Information Sheet for Teachers: St. Elmo Brady (1884 - 1966)

This information sheet is designed for teachers only.

St. Elmo Brady was born in 1884, in Louisville, Kentucky. In 1914 he received his master's in chemistry and continued his graduate studies under Professor Clarence G. Derick. Derick and the Harvard chemist Arthur Michael disagreed on how the acidity of carboxylic acids was affected by replacing hydrogen atoms on the carbon chain with other functional groups. This was St. Elmo Brady's focus during his PhD; he investigated the acidity of straight-chain carboxylic acids in which a pair of hydrogen atoms were replaced with an oxygen atom to give a keto acid. Due to St. Elmo Brady's research, new methods for preparing and purifying carboxyl groups and clarifying the effect of carbonyl groups on the acidity of carboxylic acids. In 1916, in just two years, St. Elmo Brady completed his PhD; his dissertation was titled "The Scale of Influence of Substituents in Paraffine Monobasic Acids. The Divalent Oxygen Atom". He was the first African American chemist to earn a doctorate in the US.

In the KS5 chemistry national curriculum, students' study 'organic synthesis, including characteristic reactions of alkanes, alkenes, halogenoalkanes, alcohols, arenes, aldehydes, ketones, carboxylic acids, esters, amines, amino acids, and amides.' This aspect of the curriculum has a direct link to St. Elmo Brady's work as he investigated the acidity of straight-chain carboxylic acids in which a pair of hydrogen atoms were replaced with an oxygen atom to give a keto acid.

St. Elmo Brady's work shows a clear link to the national curriculum and his contributions can be incorporated without difficulty.

St. Elmo Brady

St. Elmo Brady was born in 1884 in Louisville, Kentucky. In 1903 he graduated from Louisville Colored High School. While attending Fisk, an all-black college in Nashville, Tennessee, his chemistry teacher, Thomas W. Talley, encouraged him to study chemistry further.

Picture credit: University of Illinois Archives

In 1908, St. Elmo Brady graduated with a bachelor's degree from Fisk University and started teaching at Tuskegee Normal and Industrial Institute (now Tuskegee University) in Alabama. After teaching at Tuskegee for four years, the University of Illinois, Urbana-Champaign offered St. Elmo Brady a scholarship for a masters. In 1913, he joined Illinois after taking a leave of absence from Tuskegee. In 1914 he received his master's in chemistry and continued his graduate studies under Professor Clarence G. Derick, with whom St. Elmo Brady published three scholarly abstracts in *Science* between 1914 and 1915.

Derick and the Harvard chemist Arthur Michael disagreed on how the acidity of carboxylic acids was affected by replacing hydrogen atoms on the carbon chain with other functional groups. This was St. Elmo Brady's focus during his PhD; he investigated the acidity of straight-chain carboxylic acids in which a pair of hydrogen atoms were replaced with an oxygen atom to give a keto acid. Due to St. Elmo Brady's research, new methods for preparing and purifying carboxyl groups and clarifying the effect of carbonyl groups on the acidity of carboxylic acids. St. Elmo Brady's and his colleagues concluded that Michael's view was incorrect. In 1916, in just two years, St. Elmo Brady completed his PhD, his dissertation was titled "The Scale of Influence of Substituents in Paraffine Monobasic Acids. The Divalent Oxygen Atom". He was the first African American chemist to earn a doctorate in the US. In 1914 St. Elmo Brady became the first African American admitted to Phi Lambda Upsilon, the chemistry honour society at the University of Illinois.

St. Elmo Brady established a strong undergraduate curriculum and a fund-raising campaign at all four historically black colleges and universities in the US. He also established the first graduate chemistry program at a historically black college. In the University of Illinois, he set up a summer program in infrared spectroscopy, which was open to all colleges and universities. He also started a lecture series that invited recognised chemists to share their research at Fisk University.

Reference:

https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/st-elmo-brady.html
https://chemistry.illinois.edu/spotlight/alumni/brady-st-elmo-1884-1966
https://www.sciencemag.org/careers/2005/05/ancestors-science-st-elmo-brady

St. Elmo Brady

The first African American chemist to earn a doctorate in the US.

ABOUT

St. Elmo Brady was born in 1884, in Louisville, Kentucky. In 1914 he received his master's in chemistry and continued his graduate studies under Professor Clarence G. Derick. Derick and the Harvard chemist Arthur Michael disagreed on how the acidity of carboxylic acids was affected by replacing hydrogen atoms on the carbon chain with other functional groups. This was St. Elmo Brady's focus during his PhD; he investigated the acidity of straight-chain carboxylic acids in which a pair of hydrogen atoms were replaced with an oxygen atom to give a keto acid. Due to St. Elmo Brady's research, new methods for preparing and purifying carboxyl groups were identified, and and clarifying the effect of carbonyl groups on the acidity of carboxylic acids.

In 1916, in just two years, St. Elmo Brady completed his PhD; his dissertation was titled "The Scale of Influence of Substituents in Paraffine Monobasic Acids. The Divalent Oxygen Atom".

Did you know?

St. Elmo Brady established a strong undergraduate curriculum and a fund-raising campaign at all four historically black colleges and universities in the US.

He also established the first graduate chemistry programme at a historically black college.

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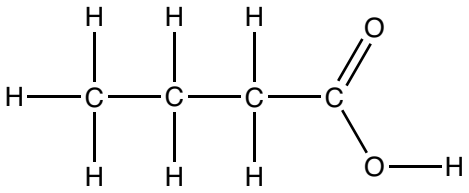
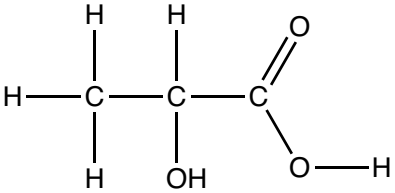
^{13}C NMR Activity (easy)

The Structures A and B are shown below. Match each structure to its ^{13}C NMR spectrum.



