NAME (Print): _____

SIGNATURE: _____

Chemistry 310N
Dr. Brent Iverson
2nd Homework
January 23, 2008

Please print the first three letters of your last name in the three boxes

Score: _____

(1 pt. each) **Circle all the statements relating to the theory of NMR that are true.**

A magnetic field will cause charges to move.

A magnetic field will not cause charges to move.

Moving charge creates a magnetic field.

Moving charge does not create a magnetic field.

Electrons, neutrons, and protons are all charged.

Neutrons and protons are both charged.

Only electrons are charged.

Both electrons and protons are charged.

Atomic nuclei with an odd atomic mass or an odd atomic number have a quantum mechanical property called spin.

The best way to the think about nuclear spin is as if nuclear postive charge (from the protons) were circulating within the nucleus, thereby creating a small magnetic field that can interact with a strong laboratory magnetic field.

^{1}H and ^{13}C nuclei have a spin quantum number of 2.

^{1}H and ^{13}C nuclei have a spin quantum number of 1.

^{1}H and ^{13}C nuclei have a spin quantum number of 1/2.

The two spins states of a ^{1}H nucleus in a strong magnetic field are +1/2 and -1/2.

The two spins states of a ^{1}H nucleus in a strong magnetic field are +1 and -1.

The two spins states of a ^{1}H nucleus in a strong magnetic field are +2 and -2.

(1 pt. each) **Suppose you place a sample of a molecule in a very strong laboratory magnetic field. Circle the following statements that are true:**

A magnetic field will cause the electron density to circulate in the molecule.

The circulating electron density will create its own magnetic field that is in the same direction as the laboratory magnetic field.

The circulating electron density will create its own magnetic field that opposes the laboratory magnetic field.

A ^{1}H nucleus with spin +1/2 will be higher in energy than an equivalent nucleus with a spin of -1/2

A ^{1}H nucleus with spin +1/2 will be lower in energy than an equivalent nucleus with a spin of -1/2

The difference in energy between +1/2 and -1/2 spin states for a given ^{1}H nucleus is directly proportional to the strength of the external magnetic field.

If electromagnetic energy of the precise energy diffence between the +1/2 and -1/2 spins states is used to irradiate the sample, the energy is absorbed as the spin "flips" from the +1/2 state to the -1/2 state.

If electromagnetic energy of the precise energy diffence between the +1/2 and -1/2 spins states is used to irradiate the sample, the energy is absorbed as the spin "flips" from the -1/2 state to the +1/2 state.

"Resonance" in NMR refers to the phenomenon of absorption of energy when a nuclear spin "flips".

The magnetic field "felt" by any given nucleus in a molecule is actually the sum of (i) the external magnetic field plus (ii) the magnetic field of the electrons around the nucleus plus (iii) the magnetic fields caused by the different spin states of adjacent nuclei.

A ^{1}H nucleus surrounded by greater electron density feels a weaker net magnetic field (external magnetic field plus the induced magnetic field from the circulating electron density) compared to a ^{1}H nucleus surrounded by less electron density.

A ^{1}H nucleus surrounded by greater electron density feels a stronger net magnetic field (external magnetic field plus the induced magnetic field from the circulating electron density) compared to a ^{1}H nucleus surrounded by less electron density.

A ^{1}H nucleus surrounded by greater electron density is considered to be more shielded and comes into resonance (absorbs electromgnetic radiation) at a lower frequency (smaller ppm).

A ^{1}H nucleus surrounded by greater electron density is considered to be more shielded and comes into resonance (absorbs electromgnetic radiation) at a higher frequency (larger ppm).

(1 pt. each) **Here are some more. Circle all of the true statements.**

Increasing shielding is observed for ^1H atoms attached to C atoms hybrizied in the order sp^1, sp^2, sp^3

Pi bonds are deshielding to nearby ^1H nuclei.

TMS is used as a standard in ^1H NMR and is always assigned the value of O ppm

The frequency of electromagnetic radiation that is absorbed by "flipping" ^1H atoms is plotted on the X axis of an NMR spectrum with no correction for magnetic field strength.

The frequency of electromagnetic radiation that is absorbed by "flipping" ^1H atoms is plotted on the X axis of an NMR spectrum with a correction for magnetic field strength, resulting in the units of parts per million (ppm).

