

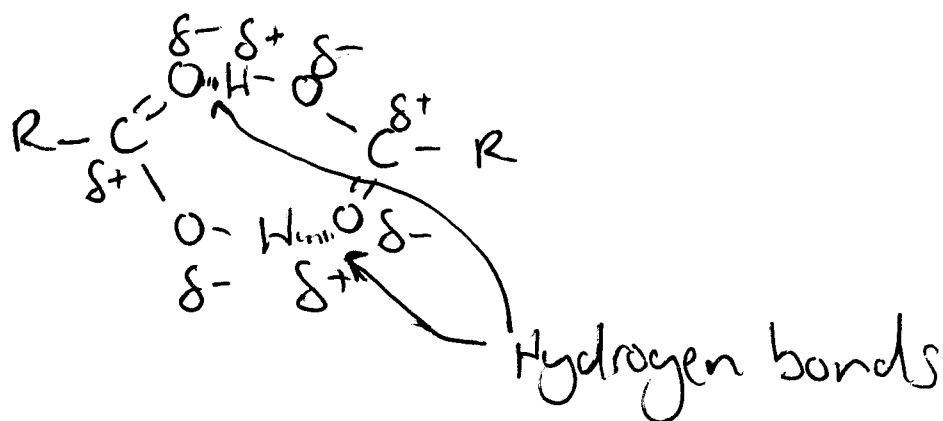
1. The table below lists the properties of the first four carboxylic acids.

Acid name	methanoic	ethanoic	propanoic	butanoic
Boiling point / °C	101	118	141	164
miscibility in water	completely	completely	slight	very slight

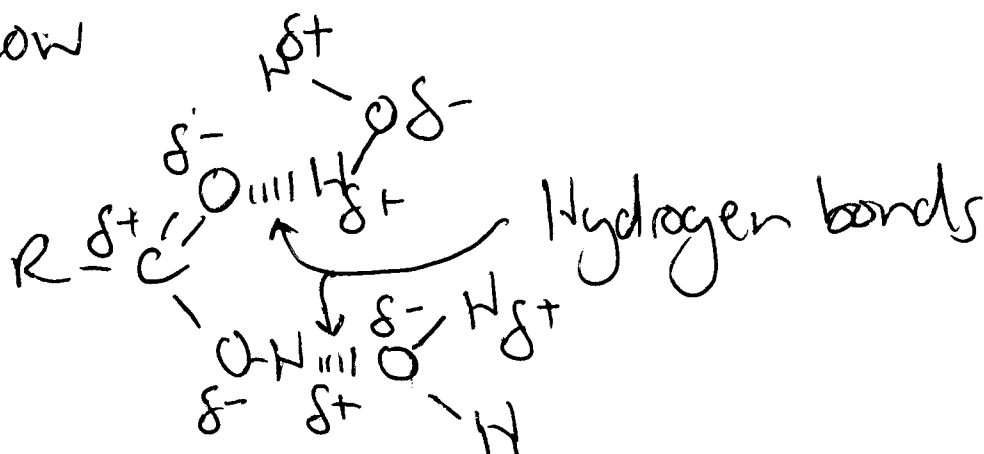
- (a) The carboxylic acids have higher than expected boiling points. Explain why this is so.
- (b) The lower members of the carboxylic acids are completely miscible with water. Explain why this is so.
- (c) As the chain length of the carboxylic acids increases their miscibility in water decreases. Explain why this is so.
2. When propanoic acid is dissolved in water some of the molecules ionise in a reversible reaction.
- (a) What is the structural formula of propanoic acid?
- (b) Write an equation for the reversible ionisation of propanoic acid molecules.
- (c) The propanoate ion is stabilised by delocalisation of electrons. Draw a diagram to illustrate this.
3. Name the carboxylic acids produced in the following reactions.
- (a) oxidation of  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- (b) oxidation of  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$
- (c) oxidation of  $\text{CH}_3\text{OH}$
- (d) oxidation of  $\text{CH}_3\text{CHO}$