A



B

Figure 1:

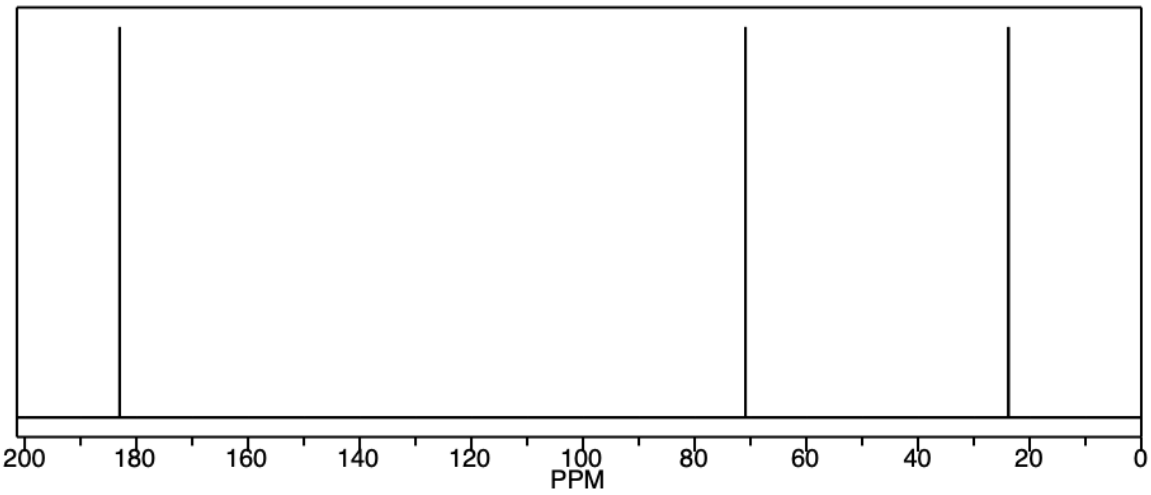


Figure 2:

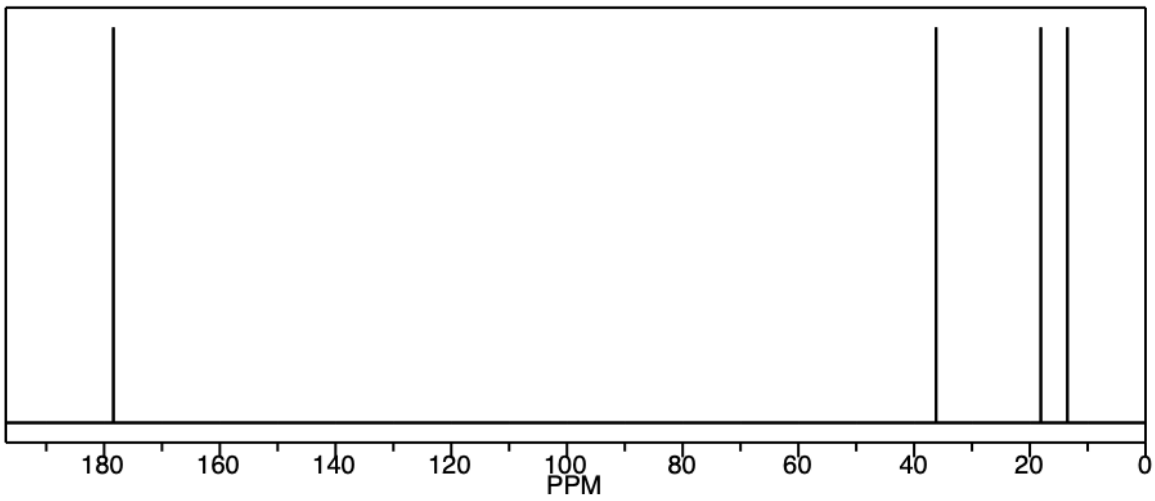


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Figure 1: _____ Figure 2: _____

This activity requires to students to identify the correct structures of carboxylic acids based on the ^{13}C NMR spectra provided.

St. Elmo Brady (1884-1966) was an African American who researched the acidity of carboxylic acids. He was the first African American chemist to earn a doctorate in the United States of America. His work is still honoured by the American Chemical Society. Throughout his life, he mentored and inspired several young African American chemists.

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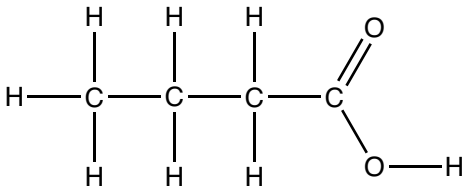
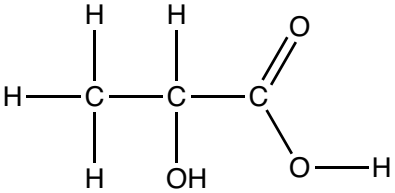


A



B

Figure 1:

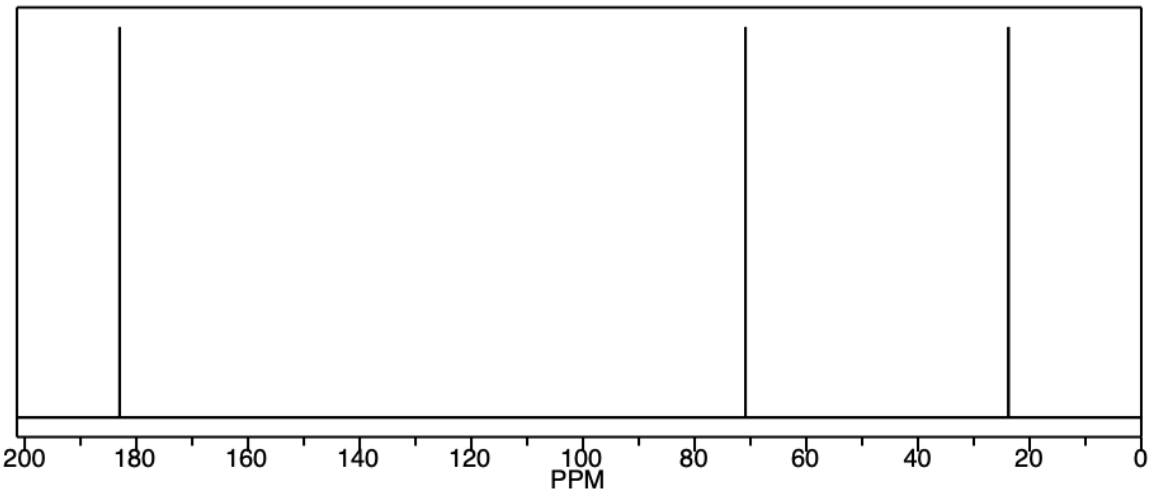
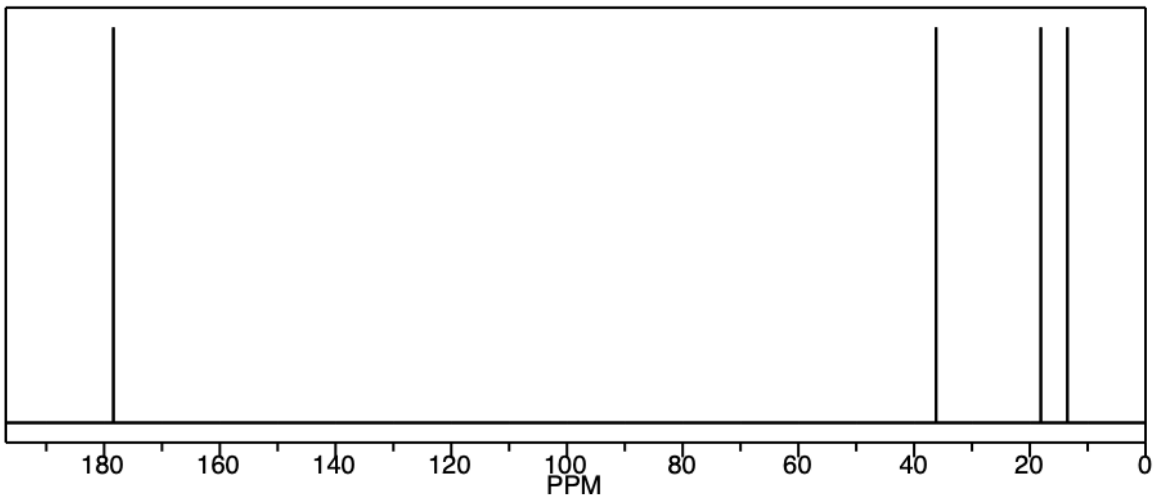


Figure 2:



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Structure A has four carbon environments, whereas structure B has three carbon environments.

Figure 1 shows three carbon environments which have the chemical shift of:

- 183 ppm is the carbonyl functional group.
- 71 ppm is the alcohol functional group.
- 24 ppm is the methyl functional group.

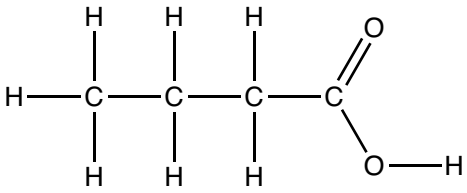
Figure 2 shows three carbon environments which have the chemical shift of:

- 178 ppm is the carbonyl functional group.
- 36, 18 & 15 ppm, is the alkyl chain.

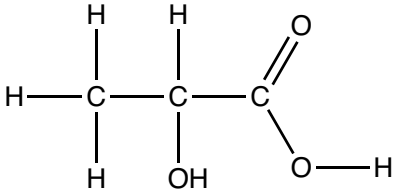
Using this information, we can determine that figure 1 is structure B and figure 2 is structure A.

^{1}H NMR Activity (medium)

The two structures A and B are shown below. Match each structure to its ^{1}H NMR spectrum.



A



B

Figure 1:

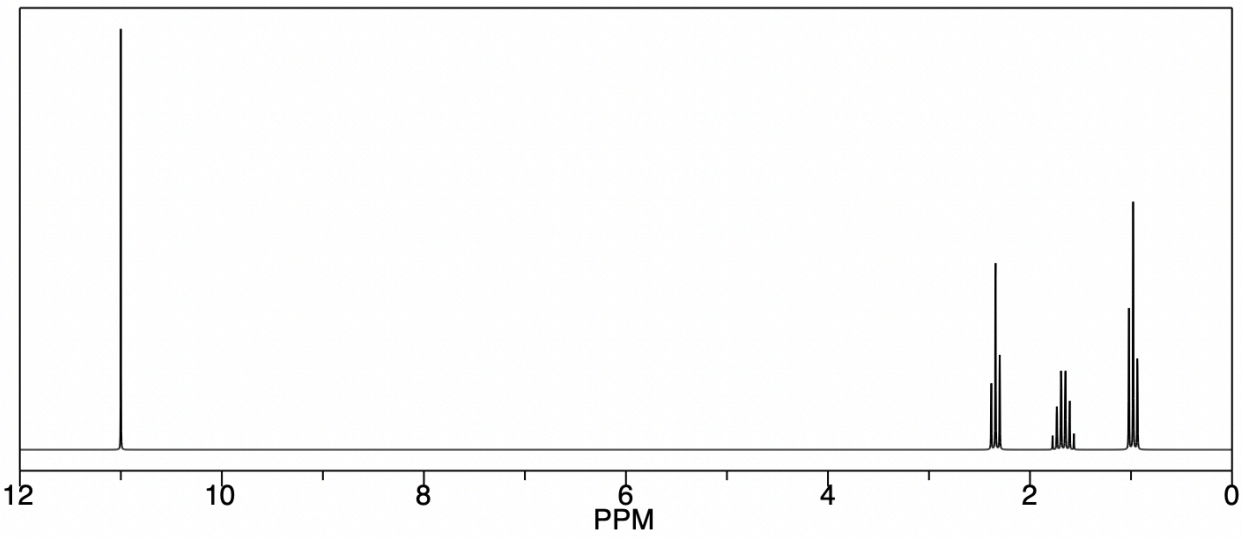


Figure 2:

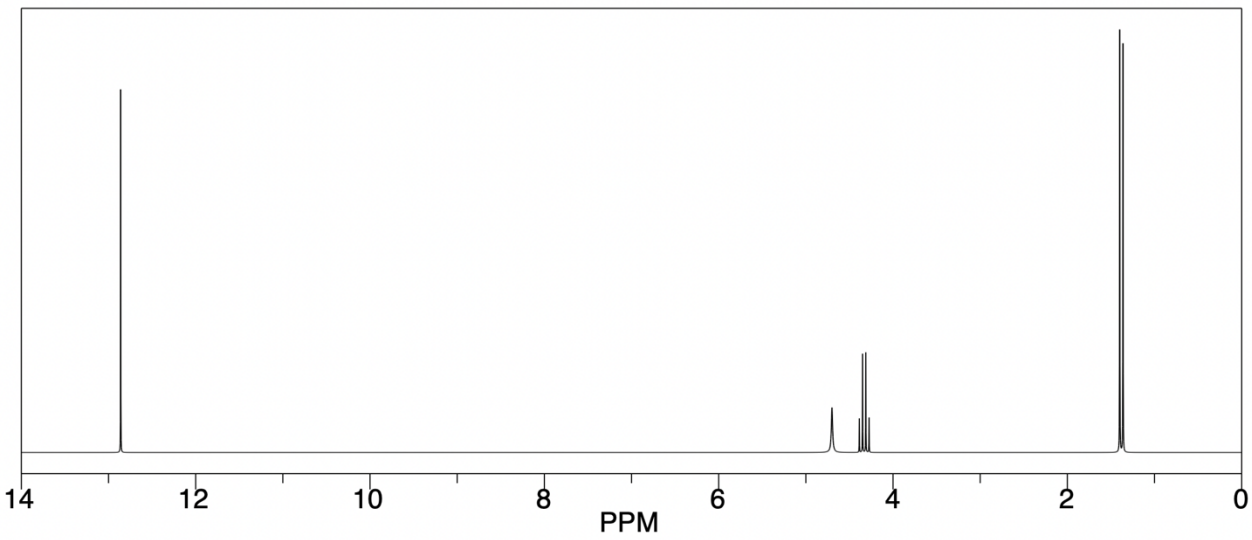


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Figure 1: _____ Figure 2: _____

This activity requires to students to identify the correct structures of carboxylic acids based on the ^{1}H NMR spectra provided.

St. Elmo Brady (1884-1966) was an African American who researched the acidity of carboxylic acids. He was the first African American chemist to earn a doctorate in the United States of America. His work is still honoured by the American Chemical Society. Throughout his life, he mentored and inspired several young African American chemists.

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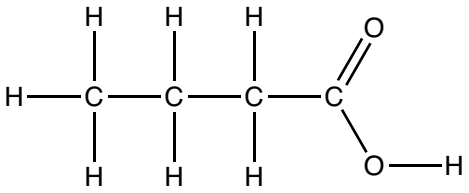
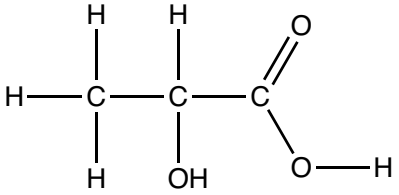
^{1}H NMR Activity (medium)

The two structures A and B are shown below. Match each structure to its ^{1}H NMR spectrum.



A



B

Figure 1:

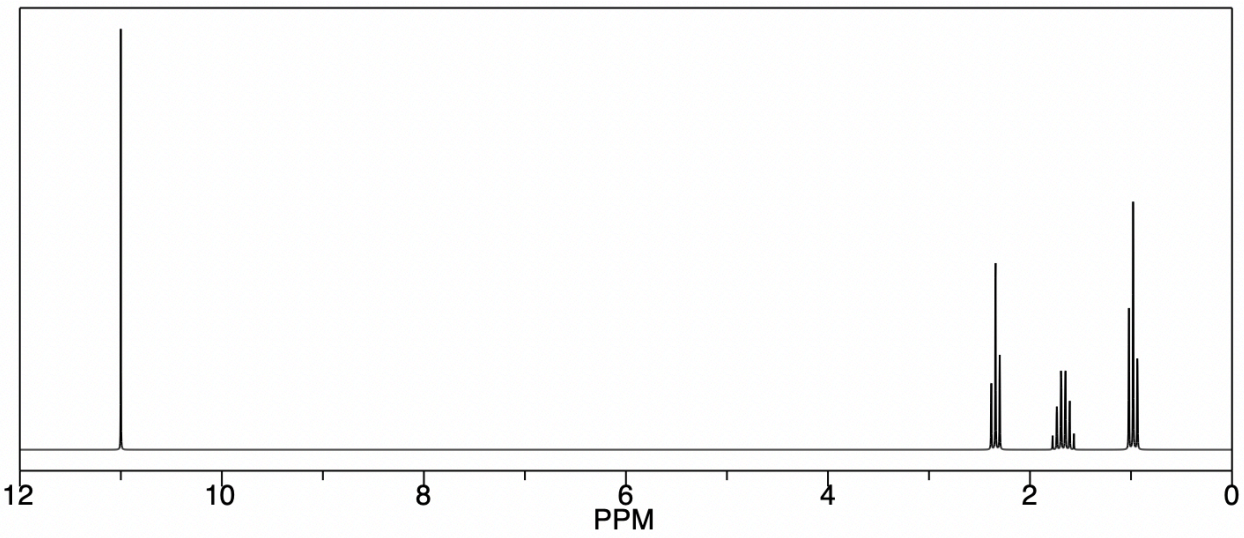
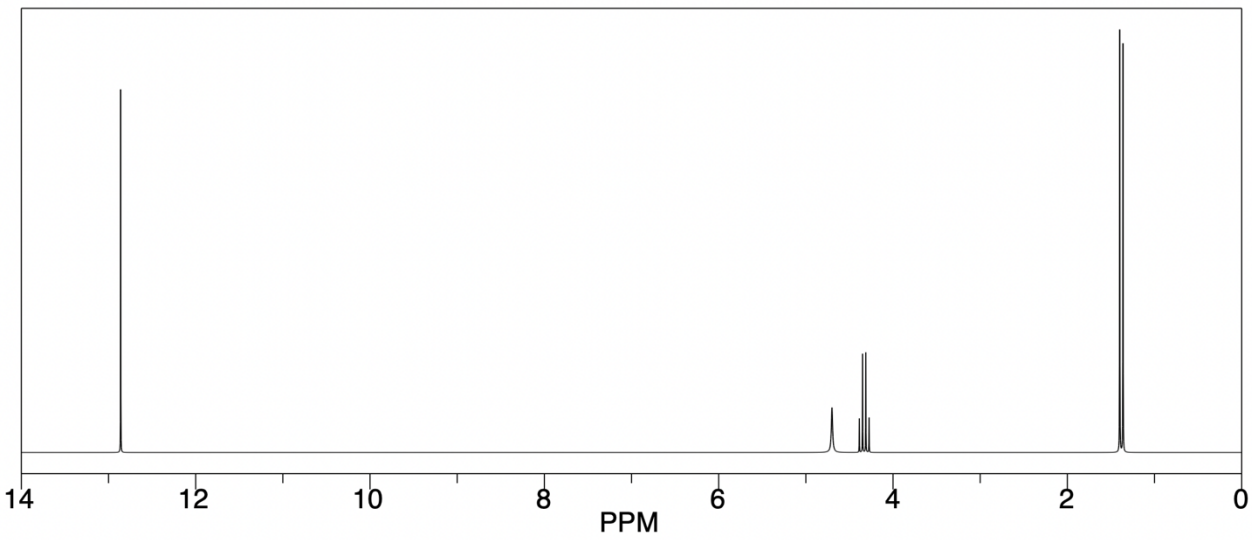


Figure 2:



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Both structures A and B have four hydrogen environments.

Figure 1 shows four hydrogen environments which have the chemical shift of:

- 11 ppm, this is of the alcohol of the carboxylic acid.
- 2.5, 1.5 & 1 ppm, this is of the alkyl group.

Figure 1 splitting:

- Singlet
- Triplet
- Multiplet
- Triplet

Figure 2 shows four hydrogen environments which have the chemical shift of:

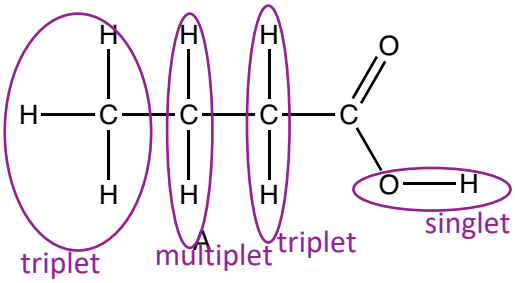
- 13 ppm, this is of the alcohol of the carboxylic acid.
- 4.8 ppm, this is of the alcohol.

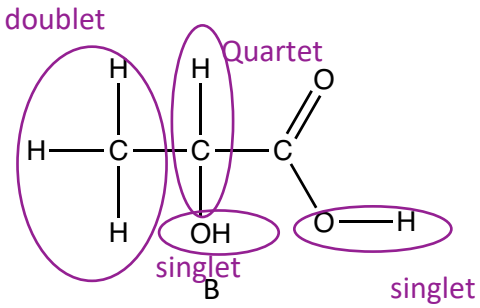
4.2 ppm, this of the second carbon C-H bond.

- 1.5 ppm, this is the methyl group.

Figure 2 splitting:

- Singlet
- Singlet
- Quartet
- Doublet



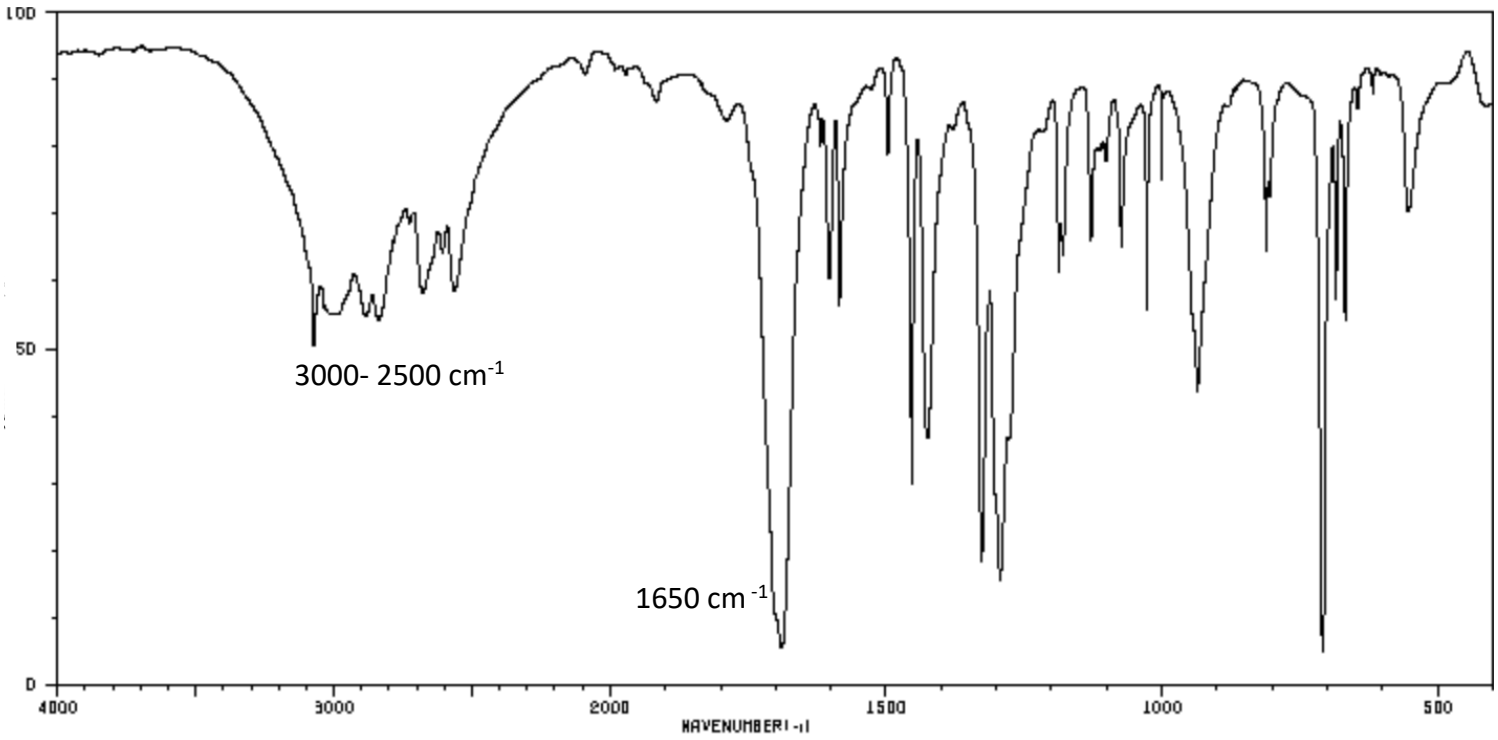


Using this information, we can determine that figure 1 is structure A and figure 2 is structure B.

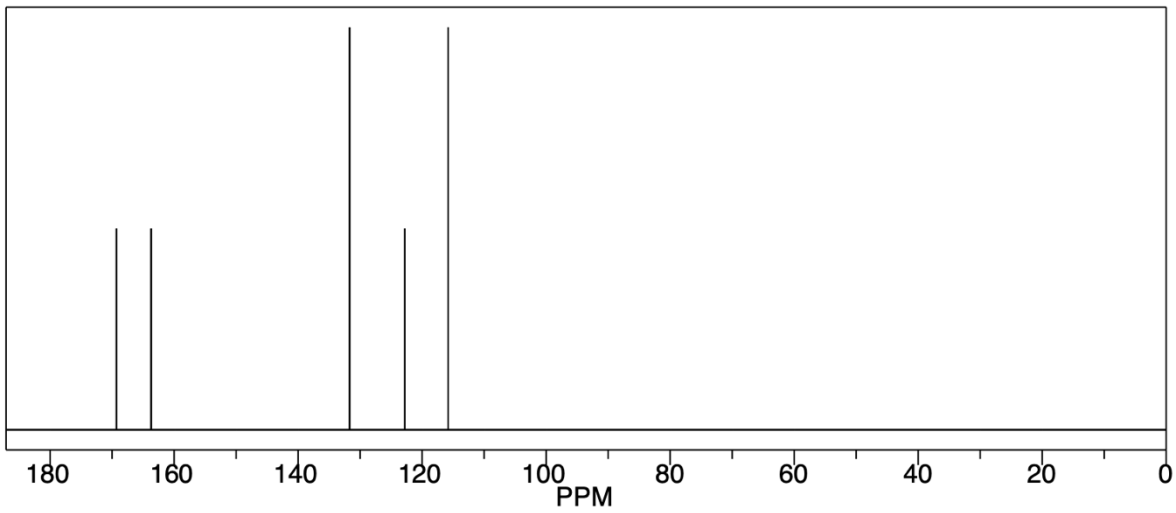
NMR Structure Determination (hard)

The figures below show the IR, ^{13}C NMR and ^{1}H NMR spectra of an unknown compound. Using the information, deduce the structure of the compound.