The frequency of electromagnetic radiation that is absorbed by "flipping" ^1H atoms is plotted on the X axis of an NMR spectrum with a correction for magnetic field strength, resulting in the units of parts per megabyte (ppm).

If electromagnetic energy of the precise energy diffence between the +1/2 and -1/2 spins states is used to irradiate the sample, the energy is absorbed as the spin "flips" from the +1/2 state to the -1/2 state.

If electromagnetic energy of the precise energy diffence between the +1/2 and -1/2 spins states is used to irradiate the sample, the energy is absorbed as the spin "flips" from the -1/2 state to the +1/2 state.

The magnetic field produced by a nucleus in a –1/2 spin state is different than that of a nucleus in a +1/2 spin state.

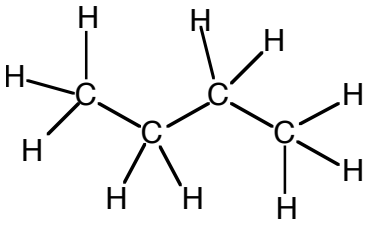
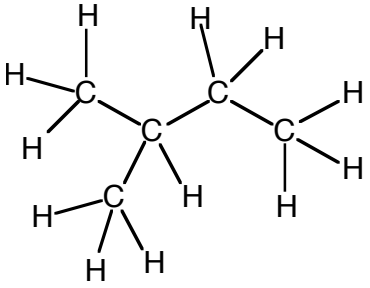
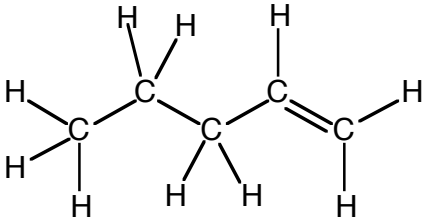
Spin-spin splitting in molecules is caused by the small magnetic fields changes caused by adjacent (no more than three bonds away) nuclei being in the +1/2 state or -1/2 state.

Spin-spin splitting in molecules is caused by some ^1H nuclei flipping from the +1/2 state to the -1/2 state while other ^1H nuclei in the sample are flipping from the -1/2 state to the +1/2 state.

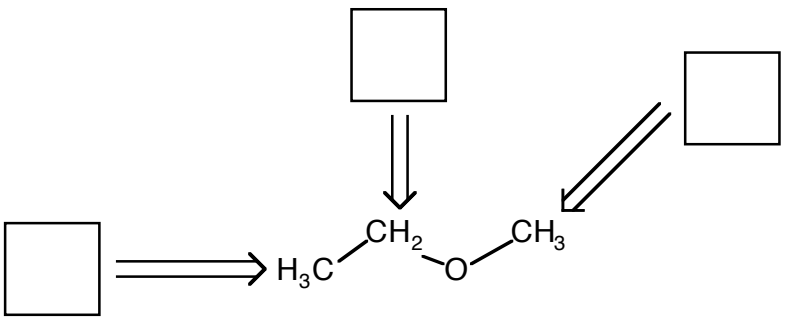
The "N+1" rule means that a given signal will be split into N+1 peaks if it is adjacent to N equivalent H atoms in a molecule.

The "N+1" rule means that if you play in the Rose Bowl N+1 times, you will win N National Championships.

(1 pt. each) **For this problem you need to ignore spin-spin splitting, in that we consider one signal to be derived from one set of equivalent H atoms, regardless of splitting pattern. For each of the next three molecules, on the lines provided state how many sets of equivalent sets of H atoms are present, next state how many different signals will appear in the ^{1}H NMR spectrum of each, and finally, the relative ratios of the integrations of the different signals (i.e. 1:2 or 1:2:6, etc.).**

	Number of sets of equivlaent H atoms	Number of different signals in the NMR spectrum	Ratio of signal integrations
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

(1 pt. each) **For the following molecule, in the boxes provided, state the number of peaks you expect in each ^{1}H NMR signal due to spin-spin splitting.**



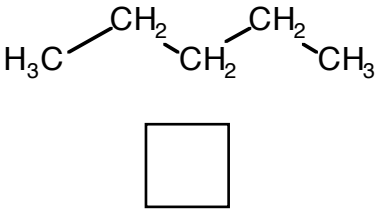
(not graded) These two questions will not be graded, but turn them in anyway. They will help you organize your thoughts regarding NMR and MRI. Something linke this might show up on the exam and that will be graded!

