

## Q1.

- 5 (a) (i)  $\text{SOCl}_2/\text{PCl}_5/\text{PCl}_3/\text{P} + \text{C}_6\text{H}_5\text{OH}$  (aq negates) [1]  
(ii)  $\text{C}_6\text{H}_5\text{OH} + \text{NaOH} \rightarrow \text{C}_6\text{H}_5\text{O}^- \text{Na}^+$  (or  $\text{C}_6\text{H}_5\text{ONa}$ ) +  $\text{H}_2\text{O}$  [1]  
(iii) **J** =  $\text{C}_6\text{H}_5\text{OCOCH}_3$  [1]  
**K** =  $\text{CH}_3\text{CONH}_2$  [1]

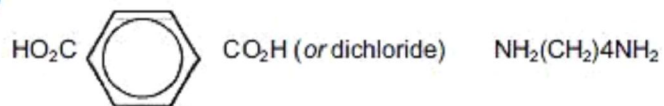
4

- (b) (i) condensation [1]  
(ii)  $\text{ClCOCH}_2\text{CH}_2\text{COCl} + 2\text{HOCH}_2\text{CH}_2\text{OH} \rightarrow$  [1]  
 $\text{HOCH}_2\text{CH}_2\text{OCOCH}_2\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_2\text{OH} (+ \text{H}_2\text{O})$  [1]

3

- (c) (i) polyamide or nylon (allow condensation) [NOT peptide or protein] [1]

(ii)



[1] + [1]

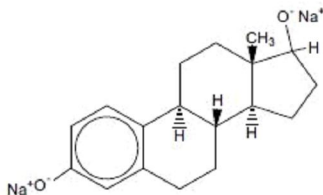
3

**Total 10**

## Q2.

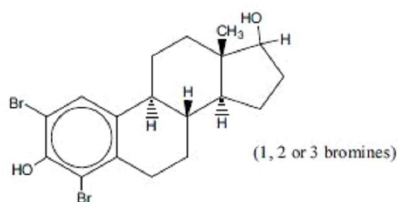
- 6 (a) (i) one correct atom circled (if >1 are circled, all must be correct) [1]  
 (ii) 5 (chiral centres) [1] [2]

- (b) (i) sodium metal



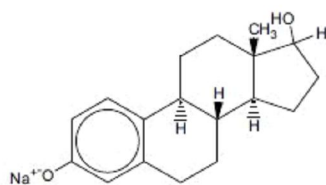
(charges not needed) [1] + [1]

- (ii) Br<sub>2</sub>(aq)



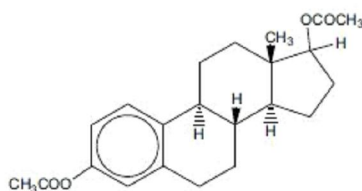
[1]

- (iii) NaOH(aq)



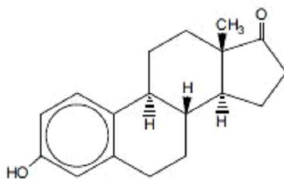
(charges not needed) [1]

- (iv) CH<sub>3</sub>COCl



[1]+ [1]

- (v) hot acidified K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>



[1]

(if one or more OH groups have been omitted in (ii), (iii) or (v) deduct [1] mark) [7]

[Total: 9]

Q3.



- 6 (a) (i)  $\text{SOCl}_2$  or  $\text{PCl}_5$  or  $\text{PCl}_3$  (1)
- (ii)  $\text{CH}_3\text{CO}_2\text{H} + \text{SOCl}_2 \longrightarrow \text{CH}_3\text{COCl} + \text{SO}_2 + \text{HCl}$   
 or  $\text{CH}_3\text{CO}_2\text{H} + \text{PCl}_5 \longrightarrow \text{CH}_3\text{COCl} + \text{POCl}_3 + \text{HCl}$   
 or  $3\text{CH}_3\text{CO}_2\text{H} + \text{PCl}_3 \longrightarrow 3\text{CH}_3\text{COCl} + \text{H}_3\text{PO}_3$  (1) [2]
- (b) (i) **A** is  $\text{C}_6\text{H}_5\text{CO}_2\text{C}_2\text{H}_5$  (1)  
**B** is  $\text{C}_6\text{H}_5\text{CONH}_2$  (1)
- (ii) ester (1)  
 amide (1)
- (iii) nucleophilic substitution / condensation (1) [5]
- (c) (i) **C** is  $\text{ClCOCOC}l$  (1)  
**D** is  $\text{ClCOCOCOC}l$  (1)
- (ii) hydrogen bonding (1)
- (iii) because it's an amide or not an amine or its lone pair is delocalised (over C=O) or less available due to electronegative oxygen [NOT: **E** is neutral, but the diamine is basic] (1)
- (iv) condensation (polymer) or polyester (1) [5]
- [Total: 12]**

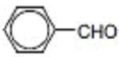
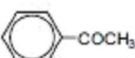
Q5.