# Answers 3.10

- 1 (a) Hydrogen bonds can form between acid molecules as shown below



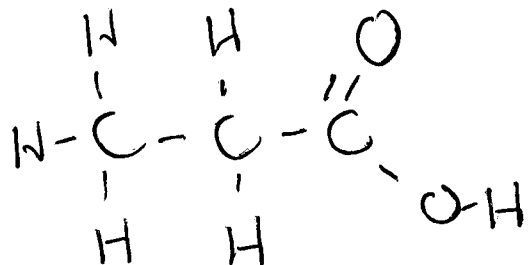
- (b) Hydrogen bonds can form between <sup>Polar</sup> acid molecules and <sup>Polar</sup> water molecules as shown below



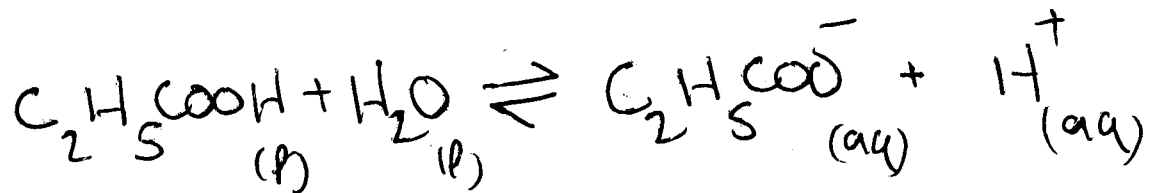
- (c) As the chain length  $\delta^+$  of the acid increase more electron density will be pumped from the alkyl group to the acid group. This decreases the polarity of the bonds in the acid group therefore the bonds to the water molecules will be weaker. This results in reduced solubility.

2.

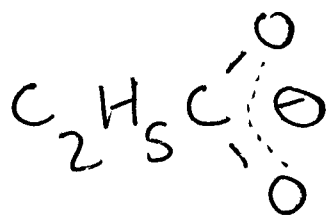
(a)



(b)



(c)



3.

