1. An amine contains the:

   ☐ –OH group

   ☐ C=C bond

   ☐ –COOH group

   ☐ $–NH_2$ group

2. Heating a halogenoalkane with KCN in ethanol makes a nitrile, which usefully:

   ☐ adds one carbon to the chain

   ☐ adds an –OH group only

   ☐ removes a carbon

   ☐ forms an alkene

3. A primary amine is made by heating a halogenoalkane with:

   ☐ ammonia in ethanol, under pressure

   ☐ aqueous NaOH

   ☐ acidified dichromate

   ☐ bromine water

4. Adding HCN to an aldehyde or ketone gives a hydroxynitrile by:

   ☐ oxidation

   ☐ elimination

   ☐ nucleophilic addition across the C=O bond

   ☐ free-radical substitution

5. The reaction is a nucleophilic substitution because:

   ☐ the lone pair on ammonia attacks the slightly positive carbon, displacing the halogen

   ☐ electrons are transferred from the carbon to the ammonia molecule

   ☐ a radical attacks the carbon and removes the halogen as a radical

   ☐ a proton is transferred from ammonia to the halogenoalkane

6. Nitriles contain the –C≡N functional group and can be reduced to amines.

   ☐ True ☐ False

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8. Hydrolysing a nitrile with dilute acid turns –CN into:

   ☐ $–NH_2$ (an amine)

   ☐ –COOH (a carboxylic acid)

   ☐ a C=C bond

   ☐ –OH (an alcohol)

9. Why is an excess of ammonia used?

   ☐ to make the reaction reversible

   ☐ to lower the temperature

   ☐ to remove water

   ☐ so the amine product does not react further

10. Reducing a nitrile (with H_2 and a catalyst) gives:

    ☐ an alkene

    ☐ a ketone

    ☐ an amine

    ☐ a carboxylic acid

1. **–NH_2 group**

   An amine has an –NH_2 group, where nitrogen replaces a hydrogen of ammonia.

2. **adds one carbon to the chain**

   The CN group adds a carbon (a nucleophilic substitution); HCN with a carbonyl gives a hydroxynitrile instead.

3. **ammonia in ethanol, under pressure**

   Ammonia (in ethanol, under pressure) substitutes the halogen to give the amine.

4. **nucleophilic addition across the C=O bond**

   CN^- adds across the carbonyl; the O^- then takes an H^+ – nucleophilic addition.

5. **the lone pair on ammonia attacks the slightly positive carbon, displacing the halogen**

   Ammonia is the nucleophile; its nitrogen lone pair attacks the C–X carbon and pushes out the halogen.

6. **True**

   They add one carbon to the chain.

7. **proton**

   R–NH_2 + H^+ → R–NH_3^+.

8. **–COOH (a carboxylic acid)**

   Hydrolysis converts the nitrile group to a carboxylic acid (with an ammonium salt by-product).

9. **so the amine product does not react further**

   The amine is itself a nucleophile and could react again; excess ammonia favours the primary amine.

10. **an amine**

    Reduction of a nitrile gives an amine – a route to a longer-chain amine.

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