A-LEVEL PAPER 2 PP4 MS

|  |  |
| --- | --- |
| **1.** |  |
|  | **[13]** |
| **2.** |  |

|  |  |  |
| --- | --- | --- |
|  | (b) | **[5]** |
| **3.** | **[2]** | |

**4.** (a)    Exp 2   14.(4) ×10–3   ***OR***   1.4(4) ×10–2   or 0.014

*Allow 2sf*

**1**

Exp 3   0.1(0)

**1**

Exp 4   0.3(0)

*If three wrong answers, check their value of k in 1(b).*

*They can score all 3 if they have used their (incorrect) value of k. see below.*

*Exp 2   rate = 0.096 × k*

*Exp 3   [****Q****] = 0.015/k*

*Exp 4   [****P****] = 0.116/√k*

**1**

(b)      

*mark is for insertion of numbers into a correctly rearranged rate equ , k = etc*

**1**

= 0.15 (min 2sfs)                   (allow )

*if upside down, score only units mark*

*AE (–1) for copying numbers wrongly or swapping two numbers*

**1**

mol–2 dm+6 s–1

*Any order*

*If k calculation wrong, allow units conseq to their k*

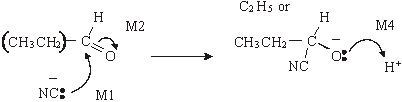
**1**

(c)     G

**1**

**[7]**

**5.**      (a)     necleophilic addition;



**1**

M3 structure;

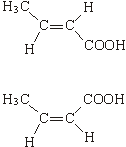
*(be lenient on position of charge on CN– )  
(M2 not allowed independent of M1,   
but allow M1 for correct attack on C+  
if M2 show as independent first.)  
(+on C of C=O loses M2 but ignore δ+ if correct)  
(M4 for arrow and lone pair (only allow for correct M3 or close))*

**4**

(b)     (i)      2-hydroxybutanoic acid

**1**

(ii)

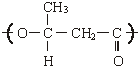


**1**

geometric(al) or cis-trans

**1**

(c)     (i)



*(one unit only) (ignore brackets or n) (trailing bonds are needed)*

**1**

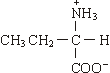
(ii)     can be hydrolysed

         OR

         can be reacted with/attacked by acid/base/nucleophiles/H2O/OH–;

**1**

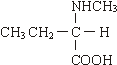
(d)     (i)



*(allow –NH3+)*

**1**

(ii)



*(or zwitterions product)*

**1**

(iii)     nucleophilic substitution;

**1**

**[14]**

**6.**      (a)     diethylamine **OR** ethyl ethanamine **OR** ethyl aminoethane

*ignore N–*

**1**

(b)     For (b) and (c)

There are three valid routes for this synthesis called  
Routes **A**, **B** and **C** below

•        Decide which route fits the answer best (this may not be the  
best for part b) to give the candidate the best possible overall mark.

•        Mark part (b)

•        For this best route mark the mechanism and reagent independently

•        Migration from one route to another is not allowed

•        Either name or formula is allowed in every case.

•        Ignore conditions unless they are incorrect.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Route A** | **Route B** | **Route C** |  |
| F | CH3CH2Br or CH3CH2Cl | C2H6 | CH3CH2OH | **1** |
| G | CH3CH2NH2 ethylamine OR ethanamine OR aminoethane | CH3CH2Br OR CH3CH2Cl | CH3CH2Br OR CH3CH2Cl | **1** |

(c)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | **Route A** | **Route B** | **Route C** |  |
| Step 1 | Reagent(s) | HBr **OR** HCl | H2/Ni (Not NaBH4) | H2O & H3PO4 **OR** H2O & H2SO4 | **1** |
| Mechanism | Electrophilic addition | addition (allow electrophilic **OR** catalytic but not nucleophilic) ignore hydrogenation | Electrophilic addition | **1** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Step 2 | Reagent(s) | NH3 | Cl2 **OR** Br2 | HBr OR KBr & H2SO4 **OR** PCl3 **OR** PCl5 **OR** SOCl2 | **1** |
| Mechanism | Nucleophilic substitution | (free) radical substitution | Nucleophilic substitution | **1** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Step 3 | Reagent(s) | CH3CH2Br **OR** CH3CH2Cl | CH3CH2NH2 **OR** NH3 but penalise excess ammonia here | CH3CH2NH2 **OR** NH3 but penalise excess ammonia here | **1** |
| Mechanism | Nucleophilic substitution | Nucleophilic substitution | Nucleophilic substitution | **1** |