6 (a) (i) aqueous alkaline iodine *or*  $I_2 + OH^-(aq)$  allow  $NaClO + KI$  [1]

(ii)  $CH_3CO^-$  *or*  $CH_3CH(OH)^-$  [1]

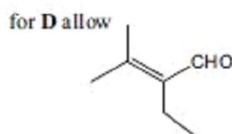
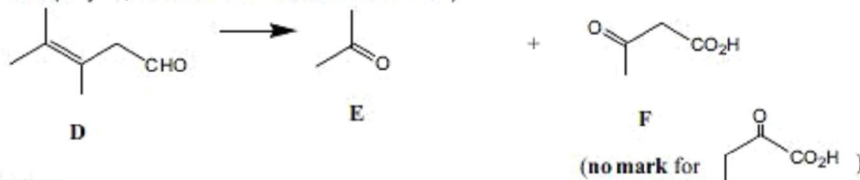
(iii) Pale yellow ppt. *or* antiseptic smell [1]

(iv)

| compound  | result |
|---|--------|
| $CH_3OH$  | ×      |
| $CH_3CH_2OH$  | ✓      |
| $CH_3CHO$   | ✓      |
| $CH_3CO_2H$   | ×      |
|  | ×      |
|  | ✓      |

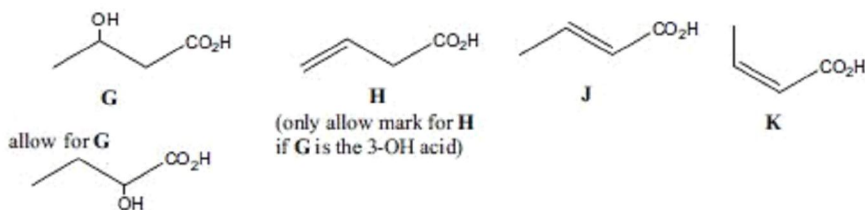
••••• [3]

(b) (allow displayed, skeletal *or* structural formulae)



(D + E + F): 3 × [1]

(c) (allow displayed, skeletal *and* structural formulae)  
Must be consistent with F



(N.B. letters H, J, K can be swapped around)

(G + H + J + K): 4 × [1]

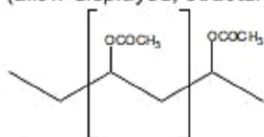
geometrical *or* cis-trans isomerism

[1]

[Total: 14]

**Q6.**

- 4 (a) (i) (allow displayed, structural or skeletal formula)



chain [1]  
repeat unit [1]

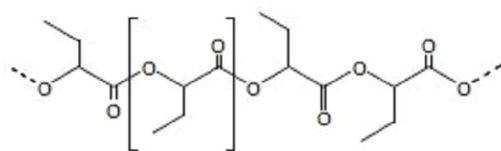
- (ii) C should be  $\text{CH}_2=\text{CHOH}$  (or skeletal formula) [1]

- (iii) C is  $\text{CH}_3\text{CH}=\text{O}$  (or skeletal formula) [1]

- (iv) e.g. add (2,4-)DNPH or DNP or Brady's reagent orange or red ppt forms (NOT yellow) ecf [1]  
(or could use Fehling's or Tollens', or  $\text{H}^+ + \text{Cr}_2\text{O}_7^{2-}$ : orange to green, or  $\text{H}^+ + \text{MnO}_4^-$ : purple to colourless) ecf [1]

[6]

- (b) (i) (allow displayed, structural or skeletal formula)



**D**

correct repeat unit bracketed (any 3 atoms in chain) [1]

- (ii) ester [1]

- (iii) E is  $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CO}_2\text{H}$  (or skeletal structure etc.) (2-hydroxybutanoic acid) [1]  
allow ecf here from the formula of the repeat unit shown in (b)(i)

