

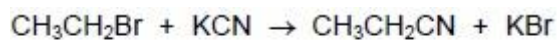
Name of the Student: _____

Max. Marks : 24 Marks

Time : 24 Minutes

Q1.

Bromoethane reacts with potassium cyanide to form compound D.



Compound **D**

(a) Outline the mechanism for this reaction.

(2)

(b) Give the IUPAC name of **D**.

(1)

(c) Calculate the percentage atom economy for the formation of **D** in this reaction.

Give your answer to the appropriate number of significant figures.

% atom economy _____

(2)

(Total 5 marks)

Q2.

Propanedioic acid contains two carboxylic acid groups. It is a solid organic acid that is soluble in water.

(a) Draw the skeletal formula of propanedioic acid.

(1)

(b) Describe how to prepare 250 cm³ of an aqueous standard solution of propanedioic acid containing an accurately measured mass of the acid.
Include essential practical details in your answer.

(6)

(c) Calculate the mass, in mg, of propanedioic acid ($M_r = 104.0$) needed to prepare 250 cm³ of a 0.00500 mol dm⁻³ solution.

Mass of propanedioic acid _____mg
(Total 9 marks)

Q3.

Some compounds with different molecular formulas have the same relative molecular mass to the nearest whole number.

- (a) A dicarboxylic acid has a relative molecular mass of 118, to the nearest whole number.

Deduce the molecular formula of the acid.

Molecular formula _____

(3)

- (b) A student dissolved some of the dicarboxylic acid from part (a) in water and made up the solution to 250 cm³ in a volumetric flask.

In a titration, a 25.0 cm³ sample of the acid solution needed 21.60 cm³ of 0.109 mol dm⁻³ sodium hydroxide solution for neutralisation.

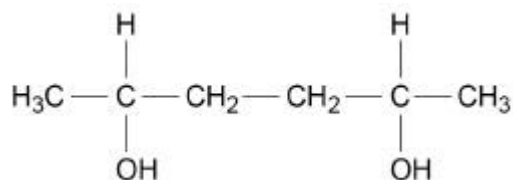
Calculate the mass, in g, of the dicarboxylic acid used.

Give your answer to the appropriate number of significant figures.

Mass _____ g

(4)

- (c) Compounds with molecular formula C₆H₁₄O₂ also have a relative molecular mass of 118 to the nearest whole number. These include the diol shown.



Deduce the number of peaks in the ¹H NMR spectrum of this diol.

(1)

- (d) Draw the structure of a different diol also with molecular formula C₆H₁₄O₂ that has a ¹H NMR spectrum that consists of two singlet peaks.

(1)

- (e) The dicarboxylic acid in part **(a)** and the isomers of $C_6H_{14}O_2$ in parts **(c)** and **(d)** all have a relative molecular mass of 118

State why the dicarboxylic acid can be distinguished from the two diols by high resolution mass spectrometry using electrospray ionisation.

(1)

(Total 10 marks)