

## Jigsaw 3B

### Home Section 3.3. Multiplet patterns

1. The  $^{17}\text{O}$  spectrum of  $\text{H}_2^{17}\text{O}$  is a triplet. The  $^1\text{H}$  spectrum has six equally spaced lines with the same intensity. What is the nuclear spin of  $^{17}\text{O}$ ?

2 equivalent protons are coupled to  $^{17}\text{O}$ : # of lines =  $2n_{\text{H}}I_{\text{H}} + 1$   
 $6 = 2 \cdot 1 \cdot I_{\text{H}} + 1$   
 $I(^{17}\text{O}) = \frac{5}{2}$

2. The  $^1\text{H}$  spectrum of  $\text{CH}_2\text{D}_2$  contains five lines.

- a. What are their relative intensities?

$m = +2, +1, 0, -1, -2$        $m = -1, 0, 1$  as  $I = 1$   
relative intensities     $1:2:3:2:1$

- b. How many lines are there in the  $^1\text{H}$  spectrum of  $\text{CHD}_3$ ?

The proton couples to 3 equivalent deuterons ( $I = 1$ ): # of lines =  $2n_{\text{D}}I_{\text{D}} + 1$   
 $= 2 \cdot 3 \cdot 1 + 1$   
 $= 7$

Good justification!

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### Home Section 3.3. Multiplet patterns

1. The  $^{17}\text{O}$  spectrum of  $\text{H}_2^{17}\text{O}$  is a triplet. The  $^1\text{H}$  spectrum has six equally spaced lines with the same intensity. What is the nuclear spin of  $^{17}\text{O}$ ?

*Coupling to nuclei with spin quantum number  $I$  produces  $2I+1$  lines*

$$6 = 2I + 1 \Rightarrow I = \frac{6-1}{2} = \frac{5}{2}$$

2. The  $^1\text{H}$  spectrum of  $\text{CH}_2\text{D}_2$  contains five lines.

- a. What are their relative intensities?

$$I(\text{D}) = 1$$

$$m = -1, 0, +1$$

$D_1$	$D_2$	$m_{\text{TOT}}$
-1	-1	-2
-1	0	-1
0	-1	-1
-1	+1	0
0	0	0
+1	-1	0
0	+1	+1
+1	0	+1
+1	+1	+2

$\Rightarrow$  1:2:3:2:1  
pattern

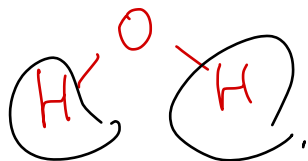
- b. How many lines are there in the  $^1\text{H}$  spectrum of  $\text{CHD}_3$ ?

Work justifications...

$$M_{\text{TOT}} = -3, -2, -1, 0, +1, +2, +3$$

$$\Rightarrow 7 \text{ lines}$$

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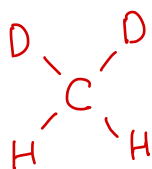


### More Section 3.3. Multiplet patterns

1. The  $^{17}\text{O}$  spectrum of  $\text{H}_2^{17}\text{O}$  is a triplet. The  $^1\text{H}$  spectrum has six equally spaced lines, with the same intensity. What is the nuclear spin of  $^{17}\text{O}$ ?

$$2I + 1 = 6$$

$$I = \frac{5}{2}$$



2. The  $^1\text{H}$  spectrum of  $\text{CH}_2\text{D}_2$  contains five lines.

$$D: +1, 0, -1$$

- a. What are their relative intensities?

$$2, 1, 0, -1, -2$$

$$\boxed{1 : 2 : 3 : 2 : 1}$$

Work justifications...

- b. How many lines are there in the  $^1\text{H}$  spectrum of  $\text{CHD}_3$ ?

$$7.$$

$$3, 2, 1, 0, -1, -2, -3$$

$$1 \ 3 \ 6 \ 7 \ 6 \ 3 \ 1$$