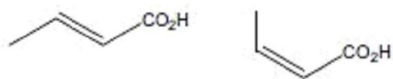
- (iv) condensation (polymerisation) [1]

- (v) they have the same "molecular" formula or  $\text{C}_4\text{H}_8\text{O}_2$  (do **NOT** allow empirical formula) or same no. and type of atoms or same functional group or both are esters or they are isomers [1]

[5]

- (c) (i) optical isomerism (or chiral) [1]

- (ii)



**F**

**G**

(letters may be reversed)(allow ecf from E, also allow ecf for G from F) [1] + [1]

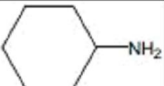
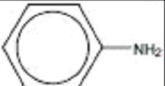
cis-trans or geometrical isomerism [1]  
[4]

[Total: 15]

**Q7.**

- 5 (a) acidities:  $\text{CHCl}_2\text{CO}_2\text{H} > \text{CH}_2\text{ClCO}_2\text{H} > \text{CH}_3\text{CO}_2\text{H}$  [1]  
 due to Cl being (more) electronegative/electron withdrawing (than H). [1]  
 this stabilises the anion or weakens the O-H bond [1]  
 [3]

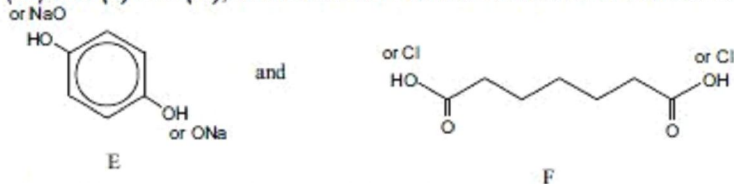
(b)

| first compound  | second compound   | test  | observation with first compound | observation with second compound |
|---|---|---|---------------------------------|----------------------------------|
|  |  | $\text{Br}_2(\text{aq})$ [not (l)]  | none                            | decolourises/<br>white ppt.      |
|   |   | $\text{NaNO}_2 + \text{HCl}$ or $\text{HNO}_2$<br>followed by phenol (+ NaOH) | none                            | yellow/orange/red<br>ppt.        |
| $\text{CH}_3\text{CH}_2\text{COCl}$   | $\text{CH}_3\text{COCH}_2\text{Cl}$   | $\text{AgNO}_3(\text{aq})$  | (immediate)<br>white ppt.       | none                             |
|   |   | add $\text{H}_2\text{O}/\text{ROH}$   | steamy/misty/<br>white fumes    | none                             |
|   |   | (2,4-)DNPH  | none                            | orange ppt.                      |
|   |   | $\text{I}_2/\text{OH}^-$  | none                            | yellow ppt./<br>antiseptic smell |
| $\text{CH}_3\text{CH}_2\text{CHO}$  | $\text{CH}_3\text{COCH}_3$  | $\text{I}_2/\text{OH}^-$  | none                            | yellow ppt./<br>antiseptic smell |
|   |   | Fehling's/Benedict's solution<br>+ warm                                       | red ppt.                        | none                             |
|   |   | Tollens' reagent + warm   | silver/black ppt.               | none                             |
|   |   | $\text{Cr}_2\text{O}_7^{2-} + \text{H}^+ + \text{warm}$                       | turns green                     | no change                        |
|   |   | $\text{MnO}_4^- + \text{H}^+ + \text{warm}$                                   | decolourises                    | no change                        |

- three correct reagents [3]  
 three correct positive results [3]  
 three × 'none' [1]  
 [7]

- (c) (i) condensation [1]

- (ii) (in parts (ii) and (iii), allow structural formulae instead of skeletal formulae) [1] + [1]



(N.B. letters **E** and **F** may be reversed.)

