

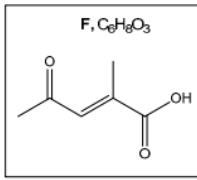
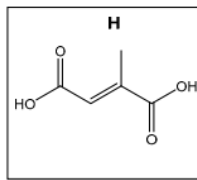
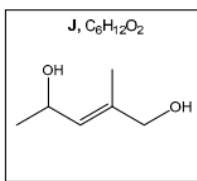
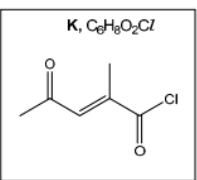
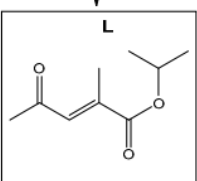
36. Organic synthesis

36.1 Organic synthesis

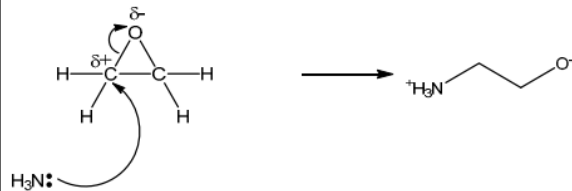
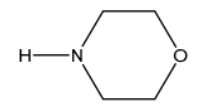
Paper 4

Marking Scheme

Q1.

(d)	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px; width: 25%;"> <p style="text-align: center;">F, C₆H₈O₃</p>  </div> <div style="width: 25%; text-align: center;"> <p>alkaline I₂(aq)</p> </div> <div style="border: 1px solid black; padding: 5px; width: 25%;"> <p style="text-align: center;">G</p> <p style="text-align: center;">CHI₃</p> </div> <div style="border: 1px solid black; padding: 5px; width: 25%;"> <p style="text-align: center;">H</p>  </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="text-align: center;"> <p>LiAlH₄</p> </div> <div style="text-align: center;"> <p>SOCl₂</p> </div> </div> <div style="display: flex; justify-content: space-between; margin-top: 20px;"> <div style="border: 1px solid black; padding: 5px; width: 25%;"> <p style="text-align: center;">J, C₆H₁₂O₂</p>  </div> <div style="border: 1px solid black; padding: 5px; width: 25%;"> <p style="text-align: center;">K, C₆H₈O₂Cl</p>  </div> </div> <div style="text-align: center; margin-top: 20px;"> <p>propan-2-ol</p> </div> <div style="border: 1px solid black; padding: 5px; width: 25%; margin-left: auto;"> <p style="text-align: center;">L</p>  </div>	6
one mark for each structure: F, G, H, J, K and L		

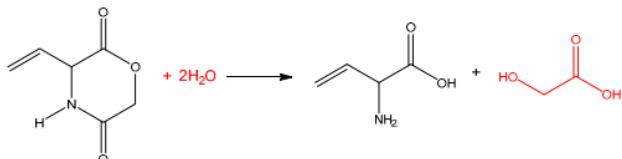
Q2.

(d)(i)	 <p style="margin-top: 10px;">H₃N:</p> <p>M1 two correct curly arrows M2 correct dipole M3 correct structure of intermediate</p>	3
(d)(ii)	use an excess of ammonia OR limiting amount of oxirane	1
(d)(iii)	<p>M1</p>  <p>M2 elimination / dehydration / condensation</p>	2

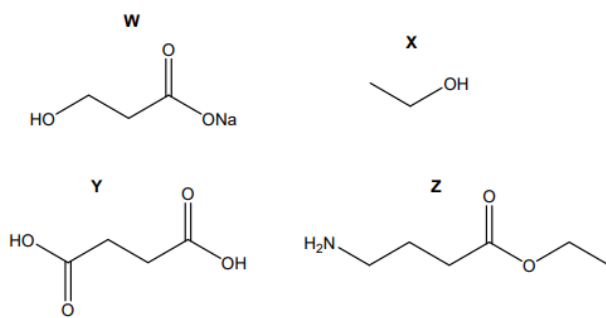
Q3.