(a) Propanoic acid

(b) butanoic acid

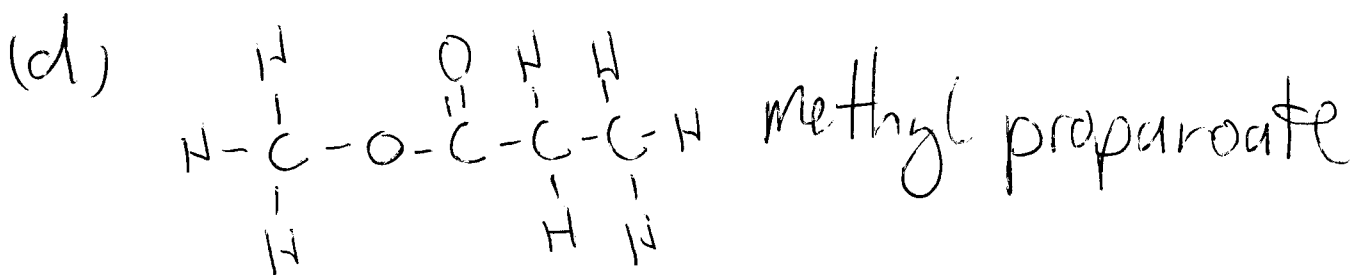
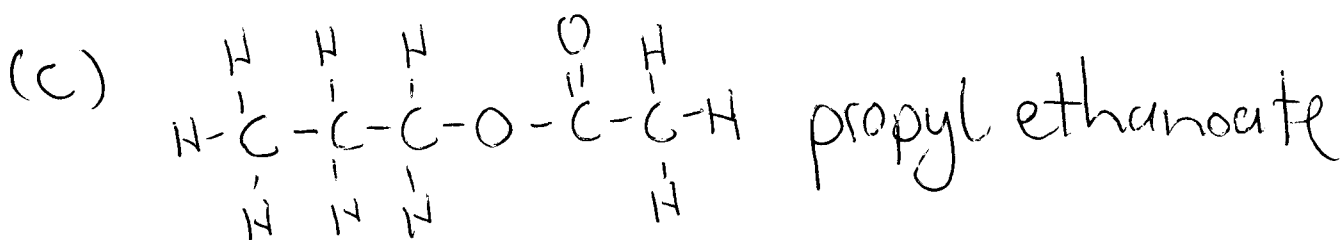
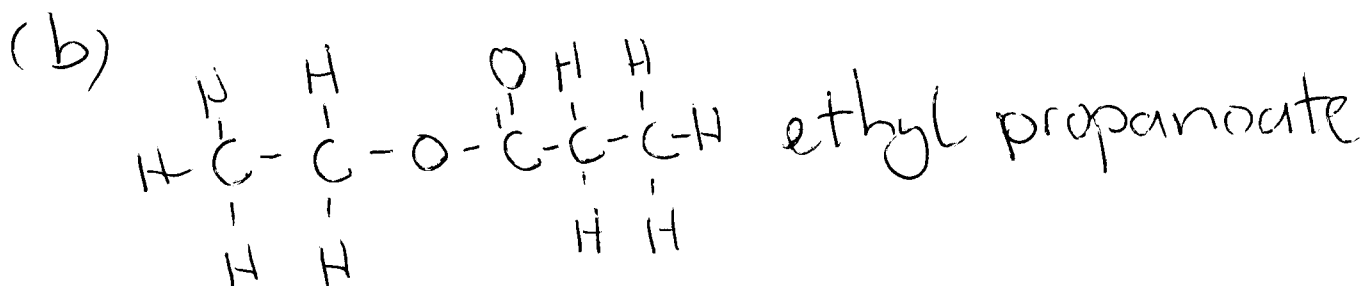
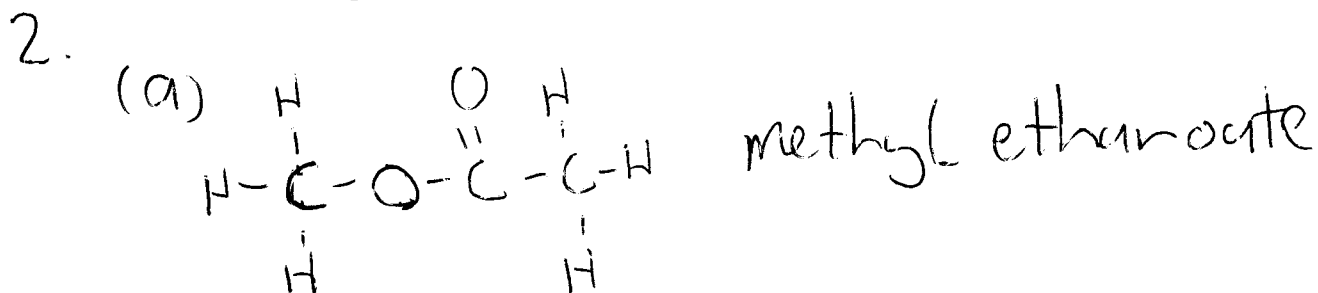
(c) methanoic acid

(d) Ethanoic acid

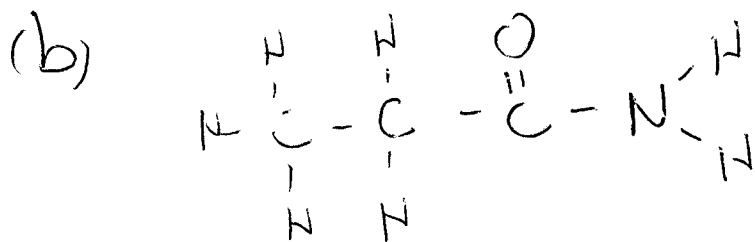
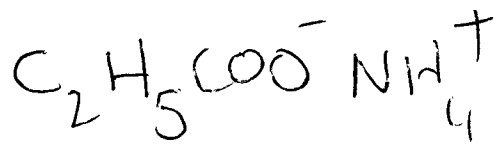
1. Give the ionic formula and name of the salts produced in the following reactions:
  - (a) methanoic acid and sodium hydroxide
  - (b) ethanoic acid and magnesium
  - (c) propanoic acid and calcium carbonate
  - (d) ethanoic acid and sodium carbonate
  - (e) methanoic acid and potassium hydroxide
  - (f) ethanoic acid and calcium
2. Name and give the structural formula of the esters produced in the following reactions:
  - (a) methanol and ethanoic acid
  - (b) ethanol and propanoic acid
  - (c) ethanoic acid and propanol
  - (d) propanoic acid and methanol
3. Some ammonia was reacted with propanoic acid to produce a salt. When the salt was heated water was lost and an organic compound formed.
  - (a) Name and give the ionic formula of the salt produced when ammonia was reacted with propanoic acid.
  - (b) Give the structural formula of the organic substance made when the salt was heated.
4. Name the substances produced in the following reactions:
  - (a) Ethanoic acid and lithium aluminium hydride
  - (b) Butanoic acid and lithium aluminium hydride
  - (c) Propanoic acid and lithium aluminium hydride
5. Write an equation for each of the following reactions
  - (a) ethanoic acid and sodium hydroxide
  - (b) methanoic acid and magnesium
  - (c) propanoic acid and sodium carbonate
  - (d) ethanoic acid and calcium carbonate