- (iii) make acyl chloride from **F** (if not already there) [1]  
 add that to a solution of **E** in  $\text{NaOH}(\text{aq})$  [1]



- (iv) F (or E, i.e. the aliphatic di-acid) should be changed to something less flexible, e.g.
- (any size ring with  $n < 6$ ; any orientation)

or

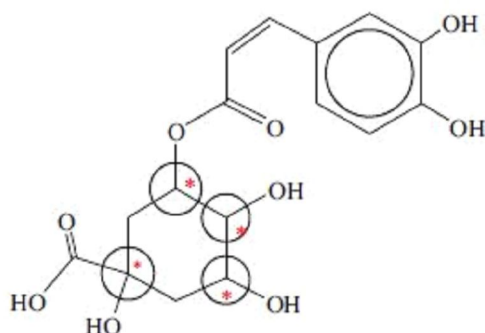
(ignore side chains: length of chain is the important feature)

or

(but not  $\text{HO}_2\text{C}(\text{CH}_2)_3\text{CO}_2\text{H}$  or longer)
- or allow a tri-carboxylic acid (or triphenol), i.e. one that will allow cross linking
- [1]  
[6]
- [Total: 16]**

## Q8.

5 (a) (i)

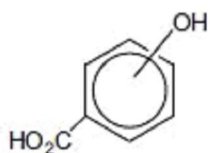


two or three centres correctly identified [1]  
four centres correctly identified [2]

- (ii)  $\text{C}_{16}\text{H}_{18}\text{O}_9$  [1]
- (iii) 3 moles of  $\text{H}_2$  [1]
- (iv) in cold: 3 moles of NaOH [1]  
on heating: 4 moles of NaOH [1]  
[6]
- (b) (i) hydrolysis [1]
- (ii) alkene or  $\text{C}=\text{C}$  [1]
- (iii) with  $\text{Na}_2\text{CO}_3(\text{aq})$ : carboxylic acid [1]  
with  $\text{Br}_2(\text{aq})$ : phenol [1]



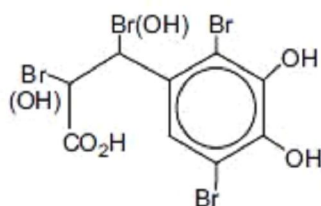
(iv)



**F**

(OH can be at the 3, 4, or 5 positions, but not the 2 or 6 positions)

[1]



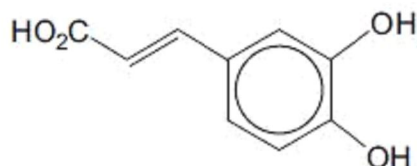
**G** (ring subst. allow 2 or 3 Br in ring) [1]

(addition to C=C: allow one of the aliphatic Br to be OH, but not both) [1]

(v) geometrical or cis-trans or E-Z

[1]

(vi)



skeletal or structural [1]

**[9 max 8]**

(c)  $M_r(\mathbf{E}) = 180$ , so  $0.1 \text{ g} = 1/1800$  ( $5.56 \times 10^{-4}$ ) mol [1]

3 mol NaOH react with 1 mol of **E**, so  $n(\text{NaOH}) = 3/1800 = 1/600 \text{ mol} = 1.67 \times 10^{-3} \text{ mol}$  [1]

volume of 0.1M NaOH =  $1000/(600 \times 0.1) = 16.7 \text{ cm}^3$  [1]

**[3]**

**[Total: 17]**

**Q9.**

|   |     |   |                  |
|---|-----|---|------------------|
| 6 | (a) | nucleophilic substitution (NOT elimination, NOT condensation)   | [1]              |
|   |     |   | 1                |
|   | (b) | CH <sub>3</sub> CH <sub>2</sub> CO <sub>2</sub> H (or name) [1] SOCl <sub>2</sub> or PCl <sub>5</sub> or PCl <sub>3</sub> or P + Cl <sub>2</sub> [1]<br>(if both given, formula takes precedence)   | [1]              |
|   |     |   | 2                |
|   | (c) | (i) CH <sub>3</sub> CH <sub>2</sub> CN (if CN is shown in full, it must be C≡N, not C-N) [1]  | [1]              |
|   |     | (ii) NaCN or KCN + heat/warm/reflux/T between 50° and 100° (in ethanol) [1]<br>(NOT CN. mention of acid negates mark)   | [1]              |
|   |     | (iii) H <sub>2</sub> + Ni/Pt/Pd or LiAlH <sub>4</sub> or Na + ethanol (NOT NaBH <sub>4</sub> ) [1]  | [1]              |
|   |     |   | 3                |
|   | (d) | (i) condensation [1]  | [1]              |
|   |     | (ii) H <sub>2</sub> N-C <sub>6</sub> H <sub>4</sub> -NH <sub>2</sub> [1] HO <sub>2</sub> C-C <sub>6</sub> H <sub>4</sub> -CO <sub>2</sub> H or ClCO-C <sub>6</sub> H <sub>4</sub> -COCl [1]<br>[allow NH <sub>2</sub> C <sub>6</sub> H <sub>4</sub> NH <sub>2</sub> but NOT CO <sub>2</sub> HC <sub>6</sub> H <sub>4</sub> CO <sub>2</sub> H] | [1]              |
|   |     | (iii) Strong forces between chains or chains are rigid/inflexible [1]   | [1]              |
|   |     | (iv) <u>warm/heat/boil/reflux with aq/dilute acid/H<sup>+</sup>/H<sub>2</sub>SO<sub>4</sub> or base/OH<sup>-</sup>/NaOH</u> [1]<br>[allow <u>warm/heat/boil/reflux with conc HCl</u> for [1] mark]  | [1]              |
|   |     |   | 5                |
|   |     |   | <b>Total: 11</b> |

