



A-LEVEL AP2 PAPER 2 MS

1. *(must state correct effect on yield or rate to score the reason mark)*
- T effect: higher temp: yield greater or shifts equilibrium to right; **1**
effect: higher temp: rate increased; **1**
reason: endothermic
OR
more particles have $E > E_a$ **1**
OR
more successful/productive collisions; **1**
- P effect: higher pressure: yield less or shifts equilibrium to left; **1**
effect: higher pressure: rate increased; **1**
reason: increase in gas moles L to R
OR
greater collision frequency;
(Q of L mark) **1**
2. (a) mol $\text{CH}_3\text{OH} = 0.07(0)$ **1**
mol $\text{H}_2 = 0.24(0)$ **1**

[6]



- (b) (i) $\frac{[\text{CH}_3\text{OH}]}{[\text{CO}][\text{H}_2]^2}$ or $\frac{(0.082/1.5)}{(0.210/1.5)(0.275/1.5)^2}$
allow () but expression using formulae must have brackets alternative expression using numbers must include volumes 1
- (ii) **M1** divides by vol
*Mark independently from (b)(i)
 any AE is -1
 if volume missed, can score only M3 and M4* 1
- M2** $\frac{(0.082/1.5)}{(0.210/1.5)(0.275/1.5)^2}$ $\left(= \frac{(0.05467)}{(0.14)(0.1833)^2} \right)$
*mark is for correct insertion of correct numbers in correct Kc expression in b(ii)
 If Kc expression wrong, can only score M1 & M4
 If numbers rounded, allow M2 but check range for M3* 1
- M3** 11.6 or 11.7
*mark for answer
 above 11.7 up to 12.2 scores 2 for M1 and M2
 if vol missed, can score M3 for 5.16 (allow range 4.88 to 5.21)* 1
- M4** mol⁻² dm⁶
Units conseq to their Kc in (b)(ii) 1
- (iii) no effect or no change or none 1
- (c) **M1** T₁
if wrong - no further marks 1
- M2** (forward) reaction is exothermic **OR** gives out heat
backward reaction is endothermic
only award M3 if M2 is correct 1
- M3** shifts to RHS to replace lost heat
OR to increase the temperature
OR to oppose fall in temp
 backward reaction takes in heat
OR to lower the temperature
not just to oppose the change 1
- (d) fossil fuels used
OR
 CO₂ H₂O produced/given off/formed which are greenhouse gases 1

MEGA LECTURE

OR

SO₂ produced/given off/formed which causes acid rain

OR

Carbon produced/given off/formed causes global dimming

not allow electricity is expensive

ignore just global warming

ignore energy or hazard discussion

1

(e) C₁₇H₃₅COOCH₃ **or** C₁₇H₃₁COOCH₃ **or** C₁₇H₂₉COOCH₃

OR

CH₃OOCC₁₇H₃₅ **or** CH₃OOCC₁₇H₃₁ **or** CH₃OOCC₁₇H₂₉

1

[13]

3. (a) exp2 4.0 × 10⁻³

1

exp3 0.45 × 10⁻⁵

1

exp4 9.0 × 10⁻³

1

(b) $\frac{1.8 \times 10^{-6}}{(3.0 \times 10^{-3})^2 (1.0 \times 10^{-3})}$

1

2000

1

mol⁻² dm⁶ s⁻¹

1

[6]

4. (a) Multiply volume of propan-1-ol by density
Allow measure the mass of the volume added
Any reference to concentration of propan-1-ol
CE = 0

1

Divide the mass by the *M_r* of propan-1-ol

1

(b) Titrate a measured volume of the concentrated HCl added initially to determine moles of HCl used in the experiment
Allow addition of AgNO₃ to form AgCl precipitate. Use mass of precipitate to calculate initial moles of HCl added.

1

Subtract this number of moles of HCl from the total moles of acid at equilibrium

1

(c) M1 ester will evaporate / escape



Allow reactants / products will evaporate

1

M2 incorrect values used (to determine K_c)

Allow the system will no longer be at equilibrium

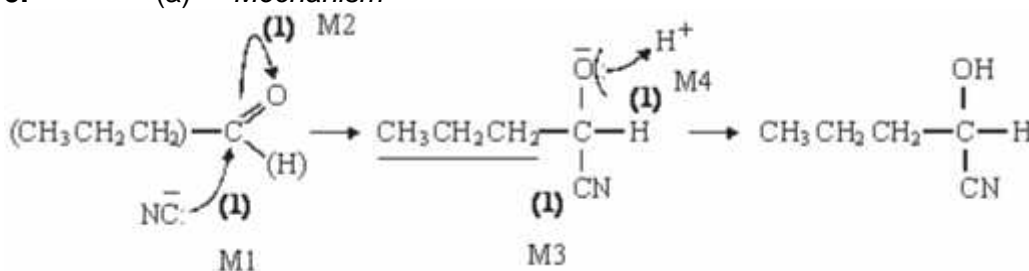
Do not allow references to equilibrium position shifting alone

