# A-Level Chemistry

## Amines

## Mark Scheme

**Time available: 58 minutes**
**Marks available: 53 marks**

**1.**

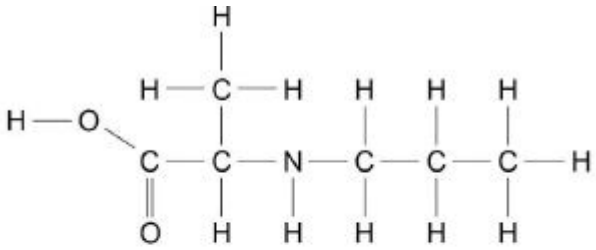
(a) One circled C atom only – The C attached to $CH_3$/C=O/ H and NH

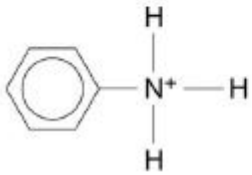
**1**

(b) Two ticks only for amine and amide

**1**

(c)

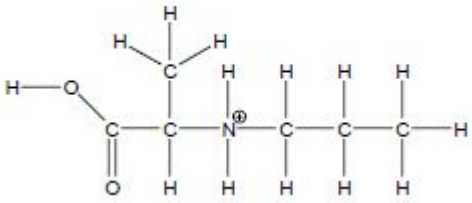




***M1*** *for choosing the correct bond to hydrolyse*

***M2*** *and* ***M3*** *for the correct structures of the products*

*Allow protonated amino acid for M2*



*Allow* $C_6H_5NH_3^+$ *or + outside a square bracket*

**3**

(d) **M1** Enzyme has an <u>active site</u>

**1**

**M2**

The G-Enantiomer / Enzyme has the correct stereo chemistry / stereospecific

Or

The G-Enantiomer / Enzyme has the complementary shape

*For M2 allow opposite argument for F-Enantiomer*

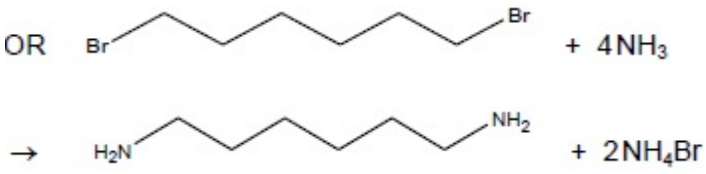
**1**

**[7]**

**2.**

(a) $Br\text{-}(CH_2)_6\text{–}Br + 4\ NH_3 \rightarrow H_2N\text{-}(CH_2)_6\text{–}NH_2 + 2\ NH_4Br$

OR



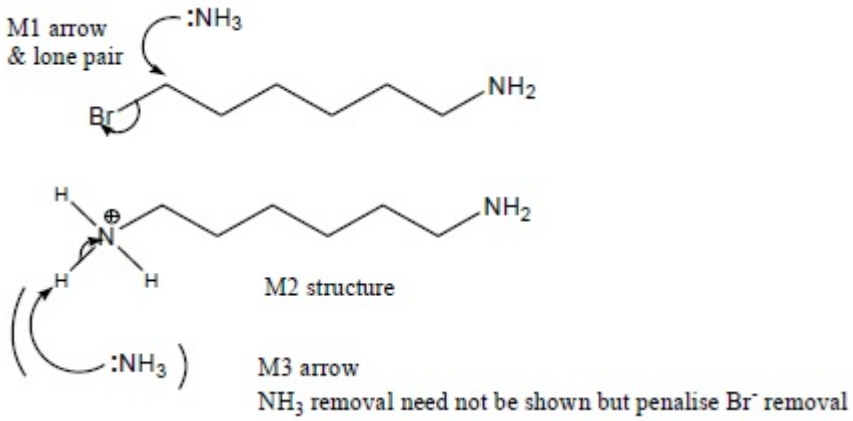

***M1*** *both organic compounds correct (not molecular formulae)*

*Allow one correct structural formula and the other correct molecular formula of type* $XC_6H_{12}X$

