

Name of the Student: _____

Max. Marks : 24 Marks

Time : 24 Minutes

Q1.

This question is about isomers.

- (a) Give a reagent and observations for a test-tube reaction to distinguish between 2-methylbutan-1-ol and 2-methylbutan-2-ol.

Reagent _____

Observation with 2-methylbutan-1-ol _____

Observation with 2-methylbutan-2-ol _____

(3)

- (b) Compounds **A** and **B** both have the molecular formula $C_4H_8Br_2$
A has a singlet, a triplet and a quartet in its 1H NMR spectrum.
B has only two singlets in its 1H NMR spectrum.

Draw a structure for each of **A** and **B**.

A

B

(2)

- (c) Compounds **C** and **D** both have the molecular formula $C_6H_3Br_3$
C has two peaks in its ^{13}C NMR spectrum.
D has four peaks in its ^{13}C NMR spectrum.

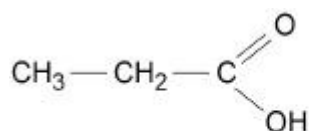
Draw a structure for each of **C** and **D**

C

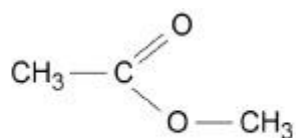
D

(2)

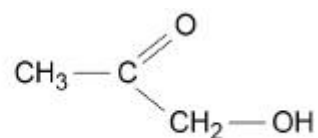
(d) Compounds **E**, **F**, and **G** are isomers.



E



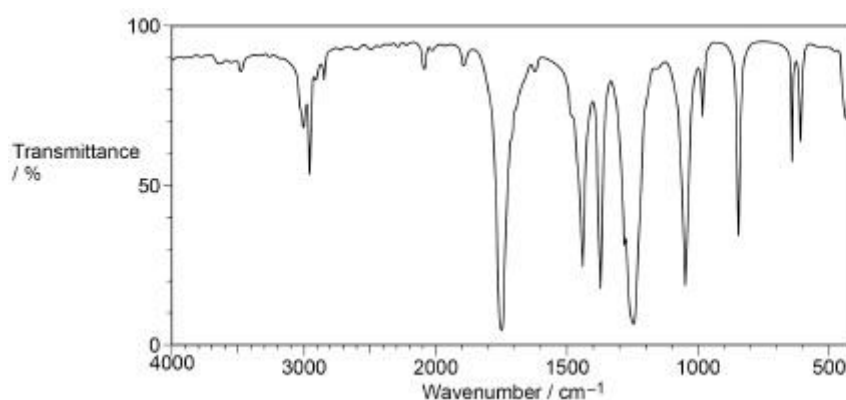
F

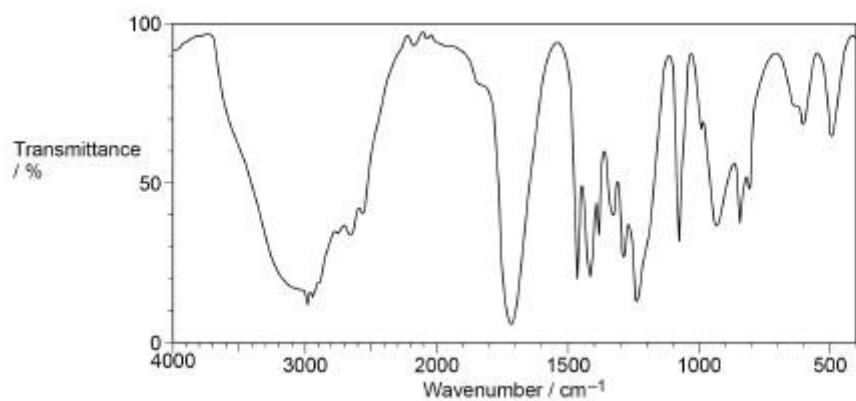
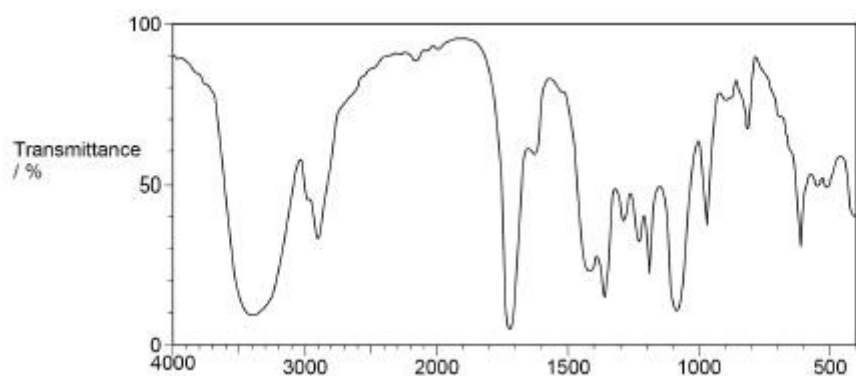


G

The diagrams below show the infrared spectra of these isomers, but not necessarily in the same order.

Label each spectrum with the correct letter **E**, **F**, and **G** in the box.



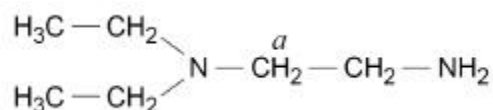


(1)
(Total 8 marks)

Q2.

There are several isomers with the molecular formula $C_6H_{16}N_2$

(a) One isomer is shown.



Give the number of peaks in the ^{13}C NMR spectrum of this isomer.

State and explain the splitting pattern of the peak for the hydrogens labelled *a* in its 1H NMR spectrum.

Number of ^{13}C peaks _____

Splitting pattern _____

Explanation _____

(3)

(b) Draw the structure of the isomer of $C_6H_{16}N_2$ used to make nylon 6,6

(1)

(c) Draw the structure of the isomer of $C_6H_{16}N_2$ that contains two **primary** amine groups and has only two peaks in its ^{13}C NMR spectrum.

- (d) Draw the structure of the isomer of $\text{C}_6\text{H}_{16}\text{N}_2$ that contains two **tertiary** amine groups and has only two peaks in its ^{13}C NMR spectrum.

(Total 6 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.

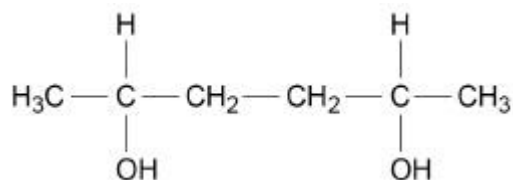
Calculate the mass, in g, of the dicarboxylic acid used.

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 $\text{C}_6\text{H}_{14}\text{O}_2$ 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)