

M1. (a) **M1** Benzene is more stable than cyclohexatriene
more stable than cyclohexatriene must be stated or implied
If benzene more stable than cyclohexene, then penalise M1
but mark on
If benzene less stable: can score M2 only 1

M2 Expected ΔH° hydrogenation of C_6H_6 is $3(-120)$
 $= -360 \text{ kJ mol}^{-1}$
Allow in words e.g. expected ΔH° hydrog is three times the
 ΔH° hydrog of cyclohexene 1

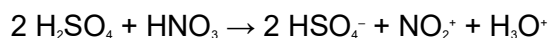
M3 Actual ΔH° hydrogenation of benzene is
 152 kJ mol^{-1} (less exothermic)
or 152 kJ mol^{-1} different from expected
Ignore energy needed 1

M4 Because of delocalisation or electrons spread out or resonance 1

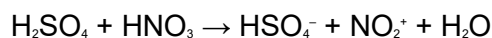
(b) **No mark for name of mechanism**

Conc HNO_3
If either or both conc missing, allow one; 1

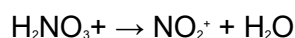
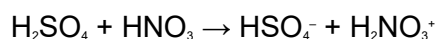
Conc H_2SO_4
this one mark can be gained in equation 1



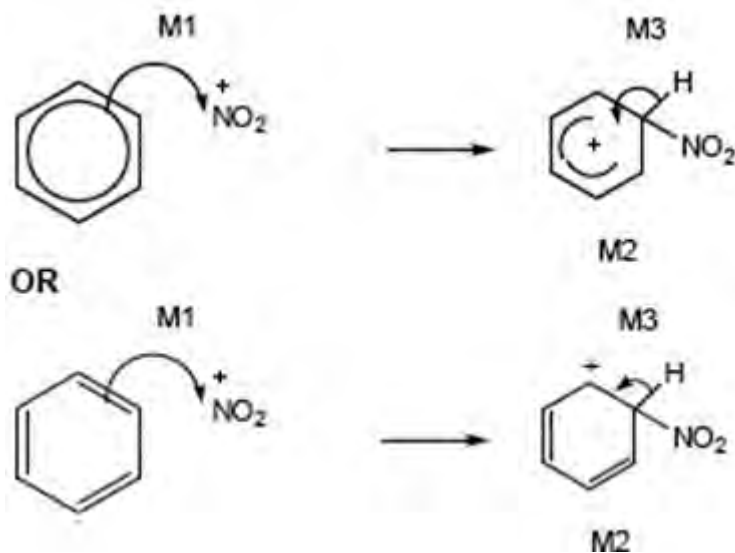
OR



OR via two equations



Allow + anywhere on NO_2^+



M1 arrow from within hexagon to N or + on N

Allow NO₂⁺ in mechanism

horseshoe must not extend beyond C2 to C6 but can be smaller

+ not too close to C1

M3 arrow into hexagon unless Kekule

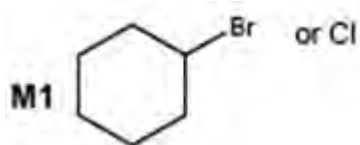
allow M3 arrow independent of M2 structure

ignore base removing H in M3

+ on H in intermediate loses M2 not M3

3

(c) **If intermediate compound V is wrong or not shown, max 4 for 8(c)**



or chlorocyclohexane or bromocyclohexane

1

Reaction 3

M2 HBr

1

M3 Electrophilic addition

Allow M2 and M3 independent of each other

1

Reaction 4

M4 Ammonia if wrong do not gain M5

1

Allow M4 and M6 independent of each other

M5 Excess ammonia or sealed in a tube or under pressure

1

If CE e.g. acid conditions, lose M4 and M5

M6 Nucleophilic substitution

1

(d) Lone or electron pair on N

No marks if reference to "lone pair on N" missing

1

Delocalised or spread into ring in U

1

Less available (to accept protons) or less able to donate (to H⁺)

1

[19]

M2. (a) (i) **W** 3

1

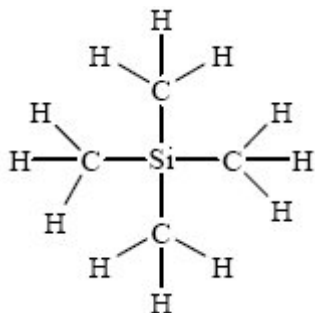
X 4

1

Y 2

1

(ii)



displayed formula shows ALL bonds

1

(b) (i) NO_2^+

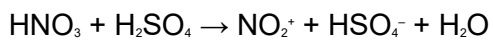
allow + anywhere
can score in equation

1



1

OR

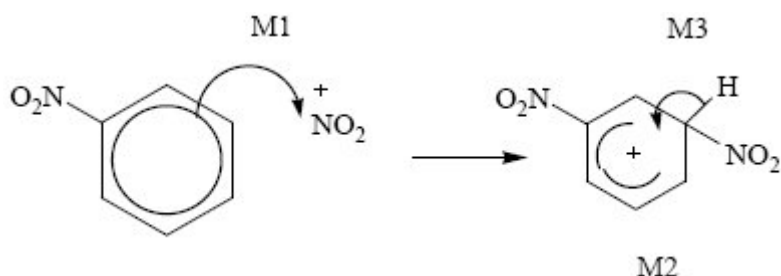


or use two equations via H_2NO_3^+

(ii) electrophilic substitution

Not Friedel Crafts

1



Allow Kekule structures

+ must be on N of $\cdot\text{NO}_2$ (which must be correct)

both NO_2 must be correctly positioned and bonded to gain M2

M1 arrow from circle or within it to N or to + on N
horseshoe must not extend beyond C2 to C6 but can be smaller

