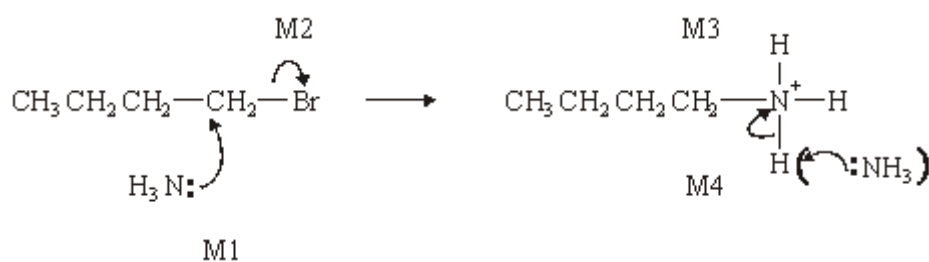


M1. (a) Nucleophilic substitution

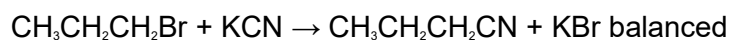


1

M1, M2 and M4 for arrows, M3 for structure of cation  
 (Allow M2 alone first, i.e. SN1 formation of carbocation)  
 (Penalise M4 if Br used to remove H<sup>+</sup>)

4

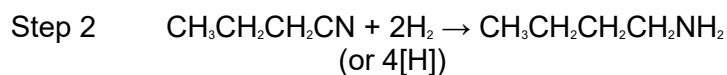
(b) Step 1  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CN}$  1



1

(or  $\text{CN}^-$ ) (or  $\text{Br}^-$ )  
 (not HCN)

1



1

(c) (i) Lone pair (on N) (in correct context)

1

R group increases electron density / donates electrons / pushes electrons / has positive inductive effect

1

(ii) Any strong acid (but not concentrated)  
 or any amine salt or ammonium salt of a strong acid

1

(d)  $\text{CH}_3\text{CH}_2\text{N}(\text{CH}_3)_2$

1

[12]

**M2.** (a) Cyclohexane evolves  $120 \text{ kJ mol}^{-1}$

∴ (expect triene to evolve)  $360 \text{ kJ mol}^{-1}$  (1) or  $3 \times 120$

$360 - 208 = 152 \text{ kJ}$  (1) NOT 150

*152 can score first 2*

*QofL: benzene lower in energy / more (stated) stable (1)*

*Not award if mentions energy required for bond breaking*

*due to delocalisation (1) or explained*

4

(b) (i) phenylamine weaker (1)

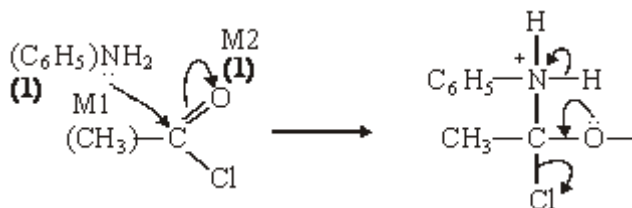
*if wrong no marks*

lone pair on N (less available) (1)

delocalised into ring (1) or "explained"

3

(ii) addition – elimination (1)



*structure (1) M3*

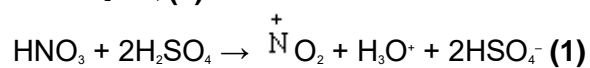
*3 arrows (1) M4*

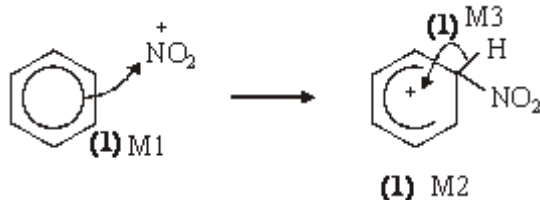
N-phenyl ethanamide (1)

6

(iii) conc  $\text{HNO}_3$  (1)

conc  $\text{H}_2\text{SO}_4$  (1)





6

(iv) peptide / amide (1)

NaOH (aq) (1)

*HCl conc or dil or neither*


*H<sub>2</sub>SO<sub>4</sub> dil NOT conc*

*NOT just H<sub>2</sub>O*

2

### Notes

- (a)
- 360 or 3 × 120 or in words (1);
  - 152 NOT 150 (1); (152 can get first two marks)
  - **Q of L** benzene more stable but not award if ΔH values used to say that more energy is required by benzene for hydrogenation compared with the triene or if benzene is only compared with cyclohexene (1);
  - delocalisation or explained (1)

- (b) (ii) or N-phenylacetamide or acetanilide  
 mechanism: if shown as substitution can only gain M1  
 if CH<sub>3</sub>CO<sup>+</sup> formed can only gain M1  
 lose M4 if Cl<sup>-</sup> removes H<sup>+</sup>  
 be lenient with structures for M1 and M2 but must be correct for M3  
 alone loses M2

- (iii) **No marks for name of mechanism in this part**  
 if conc missing can score one for both acids (or in equation)  
 allow two equations

allow  $\text{HNO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{NO}_2^+ + \text{HSO}_4^- + \text{H}_2\text{O}$

ignore side chain in mechanism even if wrong

arrow for M1 must come from inside hexagon

arrow to NO<sub>2</sub><sup>+</sup> must go to N but be lenient over position of +

+ must not be too near "tetrahedral" Carbon

horseshoe from carbons 2-6 but don't be too harsh

- (iv) reagent allow NaOH  
HCl conc or dil or neither  
H<sub>2</sub>SO<sub>4</sub> dil or neither but not conc  
not just H<sub>2</sub>O

[21]

M3.B

[1]

- M4. (a) (i) H<sup>+</sup> or proton acceptor (1)  
CH<sub>3</sub>NH<sub>2</sub> + H<sub>2</sub>O (⇌) CH<sub>3</sub><sup>+</sup>NH<sub>3</sub> (+) OH<sup>-</sup> (1)

- (ii) CH<sub>3</sub>NH<sub>3</sub>Cl or HCl (1)  
*Or any ammonium compound or strong acid  
name or formula*

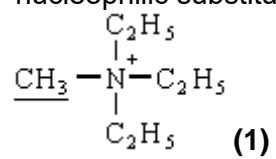
- (iii) extra OH<sup>-</sup> reacts with CH<sub>3</sub><sup>+</sup>NH<sub>3</sub>  
or reaction / equilibrium moves to left  
or ratio salt / base remains almost constant (1)  
*Any 2*

5

- (b) lone pair (on N accepts H<sup>+</sup>) (1)  
CH<sub>3</sub> increases electron density (on N)  
donates / pushes electrons  
has positive inductive effect (1)

2

(c) nucleophilic substitution (1)



2

[9]