Problem 29.13

The radius of a proton moving centripetally is:

$$\begin{aligned} q_p v_p B\sin\theta &= ma_c \\ &= m_p \frac{v_p^2}{r_p} \\ \Rightarrow \quad r_p &= m_p \frac{v_p}{q_p B\sin\theta} \end{aligned}$$

To execute this, we need to know the particle's velocity (produced by its acceleration through the potential difference ΔV). That is a job for the conservation of energy, and as all the accelerated charges are positive, we have:

$$\begin{aligned} \sum KE_1 + \sum U_1 + \sum W_{ext} &= \sum KE_2 + \sum U_2 \\ 0 \quad + \quad q_p V \quad + \quad 0 \quad &= \left(\frac{1}{2}\right) m_p v_p^2 + \quad 0 \\ \Rightarrow \quad v_p &= \left(\frac{2q_p V}{m_p}\right)^{1/2} \end{aligned}$$

Putting this all together:

$$\begin{aligned} r_p &= m_p \frac{v_p}{q_p B\sin\theta} \\ &= \left(\frac{2m_p V}{q_p B^2}\right)^{1/2} \end{aligned}$$

a.) Replacing the mass for deuterium, we get:

$$\begin{aligned} r_d &= \left(\frac{2(2m_p)V}{q_p B^2}\right)^{1/2} \\ &= \sqrt{2}r_p \end{aligned}$$

b.) Replacing the mass for alpha particle, we get:

$$\begin{aligned} r_a &= \left(\frac{2(4m_p)V}{(2q_p)B^2}\right)^{1/2} \\ &= \sqrt{2}r_p \end{aligned}$$