+ not too close to C1

M3 arrow into hexagon unless Kekule

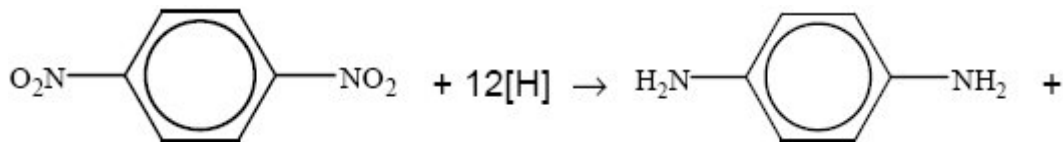
allow M3 arrow independent of M2 structure

ignore base removing H in M3

3

- (c) (i) H_2/Ni or H_2/Pt or Sn/HCl or Fe/HCl (conc or dil or neither)
allow dil H_2SO_4
ignore mention of $NaOH$

Not $NaBH_4$
Not $LiAlH_4$
Not Na/C_2H_5OH
not conc H_2SO_4 or any HNO_3

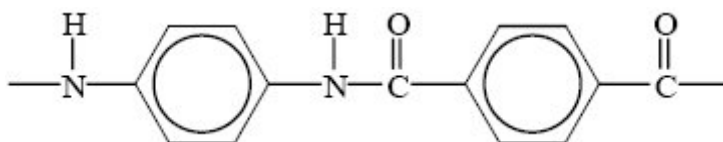


$4H_2O$
Or $6H_2$

allow $C_6H_4(NO_2)_2$ etc ,
allow NO_2-NH_2-
i.e. be lenient on structures, the mark is for balancing equ

1

(ii)



allow $-CONH$
ignore $[]_n$ as in polymer

1st mark for correct peptide link
2nd mark for the rest correct including trailing bonds

2

- (iii) **M1** Kevlar is biodegradeable but polyalkenes not
allow Kevlar is more biodegradeable
- 1

M2 Kevlar has polar bonds/is a (poly) amide/has peptide link
comment on structure of Kevlar

1

M3 can be hydrolysed/attacked by nucleophiles/acids/
bases/enzymes

1

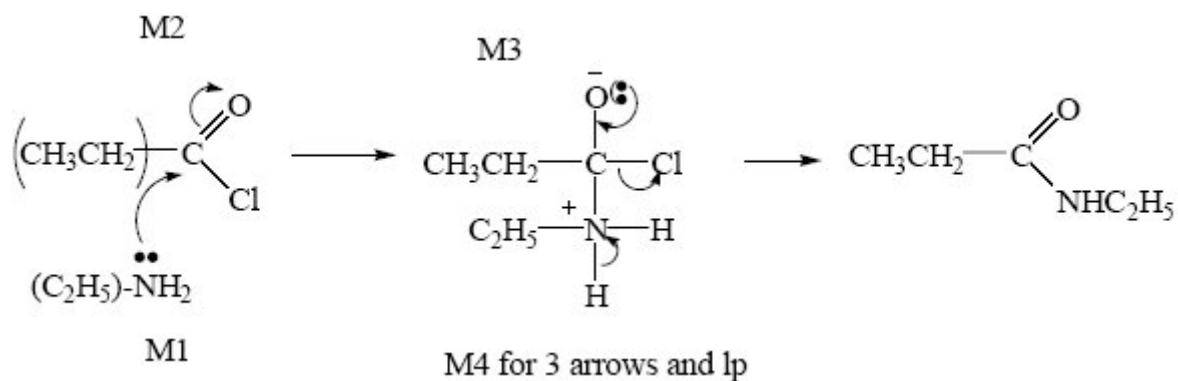
M4 polyalkenes non polar/has non-polar bonds
comment on structure of polyalkenes but not just strong bonds

1

M3.	H	CH ₃ CN or ethanenitrile	1
	S	CH ₃ CH ₂ NH ₂ or ethylamine	1
		1Step 1 KCN	1
		aq/alcoholic	1
	Step 2	H ₂	1
		Ni	1
	W	secondary amine	1
		$\left[\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3\text{CH}_2 - \text{N} - \text{CH}_3 \\ \\ \text{CH}_3 \end{array} \right]^+ \quad (\text{Br}^-)$	1
		nucleophilic substitution	1

[9]

M4.	(a)	(nucleophilic) addition-elimination	1
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4

N-ethylpropanamide

minus on NH₂ loses M1
M2 not allowed independent of M1, but allow M1 for correct attack on C+
+C=O loses M2
only allow M4 after correct or very close M3
lose M4 for Cl⁻ removing H⁺ in mechanism, but ignore HCl as a product
Not N-ethylpropaneamide

1

(b) CH₃CN or ethan(e)nitrile or ethanonitrile

not ethanitrile
but allow correct formula with ethanitrile

1

for each step wrong or no reagent loses condition mark
contradiction loses mark

1

Step 1 Cl₂
 uv or above 300 °C
wrong or no reagent loses condition mark

1

Step 2 KCN

1

aq and alcoholic (both needed)
allow uv light/(sun)light/uv radiation

1

Step 3 H₂/Ni or LiAlH₄ or Na/C₂H₅OH
not CN⁻ but mark on
NOT HCN or KCN + acid, and this loses condition mark
NOT NaBH₄
Sn/HCl (forms aldehyde!)
ignore conditions

