Name of the Student:_____
Max. Marks : 17 Marks **Time : 17 Minutes**

Q1.

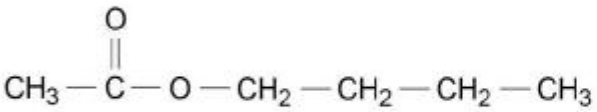
^{1}H NMR, ^{13}C NMR and infrared spectroscopy are used in organic chemistry to distinguish between compounds and to identify them.

(a) Give the skeletal formula of the compound that is used as the standard when recording a ^{13}C NMR spectrum.

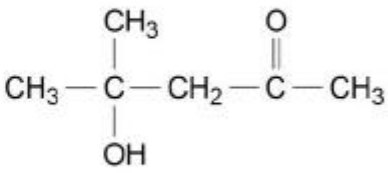
(1)

(b) Four isomers of $C_6H_{12}O_2$, **P**, **Q**, **R** and **S**, shown in **Figure 1**, were analysed by ^{13}C NMR spectrometry.

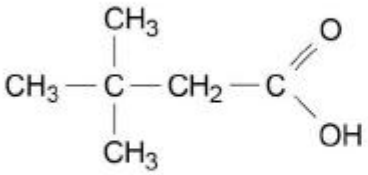
Figure 1



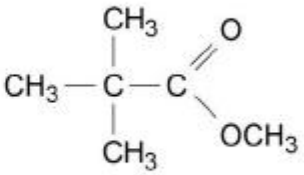
P



Q



R



S

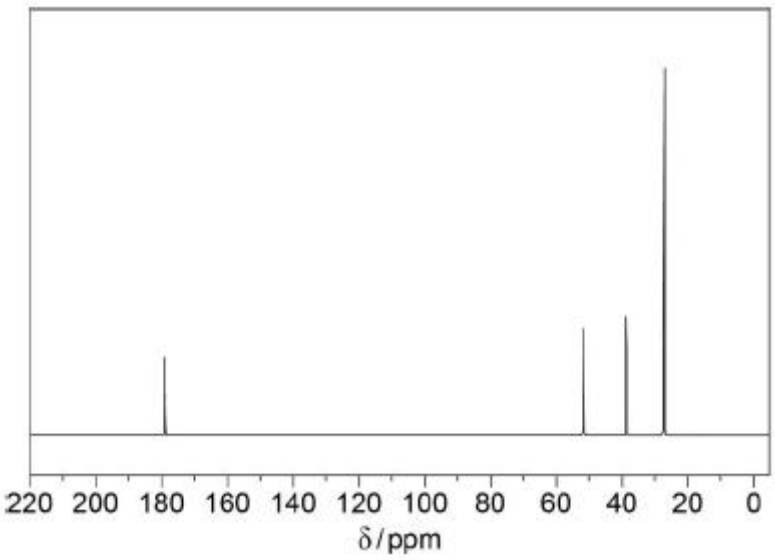
The ^{13}C NMR spectra of three of these isomers are shown in **Figure 2**.

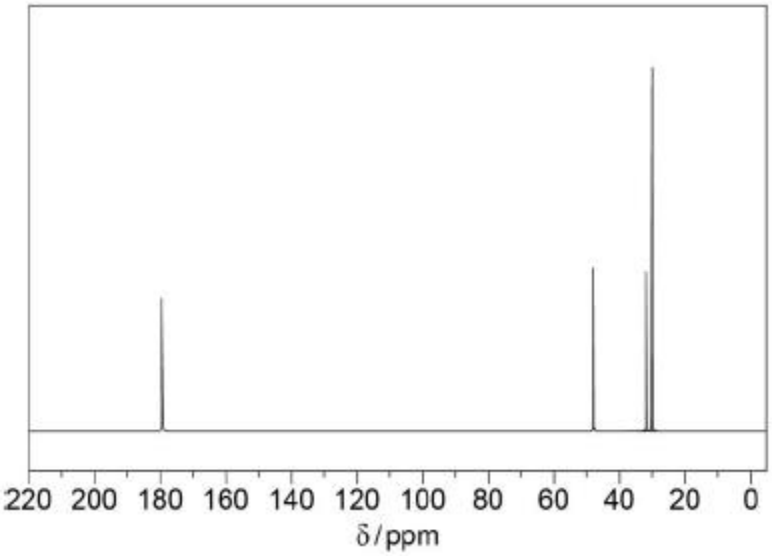
Use **Table C** in the Data Booklet to help you to identify which isomer produces each spectrum.

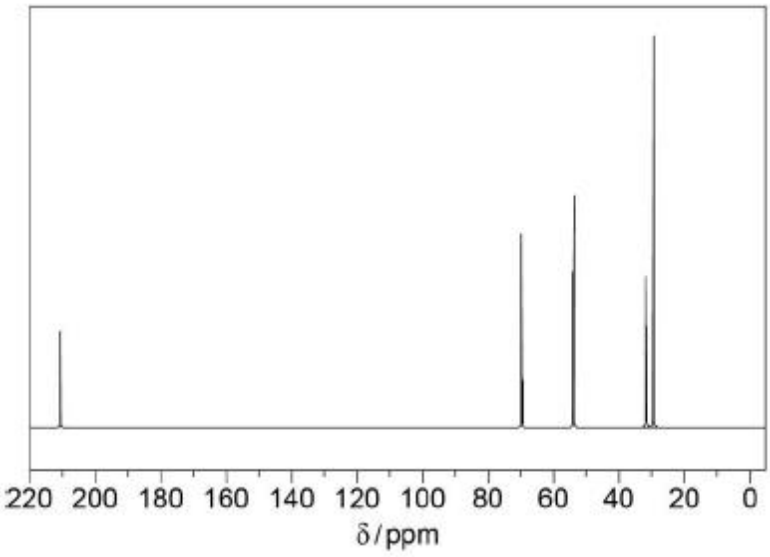
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Write the letter of each isomer opposite its spectrum in **Figure 2**.