***M2*** *balanced*

**2**

(b)




*Or with structural formulae,* $Br(CH_2)_6NH_2$ *etc*

*Allow* $S_N1$

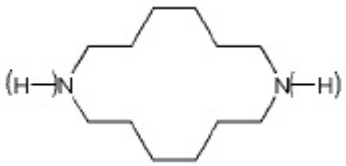
*Penalise incorrect partial charges in* ***M1***

**3**

Impurity


(or as structural formula)

*Allow*




**1**

(c) **M1** Stage 1 reagent KCN or NaCN

*Not HCN this loses **M1** and **M2***

*Any mention of acid loses **M1** & **M2***

**1**

**M2** Stage 1 condition aqueous alcohol

***M2** dependent on correct **M1** (allow condition if only $CN^-$ ions)*

**1**

**M3** Stage 2 reagent & condition $H_2$ and Ni or Pt or Pd

***M3** only accessible if a cyanide is used in stage 1*

**1**

*Allow $LiAlH_4$ (in dry ether) – acidic/aqueous = CE, but allow followed by acid.*

*NOT $NaBH_4$ NOT Sn/HCl or Fe/HCl*

*Ignore heat and reflux and pressure*

*Apply list principle to incorrect reagents/conditions*

(d) In 3-aminopentane

*Allow converse for ammonia*

Lone pair on N more available or Lone pair on N accepts $H^+$ better

*Or greater stability of protonated N*

**1**

because of alkyl electron pushing /inductive effect

*Mark independently*

**1**

(e) No carbon (atom is) attached to 4 different groups

*Allow central carbon has two alkyl groups*

*Allow symmetrical molecule*

**1**

**[12]**

**3.** (a) (Strength depends on availability of) lone pair on N (atom)

**M1**

**E** N (next to ring): (lp) delocalised into ring

**M2**

(lp) less available (to donate to or to accept a $H^+$)

**M3**

**F** or **G**: N (next to alkyl): (positive) inductive effect/electrons pushed to N

**M4**

(lp) more available (to donate to or to accept a $H^+$)

**M5**

order of increasing base strength **E**<**G**<**F**

*Or **F** is most basic **and E** is least basic*

**M6**

(b) Intermediate compounds

Product of step 1 $C_6H_5CH_1Cl$

*Allow $C_6H_5CH_2Br$*

Product of step 2 $C_6H_5CH_2CN$

***In steps 2 and 3, only allow marks for reagents/conditions if intermediate compounds are correct or close.***

**Reagents/conditions**

**Step 1**

$Cl_2$ & UV

*Allow $Br_2$ & UV*

**Step 2**

KCN alcoholic & aq (both reqd)

*Ignore temperature*

**Step 3**

$H_2$ / Ni or Pt or Pd

*Allow $LiAlH_4$ in (dry) ether – (with acid CE, followed by acid allow)*

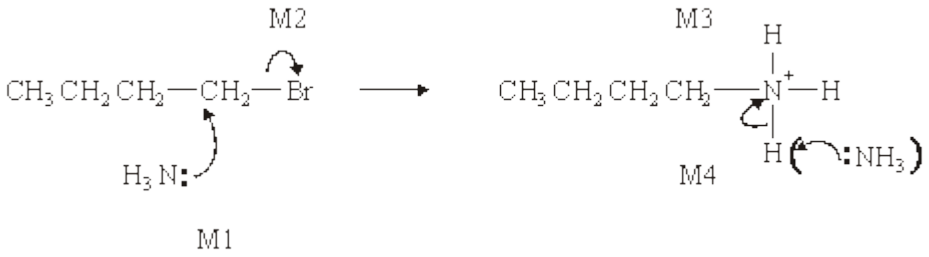
*Not $NaBH_4$ and not Sn/HCl or Fe/HCl*

**2**

**[11]**

**4.**

(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 $H^+$)*

4

(b) Step 1 $CH_3CH_2CH_2CN$ 1

$CH_3CH_2CH_2Br + KCN \rightarrow CH_3CH_2CH_2CN + KBr$ balanced

1

(or $CN^-$) (or $Br^-$)
(*not HCN*)

