

A-LEVEL PAPER 2 PP7 MS

1. Pipette = $0.05 \times 100 / 25.0 = 0.2\%$
Ignore precision

1

Burette = $0.15 \times 100 / 24.25 \text{ cm}^3$

Must show working

Allow one mark for two correct answers with no working

1

[2]

2. (a) The enthalpy (change) to break 1 mol of H—O / bonds
Allow heat energy

1

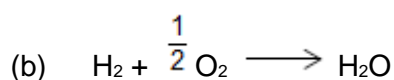
Averaged over a range of compounds / molecules

Penalise energy but mark on

ignore states

CE = 0 for ionic bonds

1



$\Delta H = (\text{H-H}) + \frac{1}{2} (\text{O=O}) - 2(\text{H-O})$ / sum of (bonds broken) – sum of (bonds formed)

$= 436 + 496 / 2 - 2 \times 464$

1

$= -244 \text{ (kJ mol}^{-1}\text{)}$

1

Allow 1 mark only for +244 and -488

Units not essential but penalise incorrect units

1

(c) (i) same reaction / same equation / same number / same reactants and same products / same number and type of bonds broken and formed
Do not allow similar

1

(ii) There must be a slight difference between the actual bond enthalpy (in water) and mean bond enthalpies for the O–H bond (in other molecules)
Allow bond enthalpy value for enthalpy of formation may not be under standard conditions.

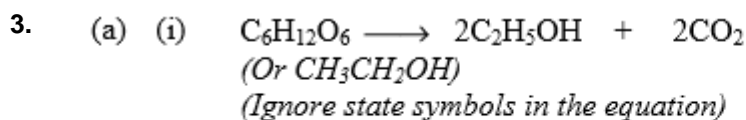
Allow reference to bond energy rather than bond enthalpy

Do not allow heat loss or experimental error

Do not allow mean bond enthalpies are not accurate

1

[7]



1

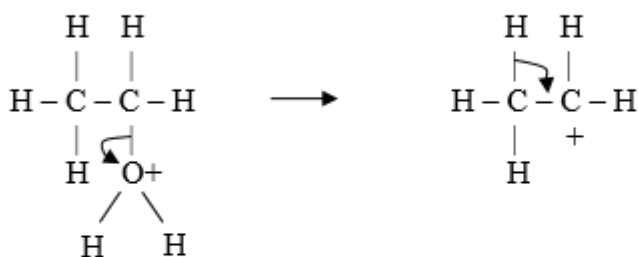
(ii) Fermentation

1

- (b) (i) $C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$ 1
(Or C_2H_6O or CH_3CH_2OH)
- (ii) CO or carbon monoxide or C or carbon ONLY 1
- (iii) $2CO + 2NO \longrightarrow 2CO_2 + N_2$ 1
 OR $2NO \longrightarrow N_2 + O_2$
 OR $2NO + C \longrightarrow N_2 + CO_2$
 OR $C_8H_{18} + 25NO \longrightarrow 8CO_2 + 12\frac{1}{2}N_2 + 9H_2O$
(In equation 2, allow additional O_2 on both sides of the equation)

- (c) Elimination 1
(Penalise additional words such as "electrophilic")

M1 structure of protonated alcohol *(allow $CH_3CH_2OH_2^+$)* 1



M2 arrow to show breakage of C - O bond on protonated alcohol 1

M3 structure of carbocation *(allow $CH_3\overset{+}{C}H_2$)* 1

M4 arrow from correct C - H bond on carbocation 1

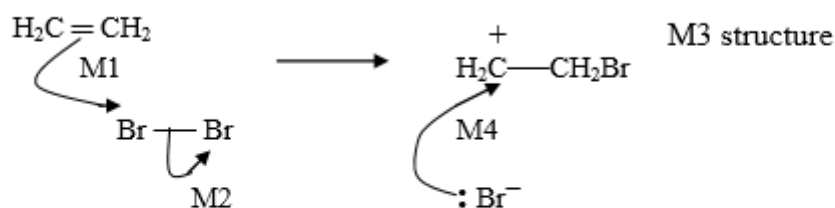
(penalise 'sticks' once only for structures M1 and M3)