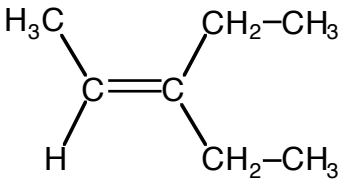
In no more than four sentences, explain what happens in a ^{1}H NMR experiment.

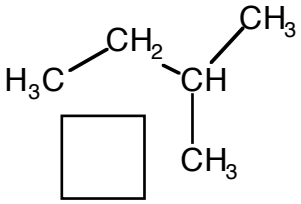
Suppose a relative of yours is having an MRI. In no more than four sentences, explain to them what is happening when they have the MRI scan.

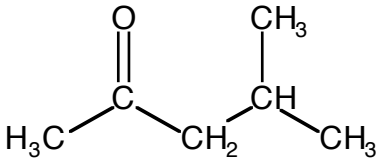
Homework Problem Set 2 Iverson CH310N Due Friday, February 1

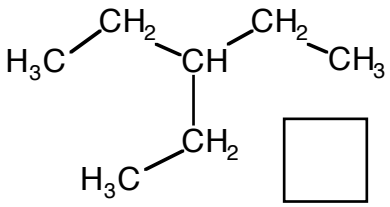
On the following pages there are six NMR spectra. The relative integrations are given above each signal. Assign each spectra to the appropriate structure out of the following possibilities. **Each NMR spectrum has a letter on it. Write the appropriate letter underneath the molecules in the space provided.** Notice that not all of the molecules below will have letters underneath them, as there are only six spectra but ten molecules. You didn't want us to make it too easy, did you? We recommend you print the problems as the spectra are easier to read when printed.