Q10.

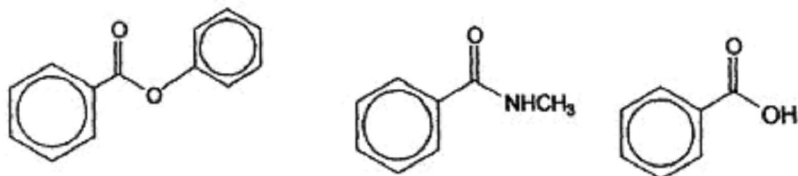
|   |     |  |                  |
|---|-----|--|------------------|
| 5 | (a) | reagents: NaOH + I <sub>2</sub>  | (1)              |
|   |     | observations: yellow solid/ppt. with H and nothing with L.   | (1) [2]          |
|   | (b) | J is more acidic than propanoic acid   | (1)              |
|   |     | chlorine is electrogegative/electron-withdrawing   | (1) [2]          |
|   | (c) | $\text{NH}_2\text{CH}(\text{CH}_3)\text{CO}_2\text{H} + (\text{Na}^+)\text{OH}^- \longrightarrow \begin{array}{c} \text{H} \quad \text{H} \quad \text{O} \\   \quad   \quad    \\ \text{N}-\text{C}-\text{C}-\text{O}^- (\text{Na}^+) \\   \quad   \\ \text{H} \quad \text{CH}_3 \end{array} + \text{H}_2\text{O}.$        | (1)              |
|   |     | <i>balancing</i>   | (1)              |
|   |     | <i>displayed formula</i>   | (1) [2]          |
|   | (d) | +NH <sub>3</sub> CH(CH <sub>3</sub> )CO <sub>2</sub> <sup>-</sup>  | (1) [1]          |
|   | (e) | (i) peptide or amide   | (1)              |
|   |     | (ii) $\begin{array}{c} \text{H} \quad \text{H} \quad \text{O} \quad \text{H} \quad \text{H} \quad \text{O} \\   \quad   \quad    \quad   \quad   \quad    \\ \text{N}-\text{C}-\text{C}-\text{N}-\text{C}-\text{C}-\text{OH} \\   \quad   \quad \quad   \\ \text{H} \quad \text{CH}_3 \quad \quad \text{CH}_3 \end{array}$ | (1) [2]          |
|   | (f) | (i) C <sub>6</sub> H <sub>5</sub> COCl   | (1)              |
|   |     | (ii) HCl or H <sub>2</sub> SO <sub>4</sub> or NaOH   | (1)              |
|   |     | (aq) + heat/reflux   | (1) [3]          |
|   |     |  | <b>Total: 12</b> |

Q11.

- 5 (a) (i)  $AlCl_3/FeCl_3/Al/Fe/I_2$  (+ heat) [aq negates] (N.B. NOT  $AlBr_3$  etc.) [1]  
 (or names)
- (ii) (sun)light/hf/UV (aq negates) [1] 2
- (b)  $SOCl_2/PCl_3/PCl_5$  [aq negates] [1]  
 (or names) 1
- (c) (i)  $C > B > A$  (i.e. a mark in the penultimate box) [1]
- (ii) (*acyl chloride fastest*) highly  $\delta +$  carbon atom joined to 2 electronegative atoms  
 or addition-elimination mechanism is possible [1]
- (*aryl chloride slowest*) delocalisation of lone pair over ring  $\Rightarrow$  stronger C-Cl bond  
 or impossibility of 'backside' attack on the C-Cl bond [1] 3

- (d)  $C_6H_5-CO_2C_6H_5$  [1]       $C_6H_5-CONHCH_3$  [1]       $C_6H_5-CO_2H$  [1]


OR



3

Total 9

Q12.

