

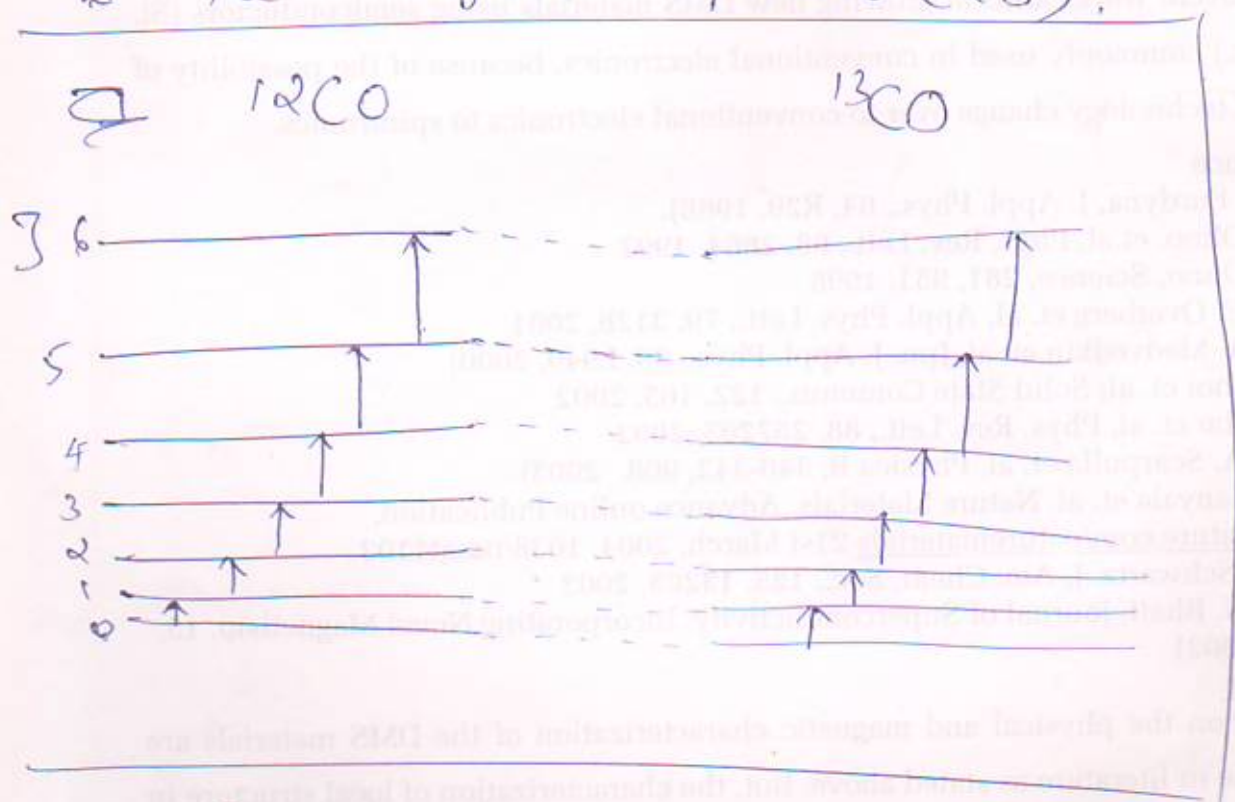
# The effect of isotopic substitution (b)

Consider CO (carbon monoxide) as an example.

When going from  $^{12}\text{C}^{16}\text{O}$  to  $^{13}\text{C}^{16}\text{O}$ , there is a mass increase, & hence a decrease in the B value.

$(B \propto \frac{1}{I})$ . Let the B for  $^{13}\text{C}$  is  $B'$   
 $(B = B, \text{ for } ^{12}\text{C})$

The heavier species will show smaller separation between lines ( $2B'$ ) compared to the lighter species ( $2B$ ).



The values of B from the figure

i  $B = 1.921 \text{ cm}^{-1}$

heavier  $B' = 1.836 \text{ cm}^{-1}$

$$\frac{B}{B'} = \frac{h}{8\pi^2 T_c} \frac{8\pi^2 I' c}{h} = \frac{I'}{I} = 1.046$$

$M = \text{reduced mass} \left( M = \frac{m_1 m_2}{m_1 + m_2} \right)$  (2)6

Mass of Oxygen  $\rightarrow 15.9994 \rightarrow m_1$

12C  $\rightarrow 12.000 \rightarrow m_2$   
( $m \approx 13$ )

$$\frac{M'}{M} = 1.046 = \frac{15.9994 \times m'}{15.9994 + m'} \times \frac{12 + 15.9994}{12 \times 15.9994}$$

$m'$  is found to be 13.007

$\therefore$  The atomic mass of  $^{13}\text{C}$  is 13.007