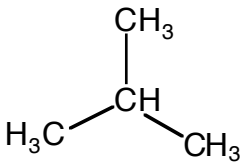


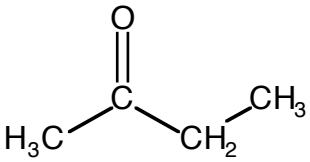


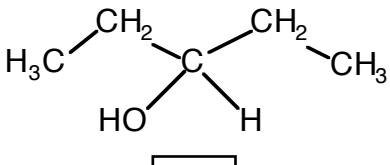


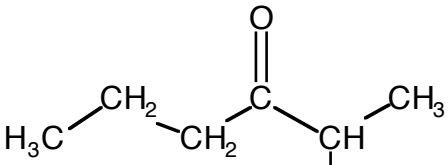


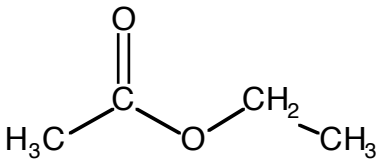




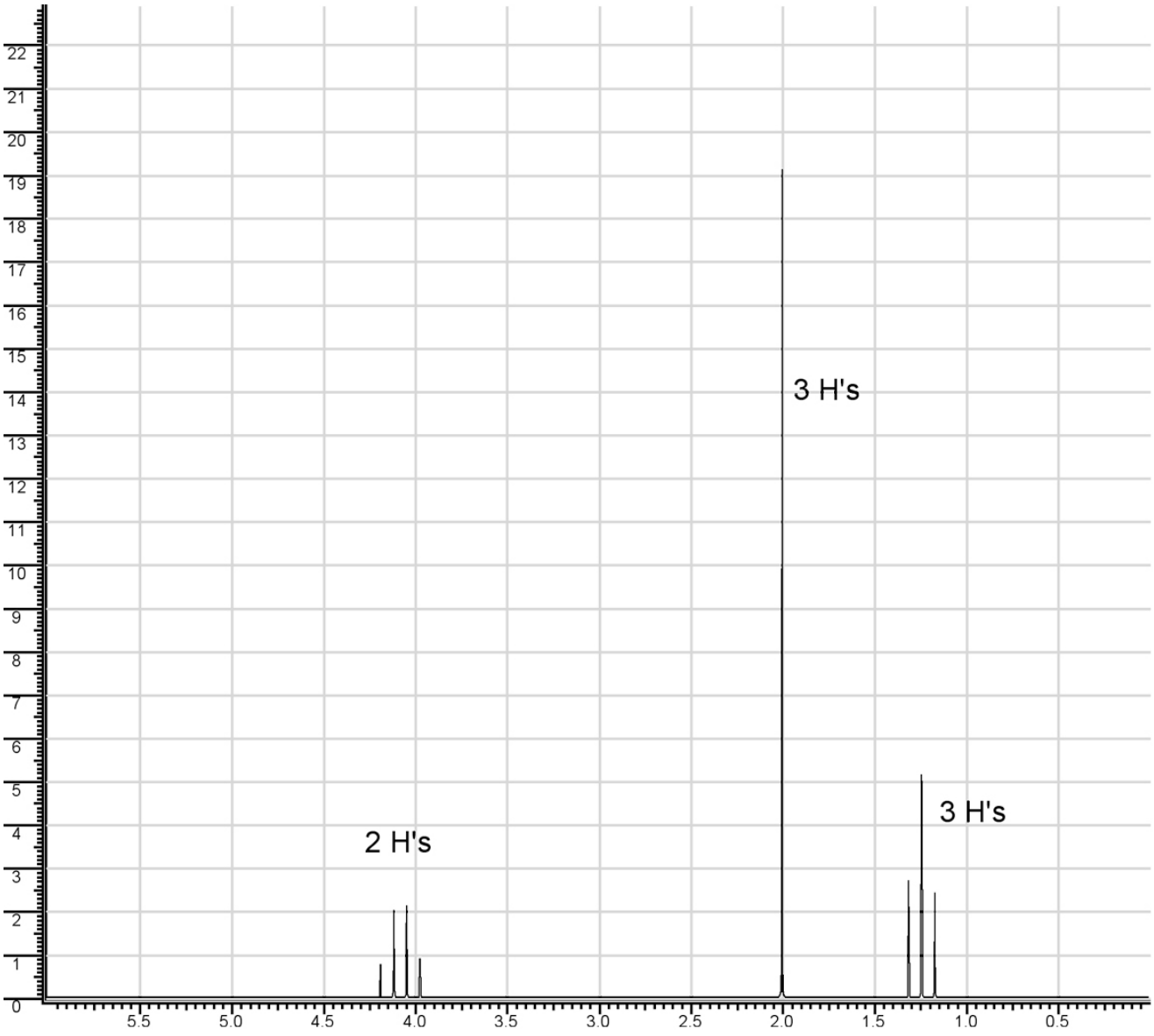








A


3 H's
2 H's
3 H's
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21
20
19
18
17
16
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8