(synchronous mechanism using correct structure required for M1, loses M3)

[10]

4. (a) (i) Fermentation (1)
(Credit correct phonetic spelling)
- (ii) M1 $C_6H_{12}O_6 \longrightarrow 2CH_3CH_2OH + 2CO_2$ (1)
 OR $C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$
(Penalise C_2H_6O)
- M2 Any temperature, OR range, in the range $30^\circ C$ to $42^\circ C$ (1)
 OR $303K$ to $315K$
(Assume the units are correct if not specified, but penalise incorrect units)
- (b) elimination (1)
(Penalise "dehydration" on its own, but not in addition to correct answer)
(Penalise any words in front of the word "elimination" except credit "acid-catalysed elimination" OR "acid elimination")

(c)



(4)

(Penalise M3 if HBr or wrong alkene is used)

(Penalise M2 if polarity on Br-Br is incorrect or formal charges used)

(Penalise M1 if partial charges are placed on the double bond)

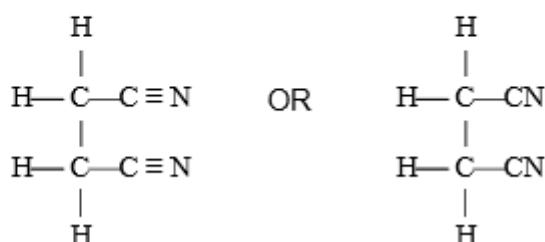
(d)

(i) Nucleophilic substitution

(1)

(Insist on both words and credit correct phonetic spelling)

(ii)



(1)

[10]

5. (a) the plotting of the graph
plots $\log(1/\text{time})$ on the y axis, $\log(\text{volume of KI})$ on the x axis
sensible scale for y axis
sensible scale for x axis
labels the axes

4 scoring points
any 3 = 1 mark

plots the points correctly
line through the points is smooth

both = 1 mark

line through the points plotted is best fit

1 mark

Notes * if graph does not cover half of the paper deduct 1 mark;
do not penalise again under nomenclature

* if the graph plot goes off the squared paper deduct 1 mark;
do not penalise again under nomenclature

* if uses an ascending y axis of negative numbers deduct 1 mark;
do not penalise again under nomenclature

* if plots a non-linear/broken scale deduct 1 mark;
mark part 2 consequentially but loses the nomenclature mark

* three points scored across the sections gives at least 1 mark

* if axes unlabelled use data to decide that $\log(1/\text{time})$ is on y axis

* allow mark for axes labelled " $(1/\text{time})$ " and "volume of KI"

(b) correct use of the graph to determine gradient

appropriate x and y readings on graph or clearly in part 2

1 mark

correctly calculates gradient

0.90 ± 0.02

1 mark

shows working

1 mark

Notes * consequential marking from candidate's data, to a maximum of 2;

* if gradient calculation upside down maximum of 2;