1

[6]

MEGA LECTURE

5. (a) Mechanism



Allow C_3H_7 if structure shown elsewhere
penalise HCN splitting if wrong

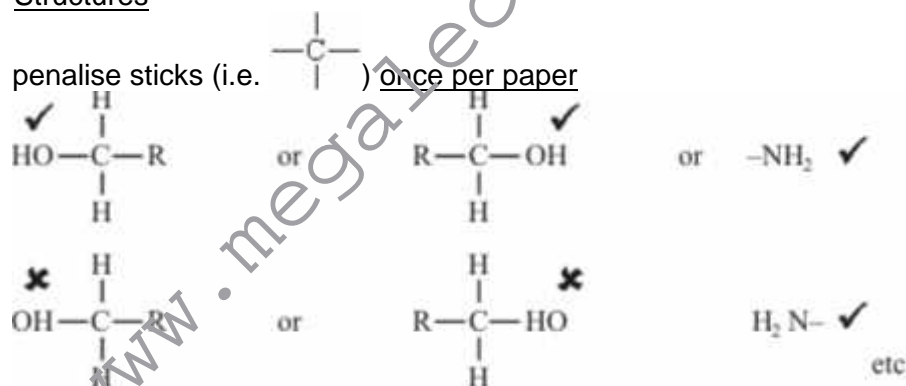
Name of product: 2-hydroxypenta(neo)nitrile (1)
or 1-cyanobutan-1-ol

Organic points

- (1) Curly arrows: must show movement of a pair of electrons, i.e. from bond to atom or from lp to atom / space e.g.



- (2) Structures



Penalise once per paper

allow $\text{CH}_3\text{—}$ or —CH_3 or CH_3
or $\text{H}_3\text{C—}$

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MEGA LECTURE

6. (a) (i) M_r of $C_6H_5NH_2 = 93$ M_r of $CH_3COCl = 78.5$
total M_r of reagents = 264.5

$$\% \text{ atom economy} = \frac{M_r \text{ of wanted product}}{\text{total } M_r \text{ of all reagents}} \times 100 \text{ QWC}$$

$$= \frac{135}{264.5} \times 100 = 51.0 \%$$

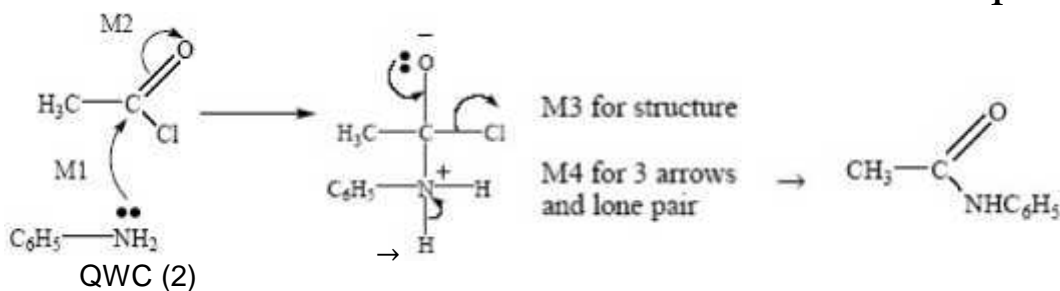
- (ii) expected yield = $\frac{10}{93} \times 0.5 \times 135 = 7.26 \text{ kg}$

$$\% \text{ yield} = \frac{5.38}{7.26} \times 100 = 74.1 \%$$

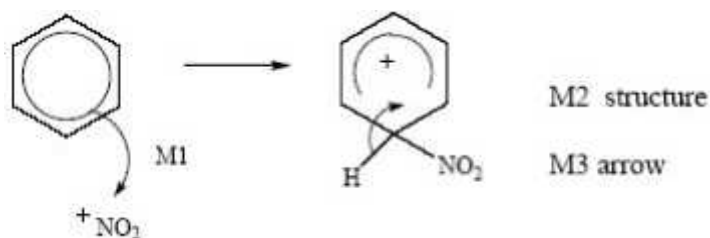
- (iii) Although yield appears satisfactory (74%) % atom economy is only 51% QWC

nearly half of the material produced is waste and must be disposed of QWC

- (b) (nucleophilic) addition-elimination



- (c) $HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$



[16]