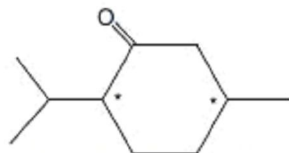
- 6 (a) (i) E [1]
- (ii)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2^-(\text{Na}^+)$  [NOT  $\text{C}_3\text{H}_7\text{COO}-\text{Na}$  or  $\text{C}_3\text{H}_7\text{COOH}$ ] [1]  
 [but allow  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{Na}$ ]
- $\text{CH}_3$  or name [1] 3
- (b) the alcohol from E has four different groups around a carbon atom [1]  
 $\therefore$  it is chiral/asymmetric or it is produced as a 50:50 mixture of mirror images [1]  
 or its mirror images are non-superimposable
- 
- formulae: [1]
- the alcohol from D has 2 identical groups on its central carbon atom [1]
- 4 max 3**
- Total 6**

### Q13.

- 6 (a) alkaline aqueous iodine ( $\text{NaOH}/\text{I}_2$ ) (allow  $\text{NaOI}$ ) [1]  
 J gives yellow ppt; K gives no reaction [1]
- (b) aqueous bromine /  $\text{Cu}^{2+}$  aq / diazotisation with phenol [1]  
 L gives no change; M decolourises/gives white ppt. [1]  
 with  $\text{Cu}^{2+}$  L goes blue, M goes green  
 with diazotisation L gives no reaction, M a coloured compound [1]
- (c) drop of water [1]  
 N fizzes/gives off steamy fumes; P has no reaction [1]  
 or add  $\text{AgNO}_3(\text{aq})$  [1]  
 N gives rapid ppt.; P gives ppt. very slowly [1]  
 or add  $\text{NH}_3/\text{RNH}_2$  [1]  
 N gives off fumes; P has no reaction [1]  
 or add alcohol/phenol [1]  
 N produces sweet-smelling liquid, P gives no reaction [1]
- (d) Universal Indicator solution/litmus [1]  
 Q shows no change; R will turn solution blue (alkaline) [1]
- [Total: 8]**

**Q14.**

6 (a)

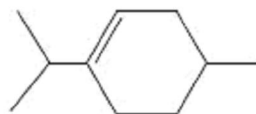


(1) for each centre – more than 2 centres shown deduct 1 mark

[2]

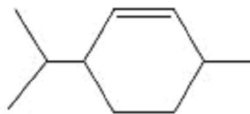
(b) (i) step 1  $\text{LiAlH}_4$  or  $\text{NaBH}_4$  or  $\text{Na} + \text{ethanol}$  or  $\text{H}_2 + \text{Ni}$  (1)  
 step 2 heat with  $\text{Al}_2\text{O}_3$  / porous pot or conc.  $\text{H}_2\text{SO}_4$  /  $\text{H}_3\text{PO}_4$  (1)

(ii)



**L** (1)

(letters may be reversed)

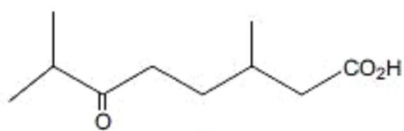


**M** (1)

[4]

(c) (i) **M** (no mark)

(ii)



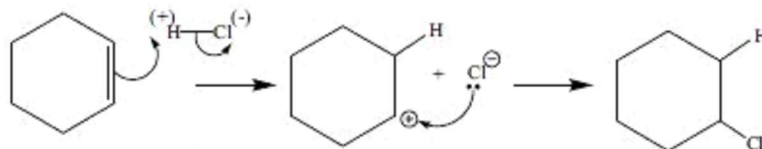
**P**

i.e. 3,7-dimethyl-6-oxo-octanoic acid (1)

(iii) 2,4-DNPH (1) orange ppt. with **P** (none with **N**) (1)  
 Mark ecf from candidates' P

[3]

(d)



2 curly arrows (1)

carbocation intermediate +  $\text{Cl}^-$  (1)

lone pair on  $\text{Cl}^-$  and last curly arrow (1)

[3]

[Total: 12]

**Q15.**

- 3 (a) reaction I: reduction or hydrogenation (1)  
 reaction II: oxidation or redox (1) [2]

