8. Find velocity

Cyclotron problem, e.g., 27-11, p. 103:

\[ R = \frac{mv}{qB} \Rightarrow \frac{v}{m} = \frac{qRB}{Kg} \times \frac{m/s}{s} \]

\[ v = \frac{1.6 \times 10^{-19} C \times 6.96 \times 10^{-3} m \times 2.50 \times m/s}{3.34 \times 10^{-27} Kg} \]

\[ = \frac{2.784 \times 10^{-21} m/s}{3.34 \times 10^{-27}} \]

\[ \boxed{v = 8.34 \times 10^{5} m/s} \]

(b) Time required to make \( \frac{1}{2} \) a revolution

\[ as \ always, \ distance \ traveled = velocity \times time \quad (D = vt) \]

\[ \Rightarrow t = \frac{D}{v} = \frac{\pi R}{v} = \frac{\pi}{2} \text{ circumference of circular orbit} \]

\[ t = \frac{\pi (6.96 \times 10^{-3} m^2)}{8.34 \times 10^{5} m/s} = 2.62 \times 10^{-8} s \]

\[ \boxed{t = 26.2 \ ns} \]

(c) Through what pot. diff. would the Deuteron have to be accelerated to acquire this speed?

See p. 1034, Eq. 27-14. The speed (v) is determined by the accelerating potential V (what we are looking for here).

The KE \( \left( \frac{1}{2} m v^2 \right) \) equals the loss of electric potential energy \( (qV) \), so

\[ \frac{1}{2} m v^2 = qV \quad \text{(27-14)} \]

\[ v = \frac{m \times v^2}{2q} \]
\[ V = \left( \frac{3.34 \times 10^{-27} \text{ kg}}{2(1.6 \times 10^{-19} \text{ C})} \right) \left( 8.34 \times 10^5 \text{ m/s} \right)^2 \left( \frac{\text{kg} \cdot \text{m}^2}{\text{s} \cdot \text{C}} \right) \frac{\text{m}^2}{\text{C}} = \frac{e^2}{c^2} = V \]

\[ = \frac{2.32 \times 10^{-15}}{3.2 \times 10^{-19}} \text{ V} \]

\[ = 7.26 \text{ V} \]

\[ V = 7.26 \text{ kV} \]