reverse reaction / to the left is <u>endothermic</u> or <u>takes in / absorbs heat</u>

M3** depends on a correct statement for **M2

M3 depends on correct M2 and must refer to temperature / heat

The (position of) <u>equilibrium shifts / moves</u> left to right to <u>oppose the decrease in temperature</u>

*For **M3**, the <u>equilibrium shifts / moves</u>*
*to <u>release heat</u> **OR***
*to <u>raise the temperature</u> **OR***
to <u>heat up the reaction</u>.

3

(ii) M1 *<u>Concentration(s)</u>* (of reactants and products) remain or stay constant / the same

*For **M1** credit [ ] for concentration.*

M2 <u>Forward rate</u> = <u>reverse / backward rate</u>

Not "equal concentrations".
Not "concentrations <u>is / are the same</u>".
Not "amount".
Ignore "dynamic" and ignore "speed".
Ignore "closed system".
It is possible to score both marks under the heading of a single feature.

2

(b) $KBr + H_2SO_4 \longrightarrow KHSO_4 + HBr$

Credit this equation in its ionic form.
Ignore state symbols.
Credit multiples.

1

(c) M1 SO_2 identified

M2 correctly balanced equation (would also gain M1)

*Credit **M2** equation in its ionic form.*
Ignore state symbols.

$\mathbf{2}HBr + H_2SO_4 \longrightarrow Br_2 + SO_2 + \mathbf{2}H_2O$

Credit multiples.
Not H_2SO_3 on the right-hand side.

Mark M3 independently

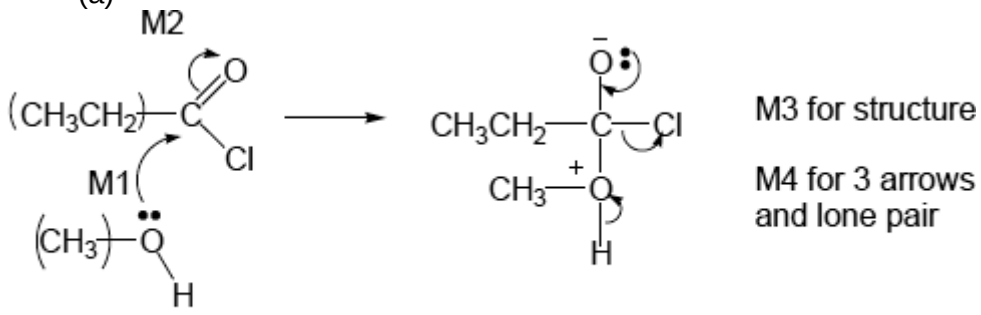
M3 Oxidising agent ***OR*** electron acceptor ***OR*** oxidant ***OR*** to oxidise the bromide (ion) / HBr

***M3** Not "electron pair acceptor".*

3

[9]

2. (a)



methyl propanoate (**NO** mark for name of mechanism)

- *M2 not allowed independent of M1, but allow M1 for correct attack on C+*
- *+ rather than δ+ on C=O loses M2*
- *If Cl lost with C=O breaking, max1 for M1*
- *M3 for correct structure with charges but lp on O is part of M4*
- *only allow M4 after correct/very close M3*
- *ignore Cl^- removing H^+*

4

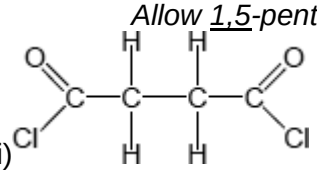
1

(b) (i) pentane-1,5-diol

Second 'e' and numbers needed

Allow 1,5-pentanediol but this is not IUPAC name

(ii)



Must show ALL bonds

1

(iii) All three marks are independent

M1 (base or alkaline) Hydrolysis (allow close spelling)

1

Allow (nucleophilic) addition-elimination or saponification

M2 δ+ C in polyester

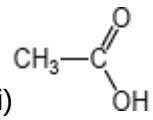
1

M3 reacts with OH^- or hydroxide ion

1

Not reacts with NaOH

1

(c) (i) 

Allow CH_3COOH or CH_3CO_2H

1

(ii) (nucleophilic) addition-elimination

Both addition and elimination needed and in that order

OR

(nucleophilic) addition followed by elimination

*Do **not** allow electrophilic addition-elimination / esterification*

Ignore acylation

1

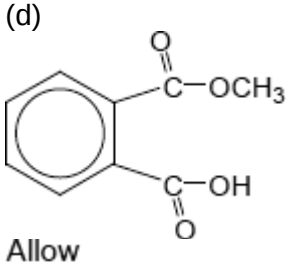
(iii) any **two** from: ethanoic anhydride is

- less corrosive
- less vulnerable to hydrolysis
- less dangerous to use,
- less violent/exothermic/vigorous reaction OR more controllable rxn
- does not produce toxic/corrosive/harmful fumes (of HCl) OR does not produce HCl
- less volatile

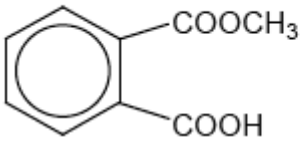
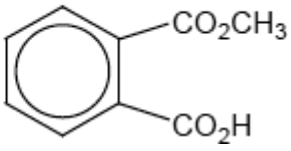
***NOT** COST*

List principle beyond two answers

2

(d) 