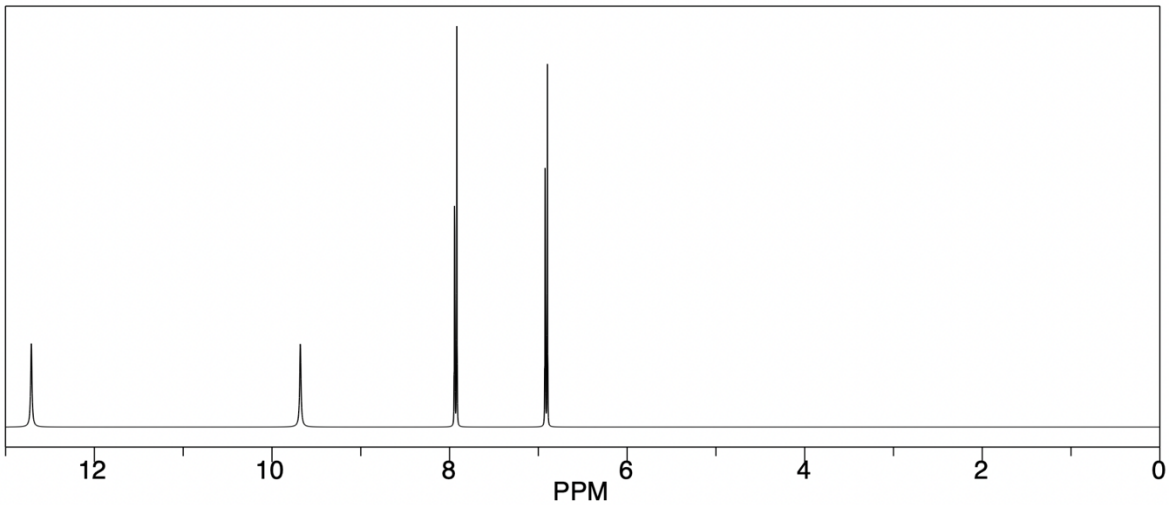
IR:



^{13}C



^{1}H



δ/ppm	12.7	9.7	7.9	6.9
Integration ratio	1	1	2	2

Structure:

This activity requires to students to identify the correct structures of carboxylic acids based on the IR, ^{13}C, ^{1}H NMR spectra provided.

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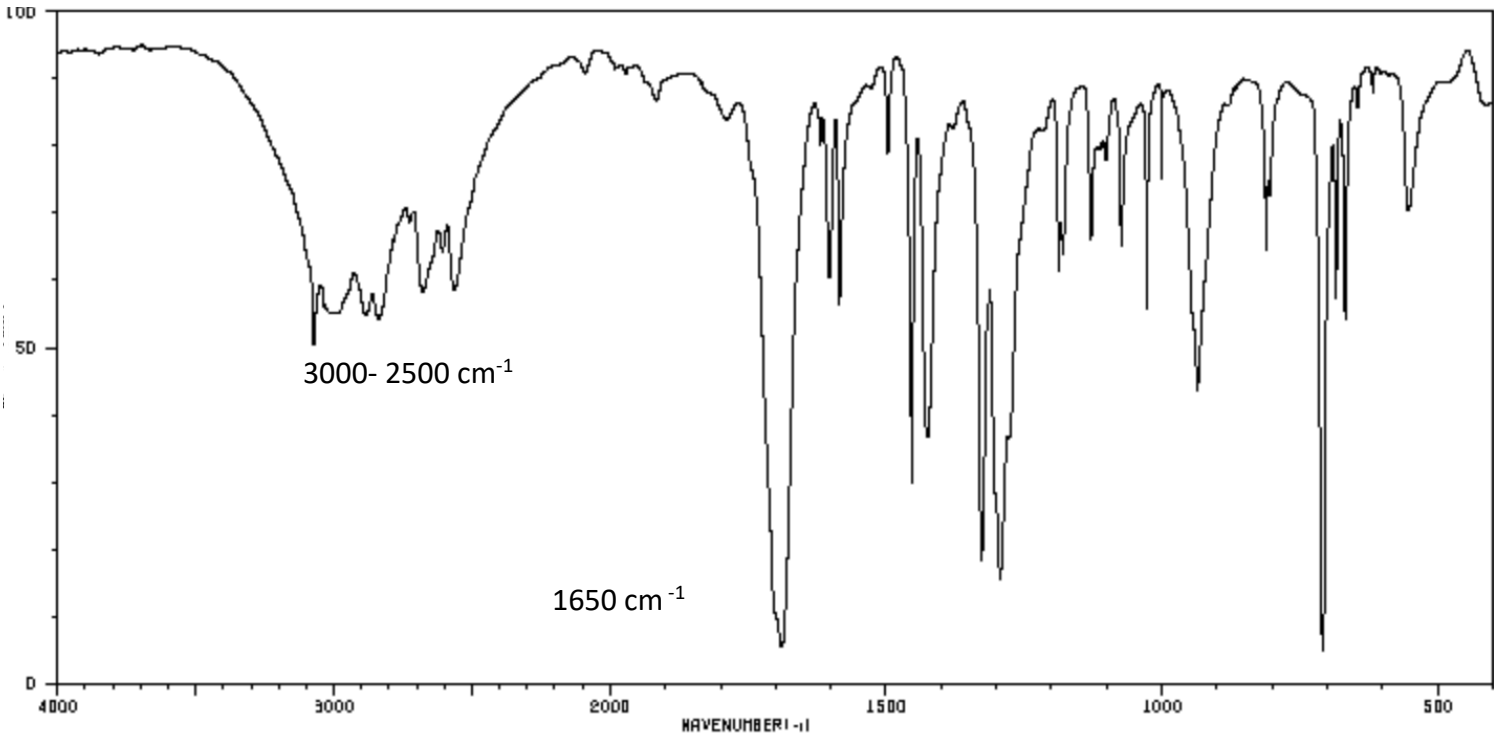
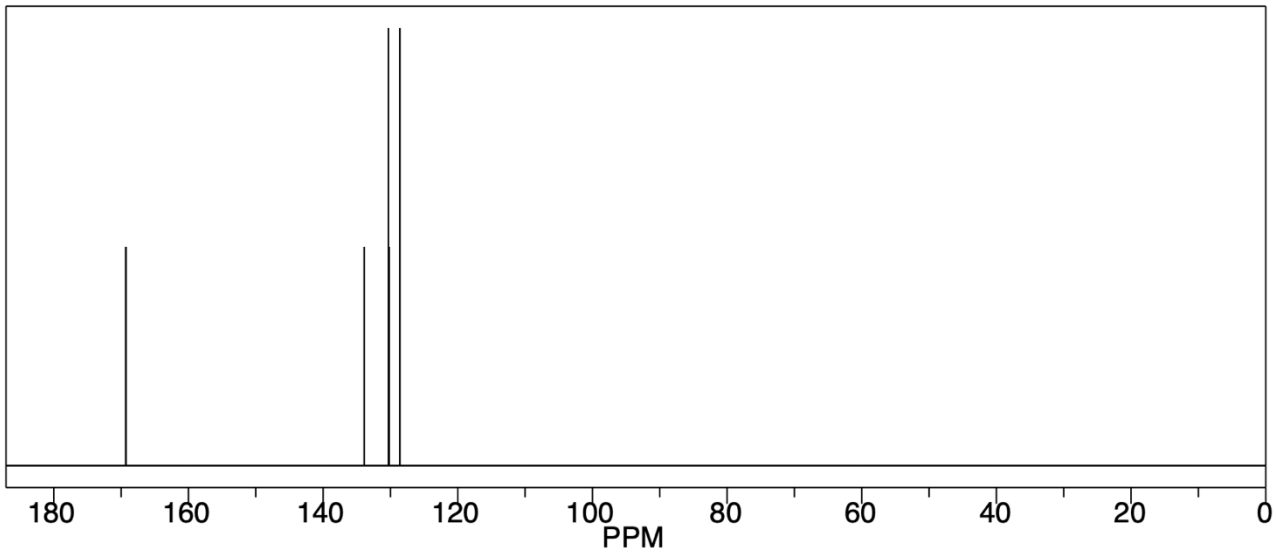
NMR Structure Determination Answers (hard)