* for second mark must quote gradient to 1 dp or 2 dp

* ignore if candidate proceeds to state order or includes a negative sign


- (c) correct estimation of errors
 estimates error in using measuring cylinder (0.5 in 10 = 5%) 3 scoring points
 estimates error in using clock (1 in 36 = 2.8%) any 2 = 1 mark
 calculates the overall apparatus error (7.8% on above values)
 Notes * ignore precision of answers
 * consequential marking for overall error
 * penalise doubled errors once
 * lose mark if answers wrong because (x 100) missing from calculations;
 don't penalise again in awarding the nomenclature mark
 * lose mark if don't use values from Experiment 3; don't penalise again
 in awarding the nomenclature mark
- the correct use of nomenclature and terminology
 clear graph with sharp trace 4 scoring points
 graph has correct profile- appreciates need to plot negative numbers all 4 = 1 mark
 explains the calculation of the gradient clearly and logically
 explains the calculation of the errors clearly
 Notes * ignore units
 * if part 2 or part 3 is blank then loses nomenclature mark
- (d) profile is good straight line/ results good quality/order close to 1/ 1 mark
 can deduce order with confidence
 Notes * must make a clear written comment
 * mark consequentially to candidate's graph
- anomalous result in Expt 5 or 20 cm³ 1 mark
 Notes * mark consequentially to candidate's graph
 * clear written comment or clearly indicated on the graph; allow ring drawn
 around Expt 5 point if it is the only point on the graph which is ringed
 * if candidate includes Expt 5 point in best fit line, loses this mark if
 claims Expt 5 is an anomaly
 * if candidate includes Expt 5 point in best fit line, and states no anomalies
 allow this mark
 * if candidate includes Expt 5 point in best fit line, and correctly identifies
 another point as anomalous allow this mark
- (e) thermostat the mixture or constant temperature 1 mark
 rate affected by temperature change 1 mark
- use burette/ pipette/ larger volume OR use more accurate clock 1 mark
 more accurate volume more accurate timings 1 mark
- spectroscopy to monitor colour change 1 mark
 eliminates human error 1 mark
- Maximum 4 marks
- Notes * Do not penalise additional answers unless they contradict

[14]

6. (a) Sensible scales
Plotted points (including 0,0) must cover more than half the graph paper.
If axis wrong way round lose this mark but mark on consequentially.
Do not allow broken axis. 1
- Plots points correctly 1
- (b) Ring around the origin 1
- (c) Line through points is smooth
Line must pass within ± 1 small square of each plotted point except the anomaly (allow one plot ± 2 small square – at 40 or 60s). 1
- Line through points is best fit and ignores anomaly (allow one plot ± 2 small square)
Lose this mark if student's line is doubled.
Kinked line loses this mark.
Lose this mark if the line does not pass through the origin $+/- 1$ small square.
Lose this mark if the line deviates to anomaly. 1
- (d) Draws suitable tangent 1
Must touch the curve at 30s and must not cross the curve.
Lose this mark if the tangent is unsuitable but mark on. 1
- Chooses appropriate x and y values from their graph
Mark consequentially if axes plotted the wrong way around.
Allow information clearly shown on graph. 1
- Correctly calculates y / x
Difference in x values and y values must be at least 10 small squares in either direction. 1
- Gives answer with correct units ($\text{mol dm}^{-3} \text{s}^{-1}$) or correct variant
Lose this mark if answer not to minimum of 2 significant figures and no units or incorrect units are given.
If student has used axis the wrong way round, the unit mark can be awarded for either the correct unit based on their graph or for the correct unit for rate. 1

[9]

all answers to 3 sfs penalise fewer once

- (a) (i) Expt 2 2.68×10^{-4} 1
Expt 3 $10.7(2) \times 10^{-4}$ 1
Expt 4 2.08×10^{-3} 1
- (ii)
- $$k = \frac{\text{rate}}{[X]^2} \text{ or } \frac{2.68 \times 10^{-4}}{(1.20 \times 10^{-3})^2} \quad 1$$
- $$= 186 \quad 1$$
- $\text{mol}^1 \text{dm}^3 \text{s}^{-1}$ 1
- (b) increases (exponentially) allow straight line but not  1

[7]

8. (a) (i) M_r N-phenylethanamide = 135.0 1
Theoretical yield = $135.0 \times 2 (1.15 / 284.1) = 1.09 \text{ g}$ 1
Answer recorded to 3 significant figures. 1
- (ii) $\frac{0.89}{\text{Ans to (a)}} \times 100$
= 81.4 %
Mark consequentially to (a)
Allow 81 to 82 1