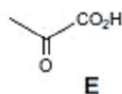
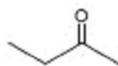
- (b) thymol: Br<sub>2</sub>(aq) (1) decolourises or white ppt (1)  
 or NaOH(aq) (1) dissolves (1)  
 or FeCl<sub>3</sub>(aq) (1) violet/purple (colour) (1)  
 menthol: Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup>/H<sup>+</sup> (1) orange → green (1)  
 or Lucas test or ZnCl<sub>2</sub>/HCl (1) cloudy or white ppt (1)  
 menthone: 2,4-DNPH/Brady's reagent (1) orange ppt (1) [6]

**[Total: 8]**

## Q16.

- 5 (a) (i) C=C double bonds / alkenes  
 (ii) -OH groups / accept alcohols or acids  
 (iii) CH<sub>3</sub>CO- or CH<sub>3</sub>CH(OH)- groups  
 (iv) carbonyl, >C=O, groups / accept aldehydes and ketones 4 × [1]  
[4]

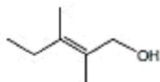
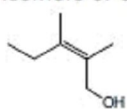
(b)



2 × [1]

**[2]**

(c) isomers of C



correct structure (excl. stereochemistry) [1]

cis and trans drawn correctly [1]

type of isomerism is **cis-trans or geometrical isomerism** [1]

**[3]**

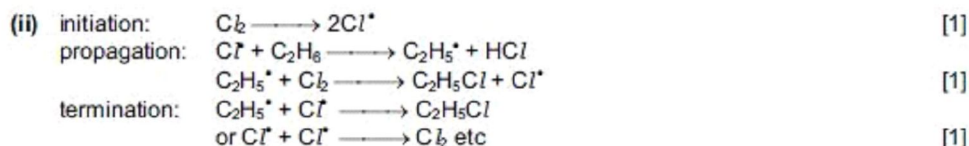
**[Total: 9]**

## Q17.



- 5 (a) Alkanes are non-polar or have no dipole or C–H bonds are strong or C and H have similar electronegativities [1]  
[1]

- (b) (i) (free) radical substitution or substitution by homolytic fission [1]



all 3 names [1]

(iii)

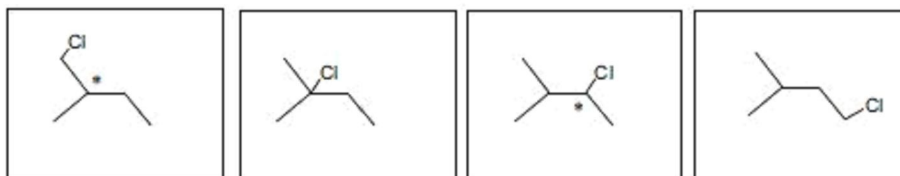
| structural formula of by-product                                    | formed by  |
|---|--|
| $\text{CH}_2\text{Cl}-\text{CH}_2\text{Cl}$ (or isomer)             | further substitution                                 |
| $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$                      | (termination of 2 ×) $\text{C}_2\text{H}_5^\bullet$  |
| $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$ (or isomer) | substitution of $\text{C}_4\text{H}_{10}$ by-product |

[3]  
 accept in the "formed by" column the formulae of radicals that will produce the compound in the "by-product" column, or the reagents, e.g.  $\text{C}_4\text{H}_9^\bullet + \text{Cl}_2$  or  $\text{C}_4\text{H}_9^\bullet + \text{Cl}^\bullet$  or  $\text{C}_4\text{H}_{10} + \text{Cl}_2$  (giving  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$ ).  
 do not allow anything more Cl-substituted than dichlorobutane.  
 N.B.  $\text{C}_2\text{H}_5\text{Cl}$  is the **major** product, not a **by-product**, so do not allow  $\text{C}_2\text{H}_5\text{Cl}$ .