Figure 2





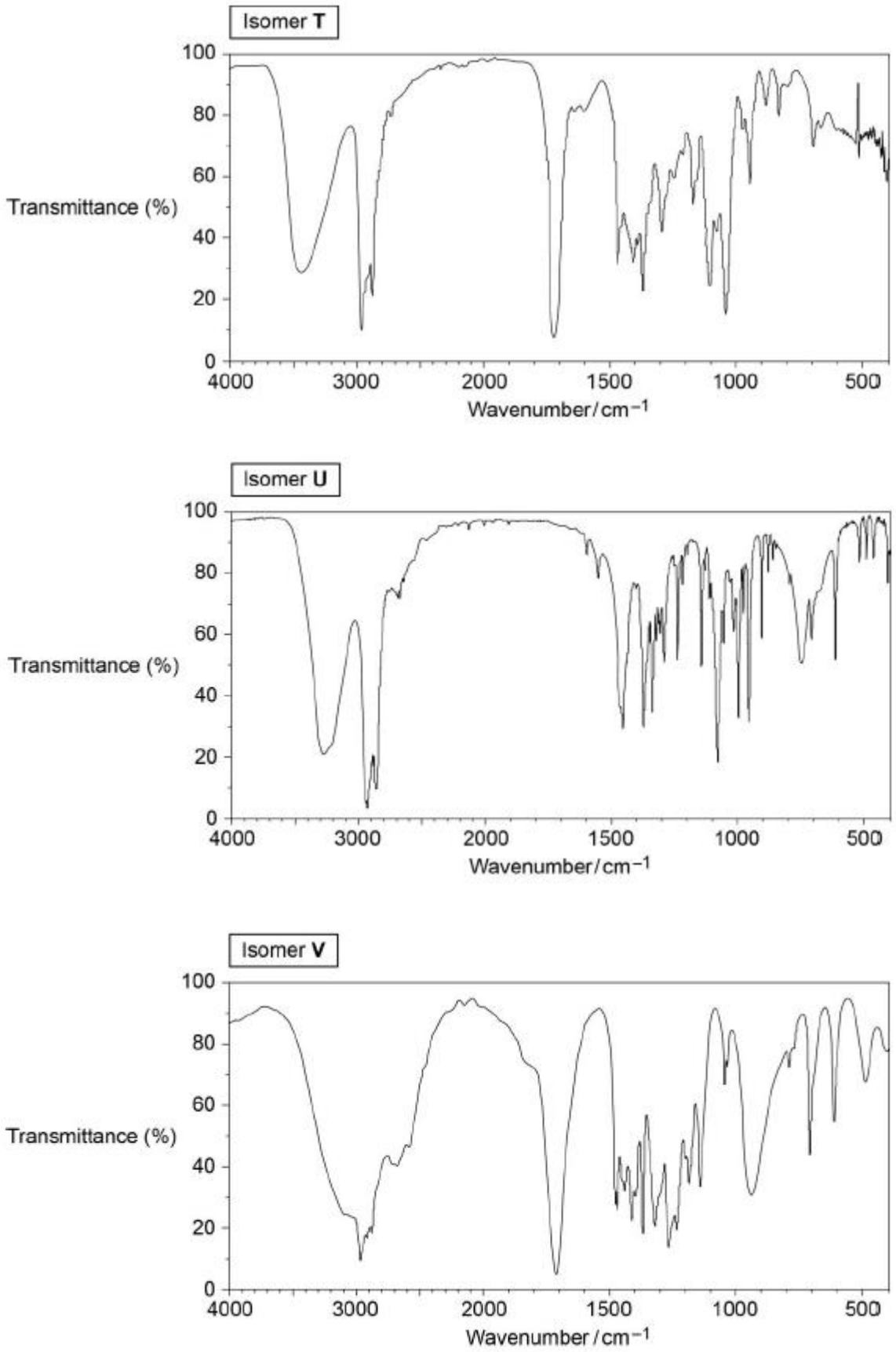


(3)

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(c) The infrared spectra shown in **Figure 3** are those of three different isomers of $C_6H_{12}O_2$, isomers **T**, **U** and **V**.

Figure 3



Identify the functional group(s) present in each isomer **T**, **U** and **V** of $C_6H_{12}O_2$ using **Table A** in the Data Booklet.

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Explain your answer.

(6)

(d) The integration values for the peaks in the ^{1}H NMR spectrum of **X**, a different isomer of $C_6H_{12}O_2$, are given in the table below.

Chemical shift, δ/ppm	3.7	3.5	2.6	2.2	1.1
Integration value	0.6	0.6	0.6	0.9	0.9
Splitting pattern	triplet	quartet	triplet	singlet	triplet

Deduce the simplest ratio of the relative numbers of protons in each environment in compound **X**.

(1)

(e) Use the data in the table above and **Table B** in the Data Booklet to help you answer this question.

Deduce the part of the structure of **X** that causes the signal at δ= 3.5 and the part of the structure at **X** that causes the signal at δ=2.2.

Explain the splitting patterns of these peaks.

Signal at δ= 3.5

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Signal at δ= 2.2 _____

(4)

(f) Deduce the structure of compound **X**, $C_6H_{12}O_2$

Use your answer from part **(e)** to help you.

You are **not** required to explain how you deduced the structure.

(2)

(Total 17 marks)

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