Allow

 or 

1

(e) (i) ester

*Do **not** allow ether*

Ignore functional group/linkage/bond

1

(ii) 12 or twelve (peaks)

1

(iii) 160 – 185

Allow a number or range within these limits

Penalize extra ranges given

Ignore units

1

(f) (i) sulfuric acid	sodium hydroxide	✓
hydrochloric acid	ammonia	X or blank
ethanoic acid	potassium hydroxide	✓
nitric acid	methylamine	X or blank

4 correct scores 2
3 correct scores 1
2 or 1 correct scores 0

2

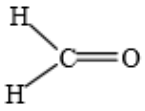
(ii) Pink to colourless

Allow 'red' OR 'purple' OR 'magenta' instead of 'pink'
*Do **not** allow 'clear' instead of 'colourless'*

1

[21]

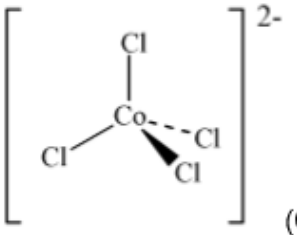
3. (a) (i)



(must show single and double bonds) (1)

Trigonal planar (allow triangular planar) (1)

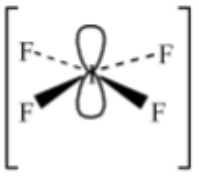
(ii)



(Charge optional (and in other shapes in (iii) and (iv)) (1)

tetrahedral (1)

(iii)



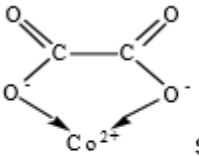
Note lone pairs not necessary (1)

Square planar (allow octahedral if lone pairs shown) (1)

(iv) $[NC—Ag—CN]^-$ (allow CN or NC linkage) (1)

linear (1)

(b)

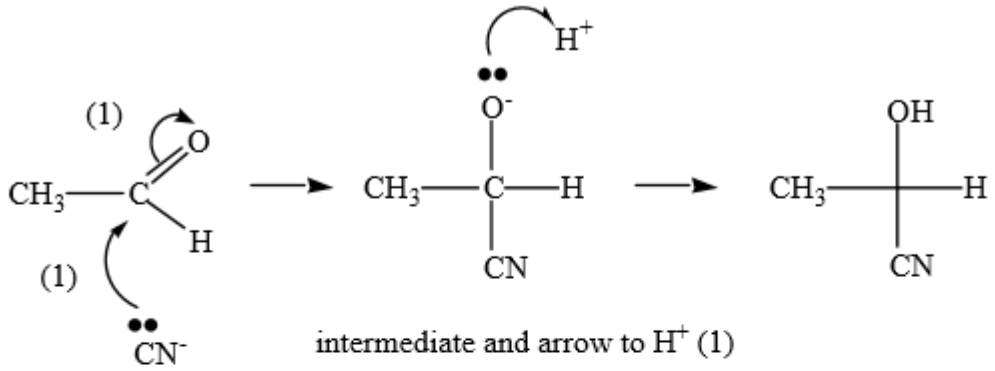


structure of ligand (1) bonds to Co (1) (allow with or without charges) (2)

(note if more than one ligand shown, all must be correct)

(Second mark only given if first mark gained)

(c) (3)

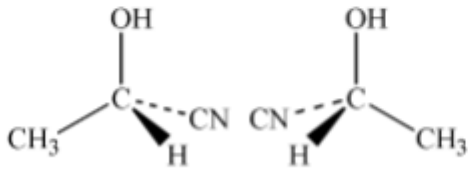


intermediate and arrow to H^+ (1)

(Equal chance of) attack on each side of carbon (or molecule or double bond) (1)

(allow from above and below the plane)

(1)



Note, do not allow structures with bond angle of 90^0

Allow CN or NC linkages as above

[15]

4. (a) $HCl + NH_3 \rightarrow NH_4Cl$ (1)

Ammonia reacts as a base or nucleophile (1)

$AgCl + 2NH_3 \rightarrow [Ag(NH_3)_2]^+ + Cl^-$ (1)

Ammonia acts as a ligand (1)

$CH_3COCl + 2NH_3 \rightarrow CH_3CONH_2 + NH_4Cl$ (2)

(Allow one mark if second product is HCl)

Ammonia behaves as a nucleophile (1)

7

(b) Pentane is non-polar (1)

van der Waals forces between molecules (1)

Butanone has a polar C=O bond (1)

Dipole-dipole attraction between molecules (1)

Propanoic acid has very polar O-H groups (1)

Hydrogen bonding between molecules (1)

vdw < dipole - dipole attraction < hydrogen bonding (1)

Link to energy needed to separate molecules (1)

(Last mark only allowed when clearly stated and all three interactions are correct)

8

[15]

5. B **[1]**

6. A **[1]**

7. D **[1]**

8. D **[1]**

9. B **[1]**

10. D **[1]**

11. B **[1]**

12. D **[1]**

13. B **[1]**

14. D **[1]**

15. B **[1]**

16. B **[1]**

17. D **[1]**

18. D **[1]**

18. B **[1]**

20. B **[1]**

21. C **[1]**

22. C **[1]**

23. D **[1]**

24. C **[1]**

25. B **[1]**

26. C **[1]**

27. D **[1]**

28. B **[1]**

29. C **[1]**

30. D **[1]**

31. B **[1]**

32. A **[1]**

33. B **[1]**

34. D **[1]**