A-LEVEL CHEMISTRY • EXERCISE SHEET

19.2 Nitriles and hydroxynitriles

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

Objective

Build the skills to answer exam questions on **nitriles and hydroxynitriles** 腈和羟基腈—making them and the **hydrolysis** 水解 of nitriles.

You must be able to:

- recall how nitriles are made (halogenoalkane + KCN) and hydroxynitriles (carbonyl + HCN)
- describe the hydrolysis of nitriles to carboxylic acids

1 Worked examples

Two ways cyanide adds a carbon

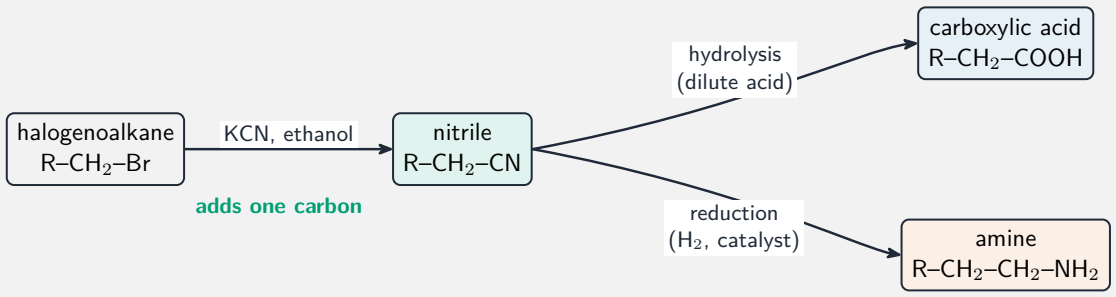
$$R\text{–}CH_2\text{–}Br + CN^- \longrightarrow R\text{–}CH_2\text{–}CN$$ nucleophilic **substitution** (nitrile)

$$R_2C{=}O + HCN \longrightarrow R_2C(OH)(CN)$$ nucleophilic **addition** (hydroxynitrile)

*KCN + halogenoalkane → nitrile (nucleophilic substitution); HCN + carbonyl → hydroxynitrile (nucleophilic addition). Both **add one carbon***

$$C_2H_5Br + KCN \rightarrow C_2H_5CN + KBr$$

Hydrolysis of nitriles



A nitrile hydrolyses to a carboxylic acid (dilute acid or alkali, then acidify) or reduces to an amine

$$CH_3CN + 2H_2O + HCl \rightarrow CH_3COOH + NH_4Cl$$

2 Practice

2.1 State the reagents and conditions to make a nitrile from a halogenoalkane. [2]

2.2 State what functional group a nitrile is changed into by hydrolysis. [1]

3 Exam-style questions

3.1 The reaction of KCN with a halogenoalkane is useful in synthesis because it: [1]

- **A** removes a carbon
- **B** adds one carbon to the chain
- **C** forms a double bond
- **D** makes an ester

3.2 Hydrolysis of ethanenitrile, CH CN, with dilute acid gives: [1]

- **A** ethanol
- **B** ethanoic acid
- **C** ethylamine
- **D** ethanal

3.3 (a) Write the equation for the reaction of bromoethane with KCN. [1]

(b) Describe how the nitrile product can be converted into a carboxylic acid. [2]

3.4 State the reagent and condition to make a hydroxynitrile from propanone (a ketone),

and name the mechanism. [2]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **19.2 Nitriles and hydroxynitriles** past-paper sheet in the Library (where available), or practise synthesis questions in **Practice mode** (nitriles often appear in multi-step synthesis questions).

Solutions

2.1 potassium cyanide (KCN) in ethanol; and heat.

2.2 a carboxylic acid (–COOH).

3.1 B. KCN adds one carbon to the chain (forming the nitrile).

3.2 B. Hydrolysis of a nitrile gives the carboxylic acid (ethanoic acid).

3.3 (a) $C_2H_5Br + KCN \rightarrow C_2H_5CN + KBr$.
(b) warm the nitrile with dilute acid (or dilute alkali then acidify); the –CN group is hydrolysed to –COOH.

3.4 HCN with a KCN catalyst (and heat); nucleophilic addition.