7. (a) $\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$
 Allow molecular formulae. 1
- $\text{CH}_2\text{OHCHOHCH}_2\text{OH}$
 Allow one mark only if formulae are swapped in position. 1
- (b) Keeping the foodstuff dry
 Allow an answer which refers to removal of water from the environment.
 Do not allow dehydration / removal of water from the fat. 1
- (c) They (antioxidants) react with free radicals 1
 And they are used up in the reaction / do not remain behind after reaction 1
 Lose one mark for any reference to 'catalysts can't slow down a reaction'. 1
- (d) Mol of fat = $(2.78 / 806 =) 3.45 \times 10^{-3}$ 1
 Mol of NaOH = $3.68 \times 10^{-3} = \text{mol of fatty acid}$ 1
- Mol of NaOH = 3.68×10^{-3} 1
 Mol of fat hydrolysed = 1.23×10^{-3} 1
- Mol of fat hydrolysed = $(3.68 \times 10^{-3} / 3 =) 1.23 \times 10^{-3}$ 1
 Mass of fat hydrolysed = 0.987 g 1
- Percentage hydrolysed = 35.5 – 35.7 1
 Percentage hydrolysed = 35.5 – 35.7
 Do not penalise precision at any point.
 Since there are a variety of approaches to this calculation, award four marks for a correct answer but it must be clear that there is some relevant working.
 The answer alone gets M4 only.
 Any incorrect use of the 3:1 ratio is CE – lose M3 and M4. 1
- [9]



8. (a) (i) $\text{CH}_3\text{CH}=\text{CHCH}_3$ 1
 Addition or radical (**QoL**) 1
- (ii) $\text{CH}_3\text{CH}(\text{OH})\text{CH}(\text{OH})\text{CH}_3$ or with no brackets 1
 butan(e)-2,3-diol or 2,3-butan(e)diol 1
- $$\begin{array}{c} \text{H} \quad \text{H} \\ | \quad | \\ \text{HOOC}-\text{C}-\text{C}-\text{COOH} \\ | \quad | \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$$

allow

$$\begin{array}{c} \text{H} \quad \text{H} \\ | \quad | \\ \text{ClOC}-\text{C}-\text{C}-\text{COCl} \\ | \quad | \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$$
- 2,3-dimethylbutan(e)dioic acid
2,3-dimethylbutan(e)diol
1
- chloride
ignore -1,4-
1
- condensation (**QoL**) 1
- (iii) NaOH or HCl etc or Na_2CO_3 1
Allow conc sulphuric/nitric
NOT water nor acidified water nor weak acids 1
- (b) Structure 1 1
- $$\begin{array}{c} \text{CH}_3 \quad \quad \quad \text{CH}_2\text{OH} \\ | \quad \quad \quad | \\ \text{H}_2\text{N}-\text{C}-\text{C}-\text{N}-\text{C}-\text{COOH} \\ | \quad || \quad | \quad | \\ \text{H} \quad \text{O} \quad \text{H} \quad \text{H} \end{array}$$
- Allow -CONH- and -COHN-, Allow zwitterions*
NOT polypeptides/repeating units 1
- Structure 2 either of
- $$\begin{array}{c} \text{CH}_2\text{OH} \quad \quad \quad \text{CH}_3 \\ | \quad \quad \quad | \\ \text{H}_2\text{N}-\text{C}-\text{C}-\text{N}-\text{C}-\text{COOH} \\ | \quad || \quad | \quad | \\ \text{H} \quad \text{O} \quad \text{H} \quad \text{H} \end{array}$$

or

$$\begin{array}{c} \text{CH}_3 \quad \quad \quad \text{CH}_2\text{OH} \\ | \quad \quad \quad | \\ \text{HOOC}-\text{C}-\text{N}-\text{C}-\text{NH}_2 \\ | \quad | \quad || \quad | \\ \text{H} \quad \text{H} \quad \text{O} \quad \text{H} \end{array}$$
- 1
- (c) (i) $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$ 1
allow -Cl, -I 1
- (ii) $\text{CH}_3\text{CH}_2\text{CN}$ 1
- (iii) (nucleophilic) substitution or from $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$ 1
if reduction written here, no further marks
 further substitution/reaction occurs or other products are formed 1
Allow reduction forms only one product 1



one of
(CH₃CH₂CH₂)₂NH
(CH₃CH₂CH₂)₃N
(CH₃CH₂CH₂)₄N⁺ Br⁻
Allow salts including NH₄Br
Allow HBr

1

[15]

9. (a) Side-arm flask / side-arm test tube
Do not allow sealed side-arm flask.

1

Flat-bottomed filter funnel with filter paper clearly shown
Either Buchner or Hirsch versions are suitable.
Allow Hirsch funnel and horizontal filter paper.
Allow three-dimensional filter funnels.
Do not allow standard Y-shaped funnel.
Do not allow sealed funnel.
If it is not clearly air-tight between the funnel
and the flask, maximum 1 mark.

1

- (b) Heat melting point tube in an oil bath
Accept 'melting point apparatus' or Thiele tube.
Do not accept water bath.

1

slowly near the melting point
Ignore any additional correct details.
Apply list principle for additional incorrect
details.

1

[4]