A particle with charge 2.15 \(\mu\text{C}\) and mass 3.2\(\times10^{-11}\) kg is initially traveling in the +x direction with a speed \(V_0=1.45\times10^3\) m/s. It then enters a region containing a uniform magnetic field that is perpendicular to the page (see the Figure). This region extends a distance 25 cm along the initial direction of travel; 75 cm from the point of entry into the magnetic field region is a screen. When the charged particle enters the magnetic field, it follows a curved path whose radius is 5.14 m. It then leaves the magnetic field having been deflected a distance \(d\). The particle then travels in the field-free region and strikes the screen after undergoing a total deflection \(D\).

1) \(20\) Determine the magnitude and direction (into or out the page) of the magnetic field.

2) \(10\) Determine \(d\), the deflection at the point of exit from the field.

\(8\) Determine \(D\), the total deflection.

\[ F_m = qv_B \times B \]

\[ m\frac{v_B^2}{R} = qB \]

\[ B = \frac{m v_B}{R q} = \frac{3.2 \times 10^{-11} \times 1.45 \times 10^3}{5.14 \times 2.15 \times 10^{-6}} = 4.2 \times 10^{-1} \text{T} \]

\[ d = R - \sqrt{R^2 - \left(\frac{L}{2}\right)^2} = \frac{L^2}{2R} = \frac{625 \times 10^{-4}}{2 \times 5.14} = 0.5 \times 10^{-2} \text{m} \]

\[ D = d + (L - d) \tan \theta = \frac{L}{\sqrt{R^2 + L^2}} = \frac{25 \times 10^{-2}}{5.14} = 5 \times 10^{-2} \text{m} \]

\[ d = 6.1 \times 10^{-2} + 0.5 \times 10^{-2} = 6.6 \times 10^{-2} \text{m} = 6.6 \text{ cm} \]
1) (15) Find the current through the 10 V battery.
2) (8) Find the power output of this battery if 1 \( \Omega \) is an internal resistance of this battery.
3) (12) Find the voltage \( V_{ab} \) if the circuit is broken now at the point \( x \).

\[
\text{1. } I_1 = I_2 + I_3 \Rightarrow I_3 = I_1 - I_2
\]

\[
\begin{align*}
\text{1. } 12 V - 4 \Omega I_1 - 4 \Omega I_2 - 10 V &= 0 \\
2 V &= 4 \Omega (I_1 + I_2) \Rightarrow I_1 + I_2 = 0.5 A
\end{align*}
\]

\[
\begin{align*}
10 V + 4 \Omega I_2 - 3 \Omega I_3 - 8 V &= 0 \\
2 V + 4 \Omega I_2 - 3 \Omega (I_1 - I_2) &= 0
\end{align*}
\]

\[
0.5 V + 10 \Omega I_2 = 0 \Rightarrow I_2 = -0.05 A
\]

\[
2) p_{out}^{10V} = (10 V - 0.05 V) 0.05 A \approx 0.5 W
\]

\[
3. \quad I = \frac{12 V - 8 V}{7 \Omega} = 0.57 A
\]

\[
V_{cd} = 12 V - 10 V - 4 \Omega I = 12 V - 10 V - 2.29 = -0.29 V
\]

or (lower branch)

\[
10 V + V_{ab} - 3 \Omega I - 8 V = 0 \Rightarrow
\]

\[
V_{ab} = 8 V - 10 V + 1.71 V = -0.29 V
\]
1. a) \( i = \frac{t}{6R} + \frac{t}{3R} = \frac{3}{6R} \rightarrow R' = 2R, (Q_c = 0, V_c = 0) \) 

\[ R_{eq} = 8R + 2R = 10R \]  

\[ I = \frac{42V}{10R} = 4.2A \]  

\[ V_{eq} = V_{2R} \rightarrow 2I_{eq} = I_{3R}, \quad I_{6R} + I_{3R} = 4.2A \]  

\[ 3I_{6R} = 4.2A \rightarrow I_{6R} = 1.4A, \quad I_{3R} = 2.8A \]  

1. b) \( R_{eq} = 14\Omega \) (current does not go through capacitor.)  

\[ I = \frac{42V}{14\Omega} = 3A, \quad V_{4\mu F} = V_{6R} = 18V \]  

\( Q_{4\mu F} = 4\mu F \cdot 18V = 72\mu C \)  

2. \( V_c = \frac{Q}{C} = \frac{Q}{3C} \)  

\[ i = I_o e^{-\frac{t}{RC}} = \frac{Q}{3C} e^{-\frac{t}{RC}} = \frac{1}{3} \]  

\[ I_o = \frac{Q}{R_{eq}C} \]  

\[ I_o = \frac{22\mu C}{9\Omega \times 4\mu F} = 2A \quad \hat{i} = \frac{2}{3}A \]