The figures below show the IR, ^{13}C NMR and ^{1}H NMR of a compound. Using the information, deduce the structure of the compound.

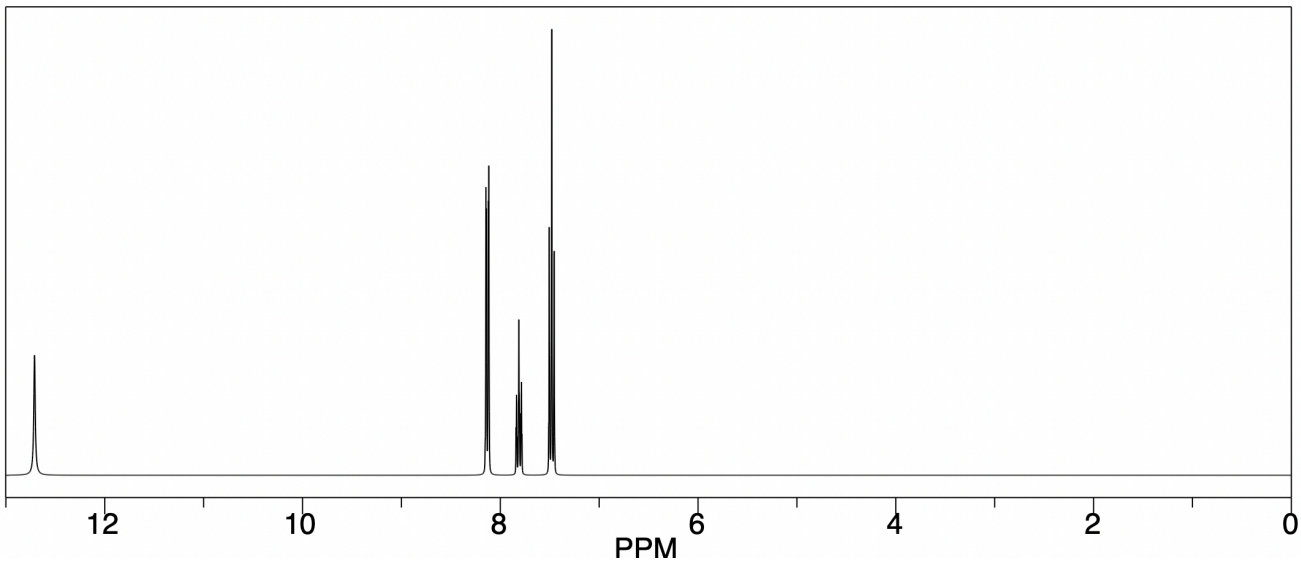
IR:



^{13}C



^{1}H



δ/ppm	12.7	8.1	7.8	7.5
Integration ratio	1	2	2	1
Splitting	s	d	t	t

Starting with IR:
Two peaks have been labelled. From that we can determine that the peak at 3000-2500 cm^{-1}, must be an O-H stretch and the peak at 1650 cm^{-1} is a C=O peak. This means that structure could potentially be an acid, to check further, we need to look at the NMR structures.

^{13}C NMR:
There are four carbon environments.
Carbon environment 1 is approximately 169 ppm, this indicates a carbonyl.
The next three carbon environments all have roughly the same chemical shift value, which would imply they are aromatic carbons.

^{1}H NMR
There are four hydrogen environments.
Hydrogen environment 1 is approximately 12.7 ppm, which is an alcohol. This alcohol must be a carboxylic acid, as it has a much higher chemical shift then it would if it was a primary, secondary, or tertiary alcohol. This also confirms the singlet peak and the integration value of 1.

From the ^{13}C NMR, we also know that we have a benzene ring. There are three environments left and five carbons, this means that the molecule must be symmetrical. We can therefore conclude that the molecule must be benzoic acid.