

**H2 Chemistry Enrichment
Nitrogen Compounds**

Name: _____

Marks: _____ /20

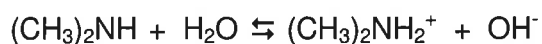
CT Group: _____

Duration: 30 min

Answer all the questions.

1. How would you expect the pK_b value of

(a) $C_2H_5NH_2$ to compare with that of $(CH_3)_2NH$ [2]



- ✓ The **basicity of alkylamines increases** with the number of **alkyl groups** attached to N.
- ✓ The electron-donating alkyl groups **inductively increases the electron density** on the N atom in RNH_2 ,
- ✓ making the **lone pair** on N **more available** to accept the H^+ .
- ✓ The equilibrium above lies more to the right hand side, K_b of $(CH_3)_2NH$ is higher, hence its pK_b will be lower.

(b) $C_2H_5NH_2$ to compare with that of $C_6H_5NH_2$ [2]

- $C_6H_5NH_2$ is a **weaker base** and hence a **larger pK_b** value.
- This is because the **lone pair** on the N atom in $C_6H_5NH_2$ is **delocalised** with the pi orbitals of the benzene ring, making it **less available** to accept H^+ .

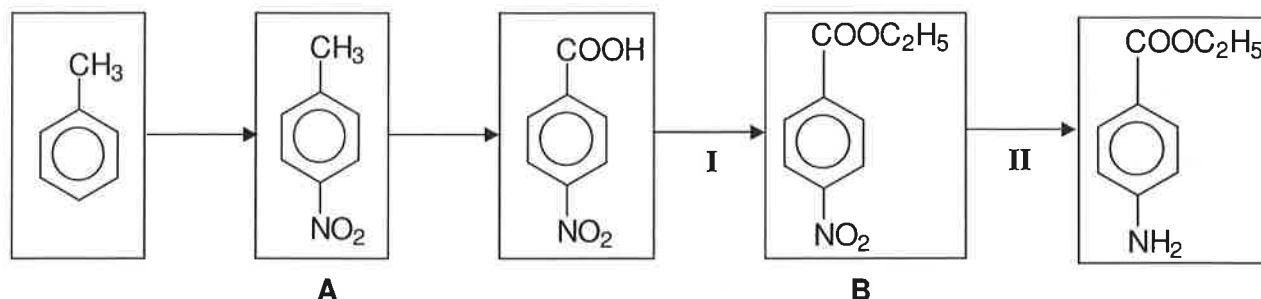
(c) 2-chloroethylamine with that of ethylamine [2]

- 2-chloroethylamine is a **weaker base** and hence a **larger pK_b** value
- ✓ since **Cl** atom is **electron-withdrawing** by the inductive effect, making
- ✓ the **lone pair** on the N atom **less available** to accept H^+ than in ethylamine.

2. Benzocaine can be made by the following reaction scheme, starting from methylbenzene.

(a) Fill the intermediate products **A** and **B** in the boxes below.

[2]



(b) State the reagents and conditions are used for each of the stages I and II.

(i) Stage I – $\text{C}_2\text{H}_5\text{OH}$, concentrated H_2SO_4 (catalyst), reflux

(ii) Stage II – Sn , concentrated HCl , reflux, then add aqueous NaOH

[2]

3. An aqueous solution of **A**, of molecular formula $\text{C}_3\text{H}_7\text{NO}_2$, is neutral to litmus. On warming **A** with $\text{NaOH}(\text{aq})$, $\text{NH}_3(\text{g})$ is evolved. **A** gives white fumes with SOCl_2 . On refluxing **A** with aqueous acidified potassium dichromate, propanedioic acid, $\text{HO}_2\text{CCH}_2\text{CO}_2\text{H}$ is obtained.

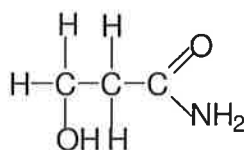
(a) State the deductions that can be made about **A** from the above observations.

[3]

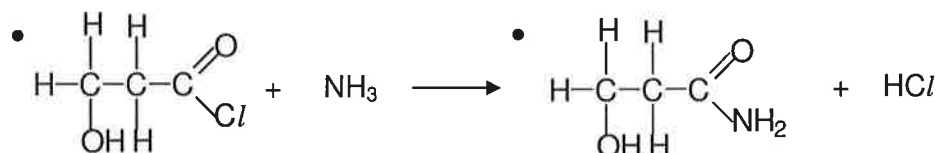
Property of A	Deduction of A
(i) Gives $\text{NH}_3(\text{g})$ with $\text{NaOH}(\text{aq})$	• $-\text{CONH}_2$ present
(ii) Gives white fumes with SOCl_2	• $-\text{OH}$ group present
(iii) Gives propanedioic acid, $\text{HO}_2\text{CCH}_2\text{CO}_2\text{H}$, on refluxing with aqueous acidified potassium dichromate	✓ Primary alcohol is oxidized to a carboxylic acid. ✓ Amide is hydrolysed to a carboxylic acid.

(b) Hence, give the structural formula of **A**.

[1]



- (c) This compound **A**, with molecular formula of $C_3H_7NO_2$, can be prepared from the reaction between an acyl chloride and ammonia. Write a balanced equation for this reaction and draw the structural formula of the acyl chloride involved in the reaction. [2]



4. State the possible R group interactions that can exist in a polypeptide chain that contains the following amino acid residues.

Amino acid	Abbreviation	R group	R group interactions
Aspartic acid	asp	-CH ₂ COOH	Ionic bonds with positively charged groups OR Hydrogen bonds with groups containing –OH or –NH bonds
Serine	ser	-CH ₂ OH	Hydrogen bonds with groups containing –OH or –NH bonds.
Lysine	lys	-CH ₂ CH ₂ CH ₂ CH ₂ NH ₂	Ionic bonds with negatively charged groups OR Hydrogen bonds with groups containing –OH or –NH bonds
Cysteine	Cys	-CH ₂ SH	Disulfide bonds with groups containing SH bonds

[4]