1

Step 2 $CH_3CH_2CH_2CN + 2H_2 \rightarrow CH_3CH_2CH_2CH_2NH_2$
(or 4[H])

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

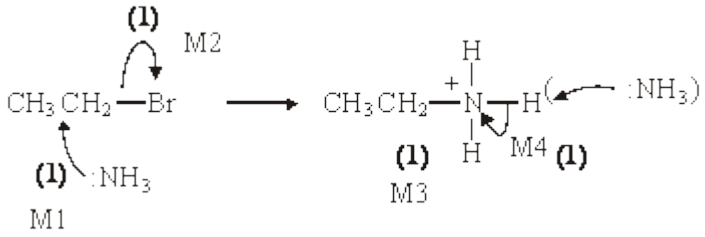
1

(d) $CH_3CH_2N(CH_3)_2$

1

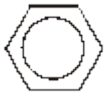
**[12]**

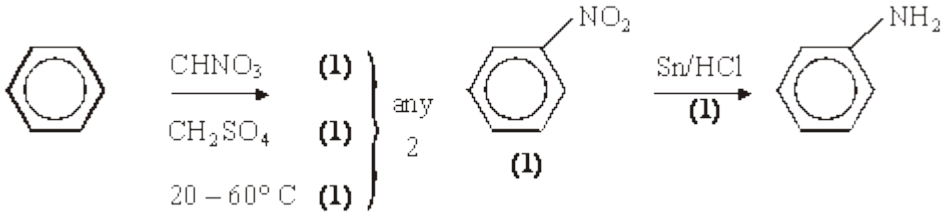
**5.** (a)




Further reaction / substitution / formation of 2° / 3° amines etc **(1)**
use an excess of $NH_3$ **(1)**

**6**

(b)  repels nucleophiles (such as $NH_3$) **(1)**




**5**

**Notes**

(a) allow $S_N1$
penalise: $Br^-$ intead of $NH_3$ removing $H^+$ for M4
not contamination with *other amines* (this is in the question) not diamines

(b) allow because $NH_3$ is a nuclephile or benzene is (only) attacked by electrophiles
or C–Br bond (in bromobenzene) is stronger / less polar or Br lp delocalized

$HNO_3$ / $H_2SO_4$ without either conc scores **(1)** allow 20 – 60° for **(1)** (any 2 ex 3)

allow name or structure of nitrobenzene

other reducing agents: Fe or Sn with HCl (conc or dil or neither)
not conc $H_2SO_4$ or conc $HNO_3$
allow $Ni/H_2$
Not $NaBH_4$ or $LiAlH_4$
ignore wrong descriptions for reduction step e.g. hydrolysis or hydration

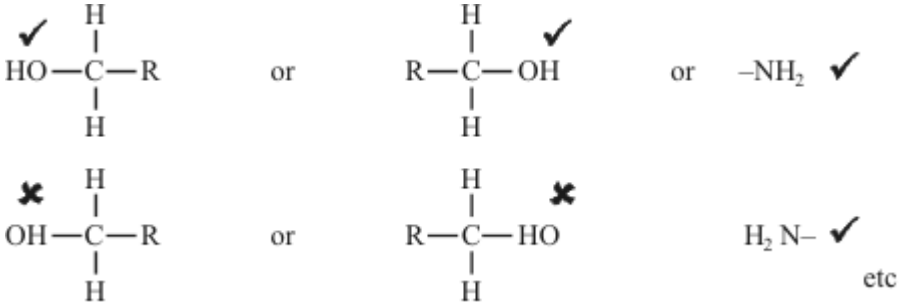
**[11]**

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 sticks (i.e.  ) once per paper




Penalise once per paper

allow $CH_3$– or –$CH_3$ or  or $H_3C$– or CH$_3$