- (b) (i) Dissolve the product in the **minimum** volume of water / solvent (in a boiling tube / beaker)
If dissolving is not mentioned, CE = 0 / 4 1
- Hot water / solvent 1
Steps must be in a logical order to score all 4 marks 1
- Allow the solution to cool and allow crystals to form. 1
- Filter off the pure product under reduced pressure / using a Buchner funnel and side arm flask 1
Ignore source of vacuum for filtration (electric pump, water pump, etc.) 1
- (ii) Measure the melting point 1
 Use of melting point apparatus or oil bath 1
 Sharp melting point / melting point matches data source value 1
- (iii) Any **two** from:
 Product left in the beaker or glassware
 Sample was still wet
 Sample lost during recrystallisation.
Do not allow "sample lost" without clarification. 2 Max
- (c) An identified hazard of ethanoyl chloride 1
E.g. "Violent reaction", "harmful", "reacts violently with water"
Do not allow "toxic", "irritant" (unless linked with HCl gas). 1
- HCl gas / fumes released / HCl not released when ethanoic anhydride used 1

[15]

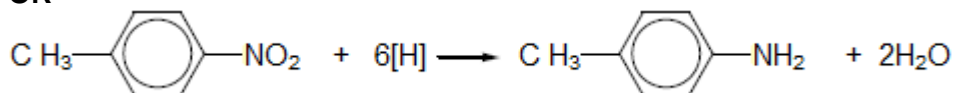
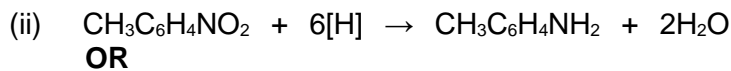
9. Test silver nitrate (solution) **(M1)** 1
Allow an alternative soluble silver salt eg fluoride, sulfate.
Do not allow 'silver ions' but can access second mark.
Incorrect formula loses this mark but can access second mark.
*Do not allow 'silver' or an insoluble silver salt and **cannot** access second mark.*
Ignore references to acidification of the silver nitrate.
If an acid is specified it should be nitric acid, but allow sulfuric acid in this case as there are no metal ions present.
If hydrochloric acid is used, CE = 0 / 2.
Do not allow 'add water'.
- Observation white precipitate **(M2)** 1
Ignore 'cloudy'.
Do not allow 'white fumes' or 'effervescence'.
Do not allow this mark if test reagent is incorrect or missing.
*Allow named indicator paper or named indicator solution for **M1**.*
*Allow correct colour change for **M2**.* 1

[2]

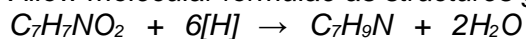
10. (a) Electrophilic substitution 1
Both words needed
Ignore minor misspellings

- (b) (i) Sn / HCl
OR H₂ / Ni **OR** H₂ / Pt **OR** Fe / HCl **OR** Zn / HCl **OR** SnCl₂ / HCl
 Ignore conc or dil with HCl,
 Allow (dil) H₂SO₄ but not conc H₂SO₄
 Not allow HNO₃ or H⁺
 Ignore NaOH after Sn / HCl
 Ignore catalyst

1



Allow molecular formulae as structures given



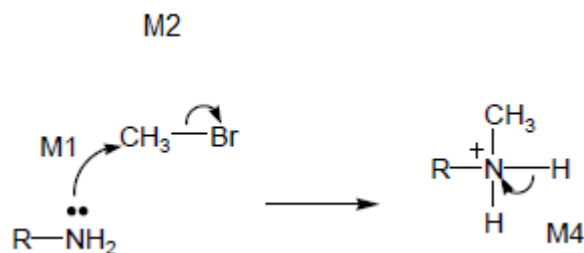
Qu states use [H], so penalised 3H₂

1

- (iii) making dyes
OR making quaternary ammonium salts
OR making (cationic) surfactants
OR making hair conditioner
OR making fabric softener
OR making detergents

1

(c)



M3

NO Mark for name of mechanism

Allow SN1

M1 for lone pair on N and arrow to C or mid point of space between N and C

M2 for arrow from bond to Br

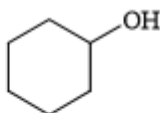
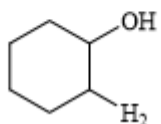
M3 for structure of protonated secondary amine

