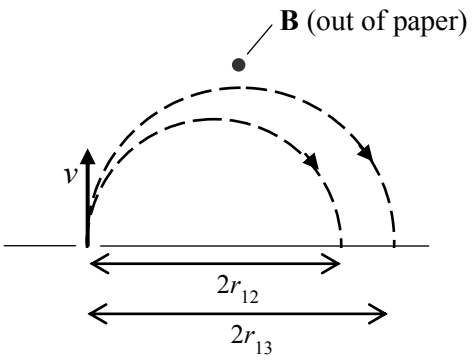
19. ***REASONING*** The drawing shows the velocity **v** of the carbon atoms as they enter the magnetic field **B**. The diameter of the circular path followed by the carbon-12 atoms is labeled as $2r_{12}$, and that of the carbon-13 atoms as $2r_{13}$, where r denotes the radius of the path. The radius is given by Equation 21.2 as $r = mv/(|q|B)$, where q is the charge on the ion (q = +e). The difference Δd in the diameters is $\Delta d = 2r_{13} - 2r_{12}$ (see the drawing).



SOLUTION The spatial separation between the two isotopes after they have traveled though a half-circle is

$$\Delta d = 2r_{13} - 2r_{12} = 2\left(\frac{m_{13}v}{eB}\right) - 2\left(\frac{m_{12}v}{eB}\right) = \frac{2v}{eB}\left(m_{13} - m_{12}\right)$$

$$= \frac{2\left(6.667\times10^{5}\ \text{m/s}\right)}{\left(1.60\times10^{-19}\ \text{C}\right)\left(0.8500\ \text{T}\right)}\left(21.59\times10^{-27}\ \text{kg} - 19.93\times10^{-27}\ \text{kg}\right) = \boxed{1.63\times10^{-2}\ \text{m}}$$