7
6
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4
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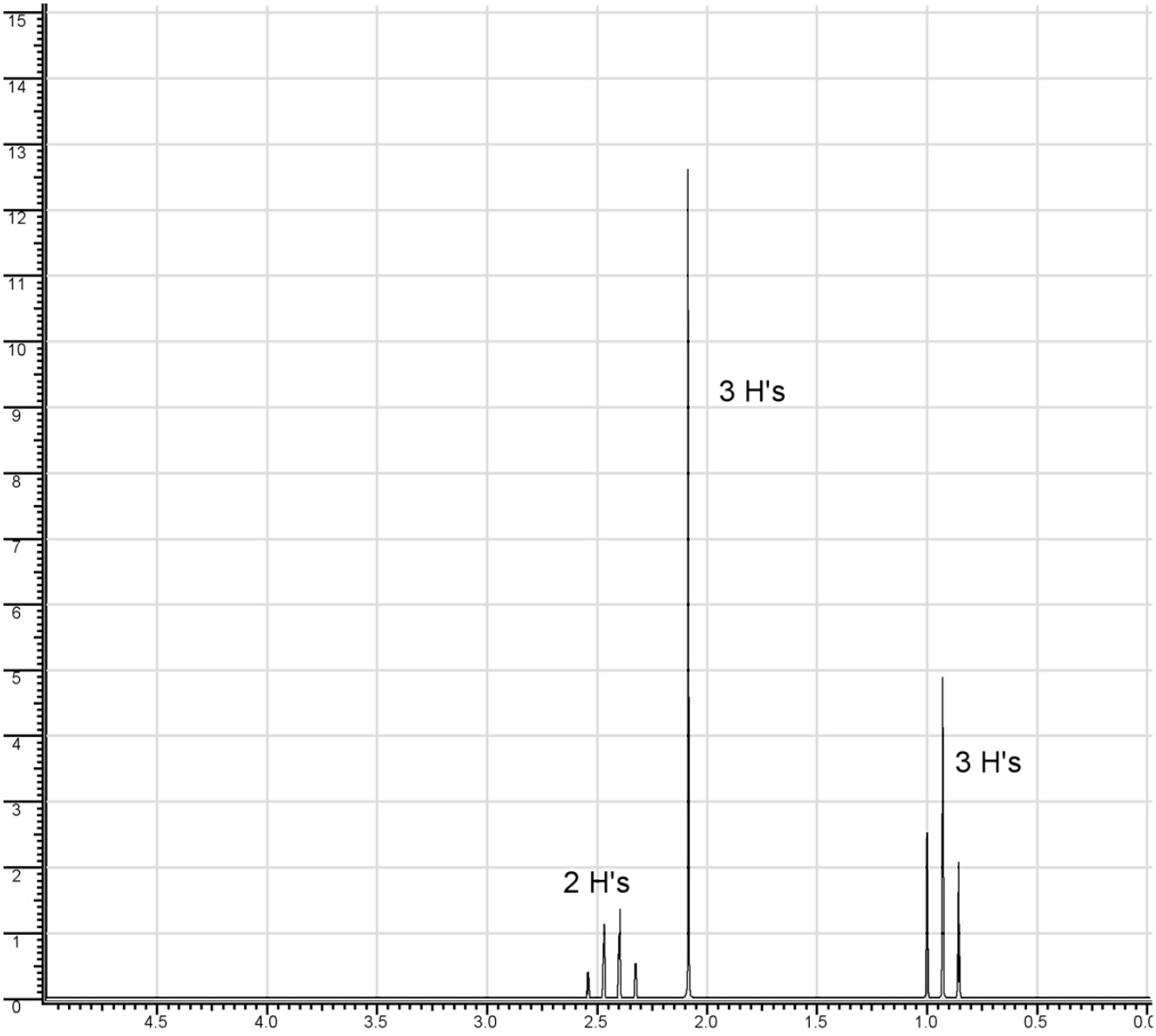
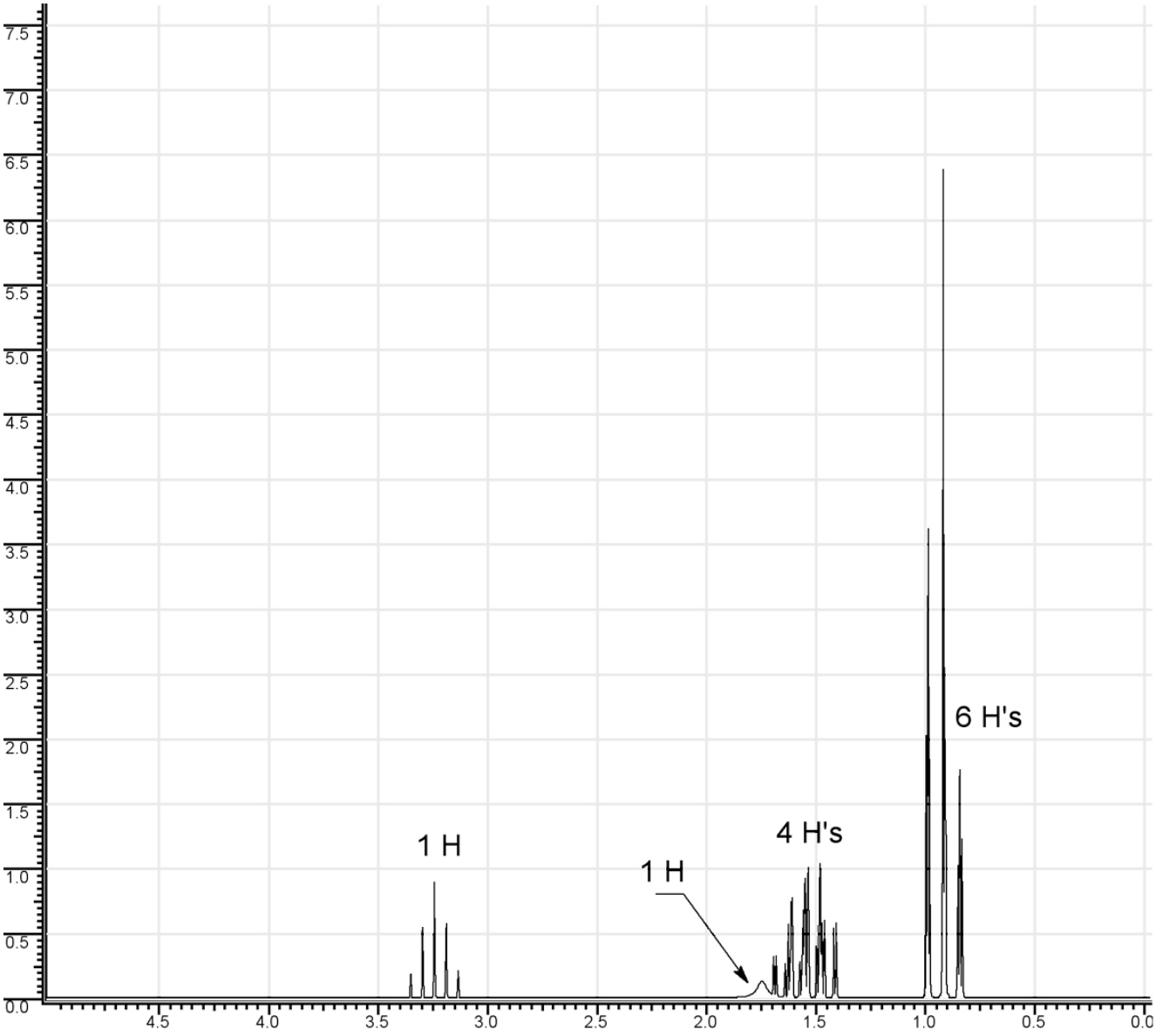
B