(d)     tertiary amine **OR** triethylamine **OR** (CH3CH2)3N  
Quaternary ammonium salt  
**OR** tetraethylammonium bromide **OR** chloride **OR** ion  
**OR** (CH3CH2)4N+ (Br– **OR** Cl–)

**1**

further substitution will take place **OR**diethylamine is a better nucleophile than ethylamine

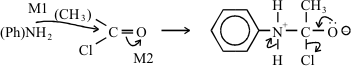
**1**

**[11]**

**7.**       (a)     CH3COCl or (CH3CO)2O **(1)**

*AlCl3 or H2O or CH2SO4 loses this mark  
CH3COOH loses reagent and M3, M4 = max 3*

          nucleophilic addition–elimination **(1)**

****

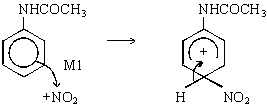
*M3: structure  
M4: 3 correct arrows  
Allow M1 for attack on CH3‑C+=O  
Penalise Cl– removing H+*

**6**

(b)     Conc HNO3 **(1)**Conc H2SO4 **(1)**HNO3 + 2 H2SO4 → NO2+ + H3O+ + 2 HSO4– **(2)  
         (or H2SO4 )             (or H2O + HSO4–)**

*HNO3 / H2SO4 scores 1  
Any 2*

          electrophilic substitution **(1)**

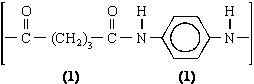
****

*M2 structure  
M3 arrow*

**6**

(c)     Sn **(or Fe)** / HCl or Ni / H2 **(1)**

*NOT LiAlH4 NaBH4*

**

**3**

**[15]**

**8.**              (i)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Reagent | Tollens | Fehlings or Benedicts | K2Cr2O7/H+  or acidified | KMnO4/H+ | I2/NaOH |
| Propanal | silver (mirror) | red ppt or goes red *(not red solution)* | goes green | goes colourless | No reaction |
| Propanone | no reaction | no reaction | no reaction | no reaction | Yellow (ppt) |

*(penalise incomplete reagent e.g. K*2*Cr*2*O*7 *or Cr*2*O*72–*/H*+ *then mark on)*

**3**

(ii)     propanal 3 peaks

*ignore splitting even if wrong*

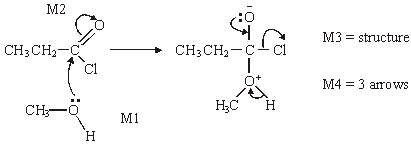
**1**

propanone 1 peak

**1**

**[5]**

**9.**          **X** is methyl propanoate



**1**

         M1 for arrow and lone pair,

**4**

M2 for arrow  
addition-elimination

**1**

          Spectrum 2

*if thinks Spectrum 1 = X can only score for structure of Y*

**1**

**Y** is CH3COOCH2CH3

**1**

The two marks for explanation are awarded for discussing one or more of the  
four peaks (not those for the CH3 of the ethyl groups)  
for stated δ values the integration or the splitting should be related to the  
structure: e.g. structure of **X** shows that  
at δ 3.7 – 4.1 **(1)** spectrum of **X** should have integration 3 / singlet **(1)**

or

at δ 2.1 – 2.6 **(1)** spectrum of **X** should have integration 2 / quartet **(1)**

Spectrum 2 has these  
[OR Spectrum 1 has  
at 3.7 – 4.1 **(1)** quartet / integration 2 **(1)** so not **X**at 2.1 – 2.6 **(1)** singlet / integration 3 **(1)** so not **X**]

**2**

**[10]**

**10.**      M1        In acid lysine has double positive or more positive charge

**1**

M2        (Lysine ion) has greater affinity / greater attraction / adheres better / sticks              better to polar / stationary phase

*M2 only scores after a correct M1.*

*Ignore greater retention time.*

**1**

**[2]**

**11.**          (i)      3,3-dimethylbutan-1-ol

*Allow 3,3-dimethyl-1-butanol*

**1**

4

**1**

Triplet on three

**1**

(ii)     2-methylpentan-2-ol

*Allow 2-methyl-2-pentanol*

**1**

5

**1**

Singlet or one or no splitting

**1**

**[6]**

**12.**    (a)     GLC or distillation

**1**

(b)     C=O

**1**

(c)     (i)      e.g. CDCl3 or CCl4

**1**

(ii)     Si(CH3)4

**1**

(d)     0 and 3

**1**

(e)



**1**

(f)     CH3CH2CH2COCl or (CH3)2CHCOCl

**1**

**[7]**

|  |  |  |
| --- | --- | --- |
| **13.** | (a) |  |
|  | (b) |  |
|  | (c) |  |
|  | (d) |  |
|  | **[8]** | |