## Answers 3-11

- 1.
- (a)  $\text{HCOO}^{\ominus} \text{Na}^{\oplus}$ , Sodium methanoate
  - (b)  $(\text{C}_2\text{H}_3\text{COO}^{\ominus})_2 \text{Mg}^{2+}$ , Magnesium ethanoate
  - (c)  $(\text{C}_2\text{H}_5\text{COO}^{\ominus})_2 \text{Ca}^{2+}$ , Calcium propanoate
  - (d)  $(\text{CH}_3\text{COO}^{\ominus}) \text{Na}^{\oplus}$ , Sodium ethanoate
  - (e)  $(\text{HCOO}^{\ominus}) \text{K}^{\oplus}$ , potassium methanoate
  - (f)  $(\text{CH}_3\text{COO}^{\ominus})_2 \text{Ca}^{2+}$ , Calcium ethanoate



3 (a) Ammonium propanoate



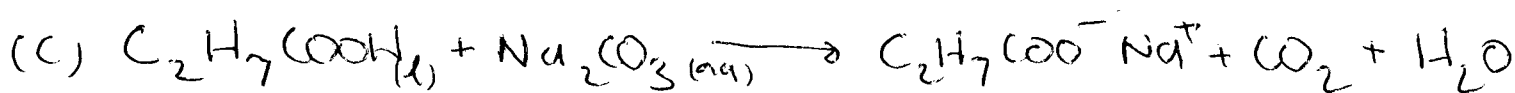
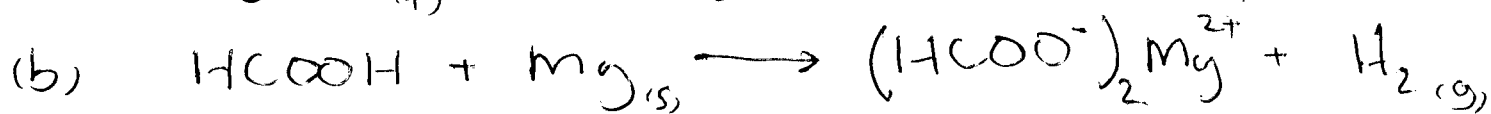
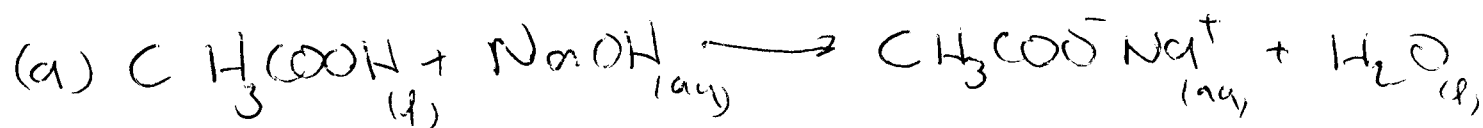
4

(a) ethanol

(b) butan-1-ol

(c) propan-1-ol

5.