C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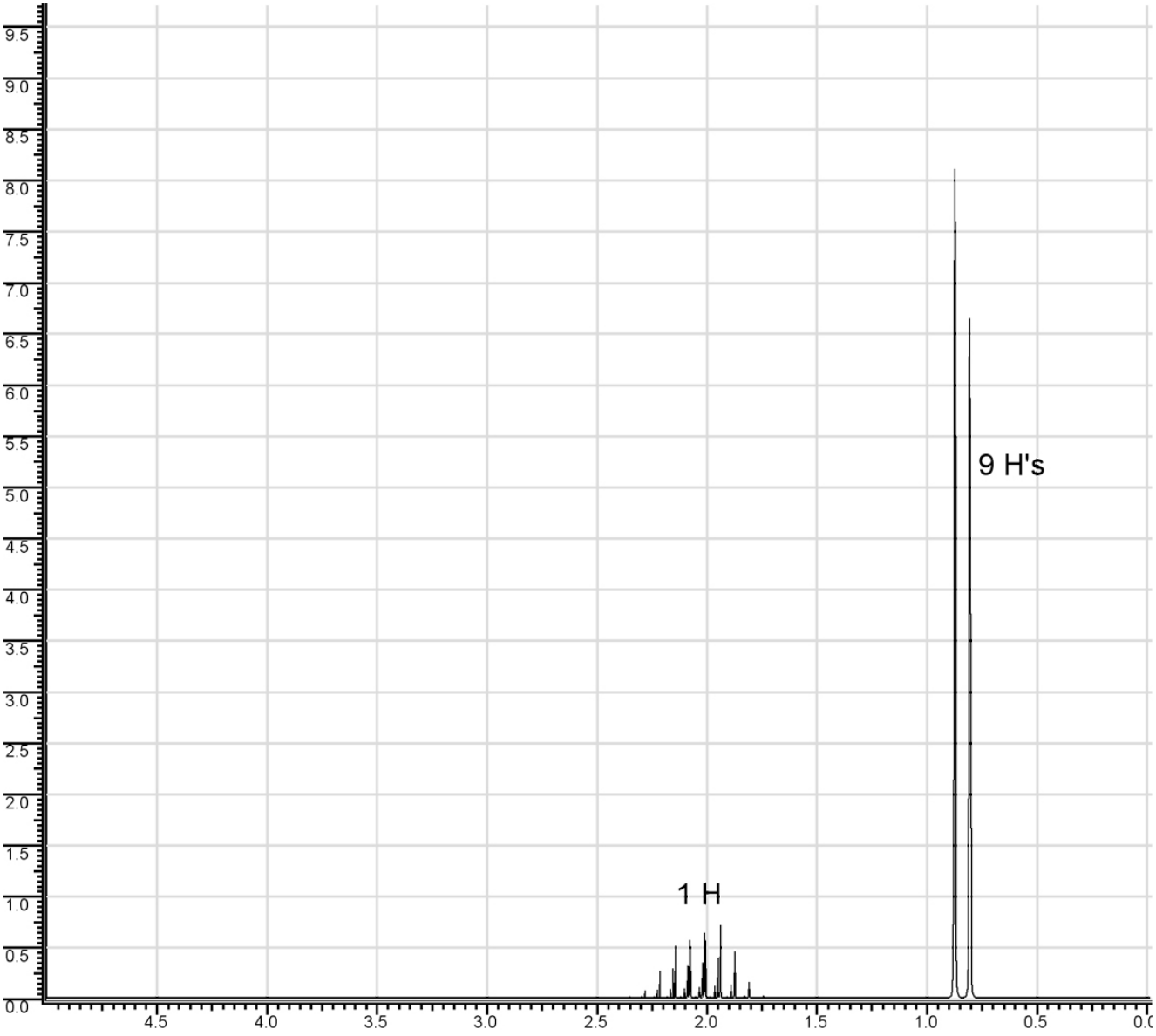
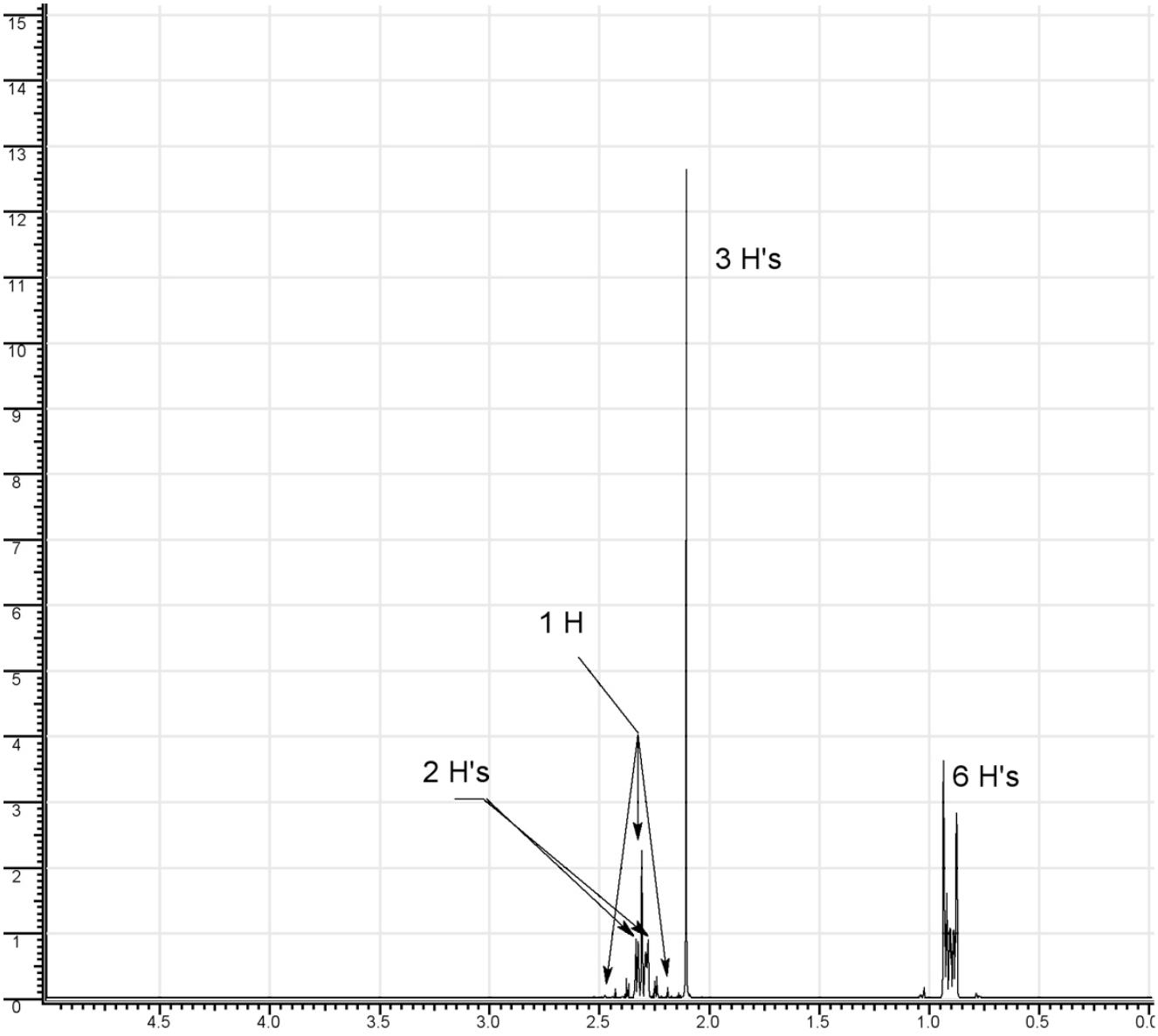
6 H's