(d)		1
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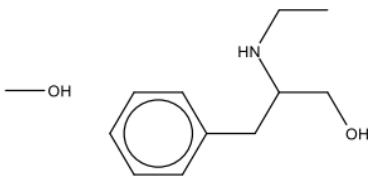
Q4.

(b)(i)		1
(b)(ii)	hydrolysis	1

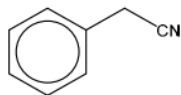
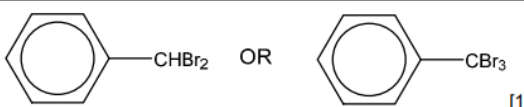
Q5.

(b)(i)	ethyl 3-chloropropanoate	1
(b)(ii)	<p>  </p> <p>4 × [1] for each structure</p>	4
(b)(iii)	<p> M1 step 1 NaCN / KCN in ethanol (heat) M2 step 2 H₂ + Ni / H₂ + Pt ALLOW LiAlH₄ </p>	2

Q6.

(b)(ii)		3
<p>methanol [1]</p> <p>ester bond → primary alcohol</p> <p>OR amide → 2° amine AND benzene ring unchanged [1]</p> <p>rest of the structure of second compound is correct [1]</p>		

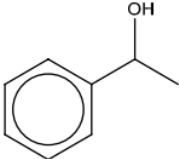
Q7.

(d)(i)	Br ₂ + UV light [1]	1
(d)(ii)	 <p>[1]</p>	1
(d)(iii)	<p>CHECK Q is correct</p> <p>step 2 – KCN in ethanol + heat [1]</p> <p>step 3 – HCl(aq) + heat/reflux/boil [1]</p>	2
(d)(iv)	 <p>[1]</p> <p>ALLOW any viable organic by-product from this radical substitution reaction, e.g. C₆H₅CH₂CH₂C₆H₅</p>	1

Q8.

(a)	<table border="1" style="width: 100%;"> <thead> <tr> <th style="width: 30%;">organic starting material</th> <th style="width: 30%;">reagent and conditions</th> <th style="width: 40%;"></th> </tr> </thead> <tbody> <tr> <td>1-butyl halide, e.g. CH₃CH₂CH₂CH₂Br</td> <td>NH₃ under pressure or heated in sealed tube</td> <td>[1] + [1]</td> </tr> <tr> <td>butanenitrile CH₃CH₂CH₂CN</td> <td>H₂ and Ni or Pt / LiAlH₄ / Na + ethanol</td> <td>[1] + [1]</td> </tr> <tr> <td>butanamide CH₃CH₂CH₂CONH₂</td> <td>LiAlH₄ / Na + ethanol</td> <td>[1] + [1]</td> </tr> </tbody> </table>	organic starting material	reagent and conditions		1-butyl halide, e.g. CH ₃ CH ₂ CH ₂ CH ₂ Br	NH ₃ under pressure or heated in sealed tube	[1] + [1]	butanenitrile CH ₃ CH ₂ CH ₂ CN	H ₂ and Ni or Pt / LiAlH ₄ / Na + ethanol	[1] + [1]	butanamide CH ₃ CH ₂ CH ₂ CONH ₂	LiAlH ₄ / Na + ethanol	[1] + [1]	6
organic starting material	reagent and conditions													
1-butyl halide, e.g. CH ₃ CH ₂ CH ₂ CH ₂ Br	NH ₃ under pressure or heated in sealed tube	[1] + [1]												
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butanamide CH ₃ CH ₂ CH ₂ CONH ₂	LiAlH ₄ / Na + ethanol	[1] + [1]												

Q9.

(f)(i)		1
(f)(ii)	M1: step 1: $\text{CH}_3\text{COCl} + \text{AlCl}_3$ [1] M2: step 2: $\text{NaBH}_4 / \text{LiAlH}_4$ [1] M3: step 3: conc. H_2SO_4 , heat [1]	3