- Ammonia and amines have similar molecular shapes, and share similar chemical reactions.
  - Describe and explain the shape of a molecule of ammonia.
  - Draw the shape of a molecule of ethylamine.
  - Write an equation for the reaction between ammonia and hydrogen chloride.
  - Write an equation for the reaction between ethylamine and hydrogen chloride.
  - Write an equation for the reaction between ammonia and water.
  - Write an equation for the reaction between ethylamine and water.

- Give the structural formula of each of the following amines and classify them as primary, secondary, or tertiary.

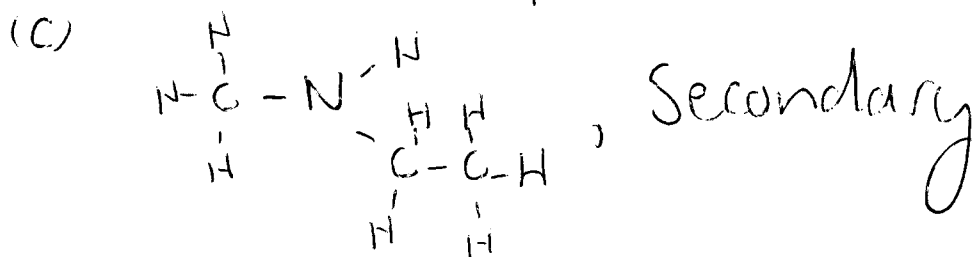
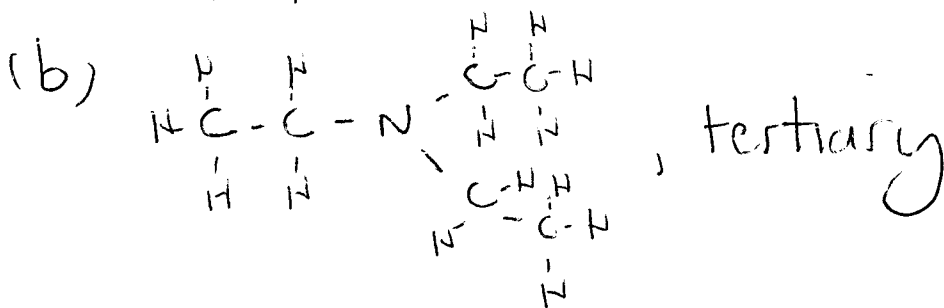
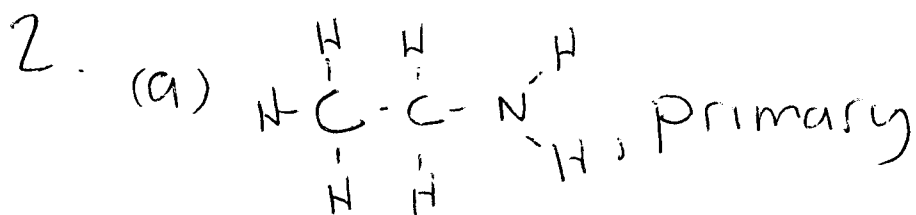
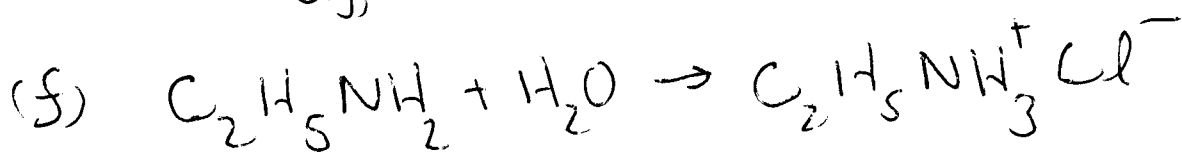
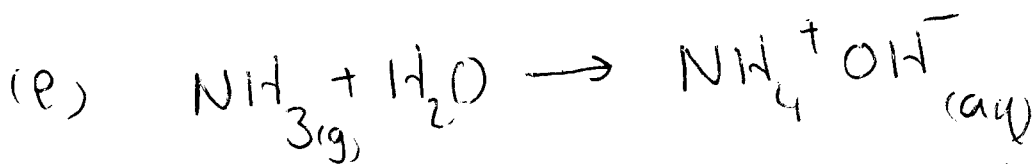
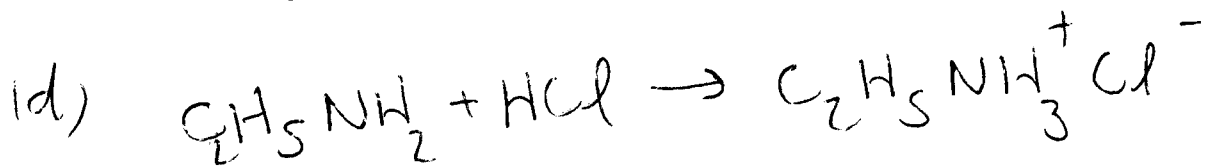
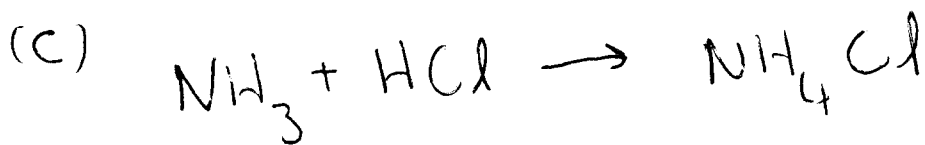
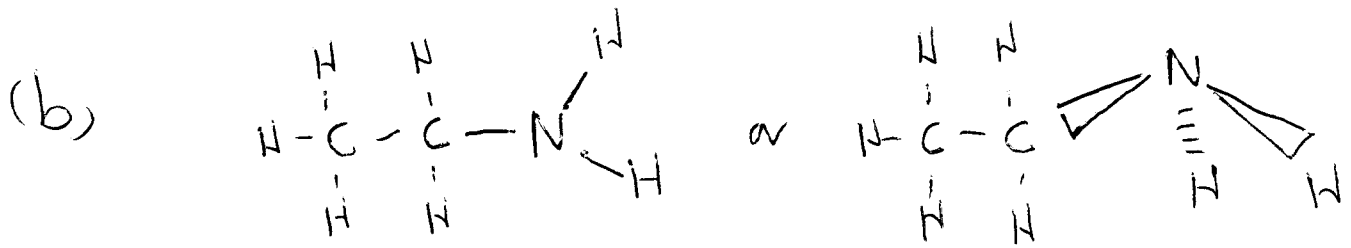
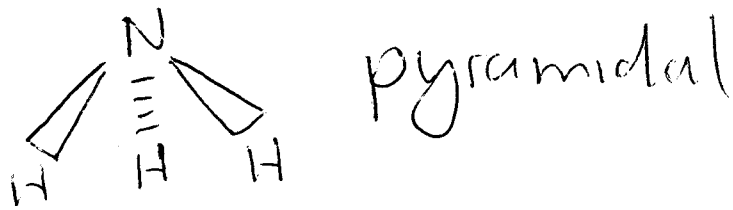
- |                        |                        |
|------------------------|------------------------|
| (a) Ethylamine         | (b) Triethylamine      |
| (c) Methyl ethyl amine | (d) diethylamine       |
| (e) Propylamine        | (f) ethyldimethylamine |