D



E


3 H's
1 H
2 H's
6 H's
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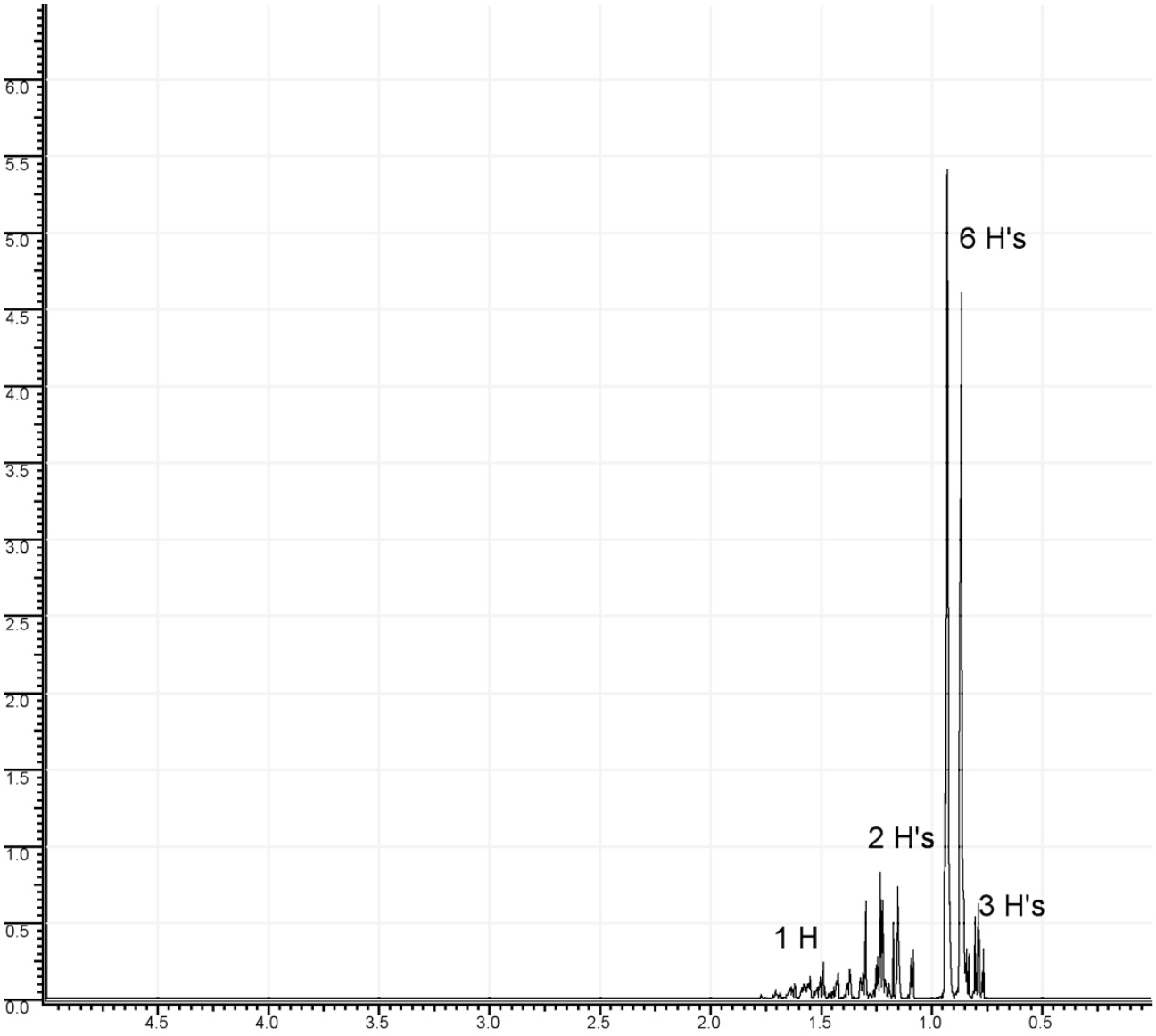
F


6 H's
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