M4 for arrow from bond to N or + on N

For M4: ignore RNH₂ or NH₃ removing H⁺ but penalise Br⁻

4

(d)	<u>lone or electron pair on N</u>		
	<i>If no mention of lone pair CE = 0</i>		
	<i>If lone pair mentioned but not on N then lose M1 and mark on</i>	M1	1
	in J spread / delocalised into ring (or not delocalised in K)		
	<i>Ignore negative inductive effect of benzene</i>		
	<i>Allow interacts with π cloud for M2</i>	M2	1
	less available (for protonation or donation in J)	M3	
	OR		
	in K there is a positive inductive effect / electron releasing)	M2	
	more available (for protonation or donation in K)	M3	1
			[11]
11.	(a)		
	(i)	$3(-120) - (-208) = -152$	
		OR	
		$3(120) - 208 = 152 \text{ (kJ mol}^{-1}\text{)}$	
		<i>Must show <u>working</u> and answer and maths must be correct, but ignore sign</i>	1
	(ii)	Electrons <u>delocalised</u> OR <u>delocalisation</u> (QOL)	
		OR allow reference to <u>resonance</u> (QOL)	1
	(b)	x, y, w	
		<i>Must be in this order</i>	1
	(c)	(i)	-240 (kJ mol ⁻¹)
			<i>Must have minus sign</i>
		(ii)	between -239 and -121 (kJ mol ⁻¹)
			<i>Must have minus sign</i>
		(iii)	Must specify which diene:
			Proximity – for 1,3 C=C bonds are close together
			<i>allow converse for 1,4 diene</i>
			M1
			1
			Delocalisation – for 1,3 some delocalisation
			OR
			some overlap of electrons, π clouds or p orbitals
			<i>allow converse for 1,4 diene</i>
			M2
			1
			some extra stability for the 1,3- isomer
			M3
			1
			[8]

12.	(a)	(i)	O-H alcohols ; C-H;	1 1	Not O-H alone and not O-H acids
		(ii)	(Unreacted) alcohol or C or any alcohol or water or moisture;	1	
(b)	(i)	Three CH ₃ groups;		1	Allow C(CH ₃) ₃
	(ii)	CH next to CH ₃ OR CH ₃ CH OR (splitting) linked to adjacent/coupling;		1	i.e. Structure fragment with or without R or OH mention of ROCH ₃ or OH linked to δ loses mark. $\begin{array}{c} \text{H} \\ \\ (\text{R})-\text{C}-\text{CH}_3 \\ \\ (\text{OH}) \end{array}$
	(iii)	$\begin{array}{c} \text{CH}_3 \quad \text{H} \\ \quad \\ \text{H}_3\text{C}-\text{C}-\text{C}-\text{CH}_3 \\ \quad \\ \text{CH}_3 \quad \text{OH} \end{array} ;$		2	Apply list principle if more than one answer given here and below penalise bond drawn as -HO one mark (once per paper)
(c)	(i)	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3\text{CH}_2-\text{C}-\text{CH}_2\text{CH}_3 \\ \\ \text{OH} \end{array} \quad \text{or} \quad \begin{array}{c} \text{CH}_3 \\ \\ (\text{CH}_3)_2\text{CH}-\text{C}-\text{CH}_3 \\ \\ \text{OH} \end{array} ;$		1	Allow C ₂ H ₅ but NOT C ₃ H ₇ .
	(ii)	$\begin{array}{c} \text{CH}_3 \quad \text{H} \\ \quad \\ \text{H}_3\text{C}-\text{C}-\text{C}-\text{CH}_2\text{CH}_3 \\ \quad \\ \text{H} \quad \text{OH} \end{array}$ OR $\begin{array}{c} \text{CH}_3 \quad \text{H} \\ \quad \\ \text{H}_3\text{C}-\text{C}-\text{C}-\text{CH}_2\text{OH} \\ \quad \\ \text{H} \quad \text{CH}_3 \end{array}$ OR $\begin{array}{c} \text{OH} \\ \\ \text{H}_3\text{C}-\text{C}-\text{CH}_2-\text{CH}(\text{CH}_3)_2 \\ \\ \text{H} \end{array} ;$		1	
(d)				1	Allow methylcyclopentanols and other alkyl cyclic alcohols. Penalise 

[10]