- Trimethylamine and propylamine have the same molecular mass but different boiling points.

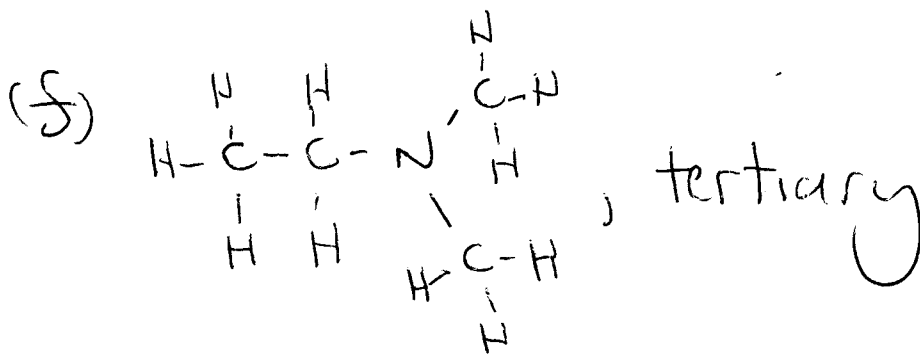
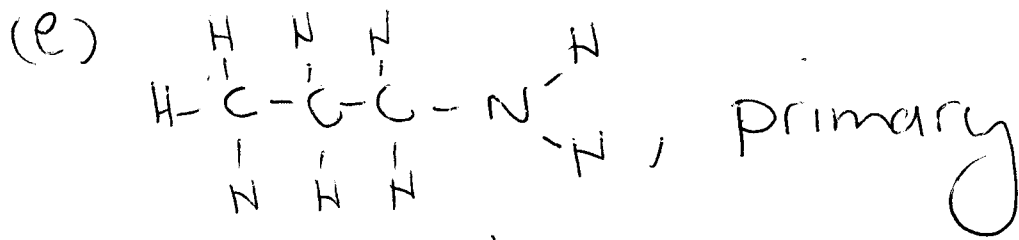
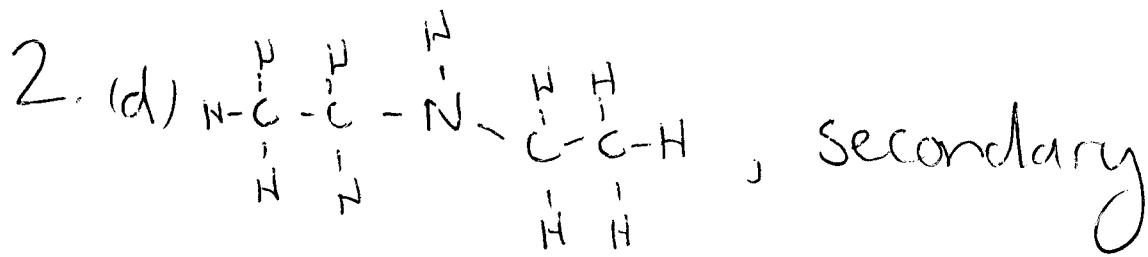
Substance	Boiling point / $^{\circ}\text{C}$
trimethylamine	3
propylamine	52

- Draw the shape of a molecule of trimethylamine.
  - What is the molecular mass of trimethylamine?
  - Explain why trimethylamine has lower higher boiling point than propylamine.
  - Explain why it is important to compare substances of similar molecular masses when considering boiling points.
- Methylamine is very soluble in water and is basic. Butylamine is insoluble in water
    - Explain the solubility of methylamine in water.
    - Explain why butylamine is insoluble in water.
    - Draw a diagram to show the shape of the methylammonium ion.
  - Methylamine is a stronger base than ammonia, whilst phenylamine is a weaker base than ammonia.  
Explain this in terms of electron donor and electron withdrawing groups.

1 (a)







3.

(a)



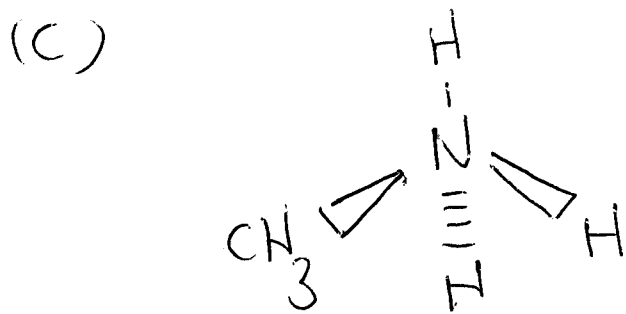
(b) 59

(c) Propylamine has hydrogen bonding between molecules because it has polar N-H bonds whereas trimethylamine only has van der Waals' attractions between molecules.

(d) molecules of similar mass will have same strength of van der Waals' forces between molecules

4. (a) methylamine contains polar N-H bonds which can form hydrogen bonds with the polar water molecules.

(b) electron donating effect of butyl group reduces polarity of N-H bonds therefore molecule can't form bonds to water molecules.



5- electron donating effect of CH<sub>3</sub> group increases electron density of lone pair on the nitrogen atom thus increasing ability to accept H<sup>+</sup> ions