- (iv) J/K = 2.3 : 1 or 7:3 or 21:9 [2]  
 (reason: straightforward relative rate suggests 21:1, but there are 9 primary to 1 tertiary, so divide this ratio by 9.  $21/9 = 2.33$ )  
 allow [1] mark if J/K ratio is given as 21:1;

[10]

(c)



2 chiral atoms identified correctly, even in incorrect structures

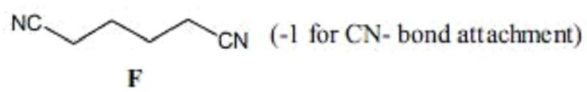
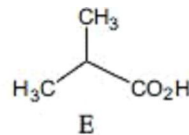
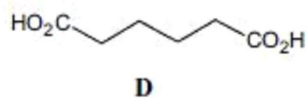
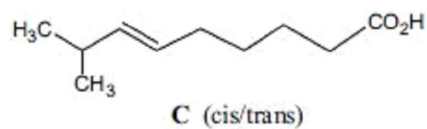
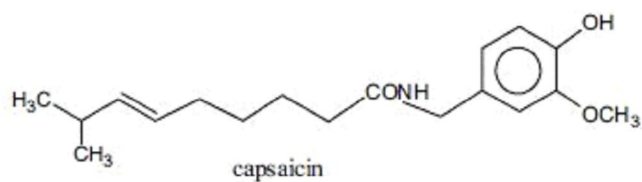
4 isomers  $4 \times [1]$   
 $[1] + [1]$   
**[max 5]**

**[Total: 16]**

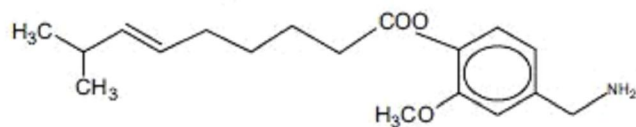
Q18.

- 4 (a)  $K_2Cr_2O_7 + H^+$  + heat under reflux [1]
- (b) nucleophilic substitution [1]
- (c) heat under reflux + aqueous HCl [1]
- (d) alkene [1]
- (e) amide or ester [1]
- [5]

(f)



alternative structure for capsaicin



ecf 5 × [1]

[5]

[Total: 10]

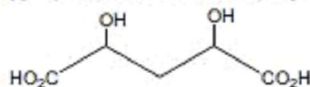
Q19.

4 (a) (i) ketone/carbonyl [NOT aldehyde] [1]

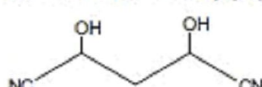
(ii) carboxylic acid (name of group needed. NOT 'carboxyl') [1]

[Total: 2]

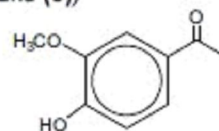
(b) (i) (allow structural, displayed or skeletal formulae in (b), (c) and (e))



**B**



**C**



**D**

[1] + [1] + [1]

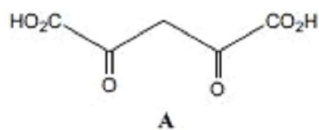
(ii) heat/reflux/boil/hot/T > 60°C in H<sub>3</sub>O<sup>+</sup> or aqueous/dilute H<sup>+</sup>/HCl/H<sub>2</sub>SO<sub>4</sub> (NOT HNO<sub>3</sub>) [1]

[Total: 4]

(c) (i) reduction/redox (allow nucleophilic addition or hydrogenation, as appropriate from (ii)) [1]

(ii)  $\text{NaBH}_4$  or  $\text{LiAlH}_4$  or  $\text{H}_2 + \text{Ni/Pt}$  or  $\text{Na} + \text{ethanol}$  [1]

(iii)



[1]

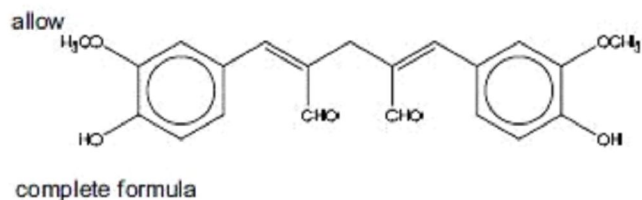
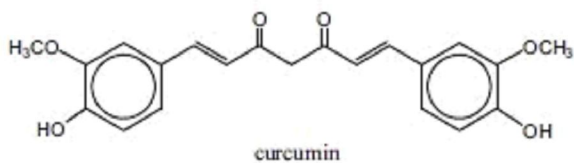
[Total: 3]

(d) (i) alkene/ $\text{C}=\text{C}/\text{C}-\text{C}$  double bond [1]

(ii) phenol and alkene/ $\text{C}=\text{C}/\text{C}-\text{C}$  double bond [1]

[Total: 2]

(e)



[2]

[Total: 2]

[TOTAL: 13]



