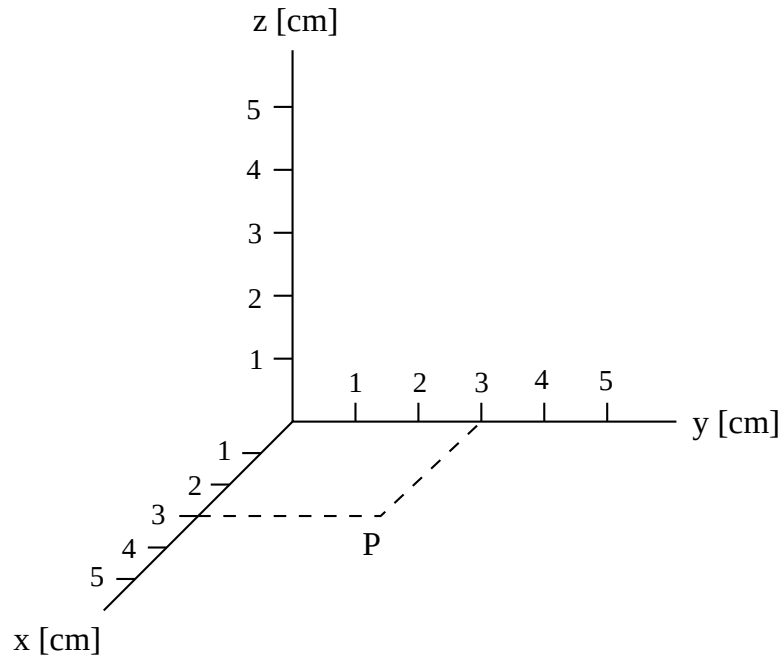
Unit Exam III: Problem #1 (Spring '13)

In a region of uniform magnetic field $\mathbf{B}$ a proton $(m = 1.67 \times 10^{-27}\text{kg},\ q = 1.60 \times 10^{-19}\text{C})$ experiences a force $\mathbf{F} = 9.0 \times 10^{-19}\text{N}\,\hat{\mathbf{i}}$ as it passes through point P with velocity $\mathbf{v}_0 = 3000\text{m/s}\,\hat{\mathbf{j}}$ on a circular path.

(a) Find the magnetic field $\mathbf{B}$ (magnitude and direction).

(b) Calculate the radius r of the circular path.

(c) Locate the center C of the circular path in the coordinate system on the page.



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(a) Find the magnetic field $\mathbf{B}$ (magnitude and direction).
(b) Calculate the radius r of the circular path.
(c) Locate the center C of the circular path in the coordinate system on the page.

Solution:

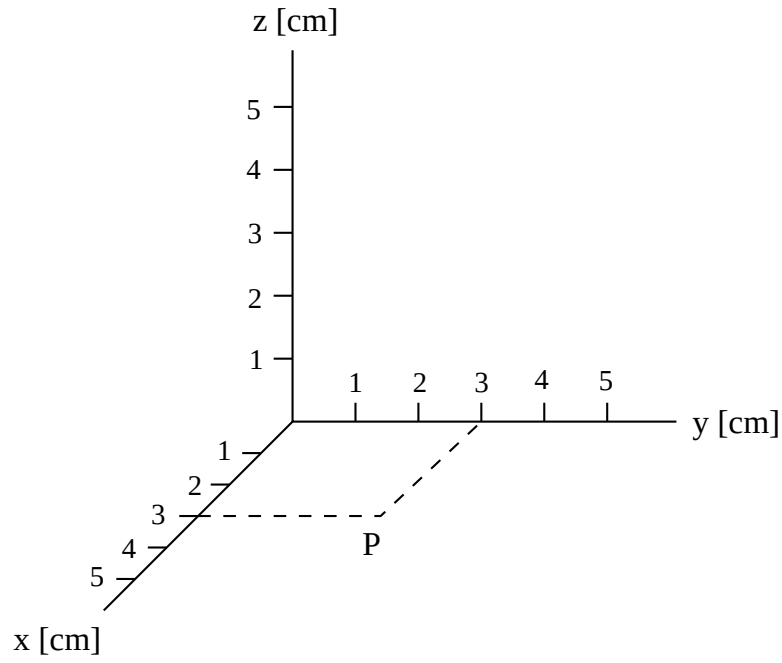
(a) $B = \dfrac{F}{qv_0} = 1.88 \times 10^{-3}\text{T}, \quad \hat{\mathbf{i}} = \hat{\mathbf{j}} \times \hat{\mathbf{k}}$

$\Rightarrow\ \mathbf{B} = 1.88 \times 10^{-3}\text{T}\,\hat{\mathbf{k}}.$

(b) $F = \dfrac{mv_0^2}{r} = qv_0 B$

$\Rightarrow\ r = \dfrac{mv_0^2}{F} = \dfrac{mv_0}{qB} = 1.67\text{cm}.$

(c) $C = 4.67\text{cm}\,\hat{\mathbf{i}} + 3.00\text{cm}\,\hat{\mathbf{j}}.$



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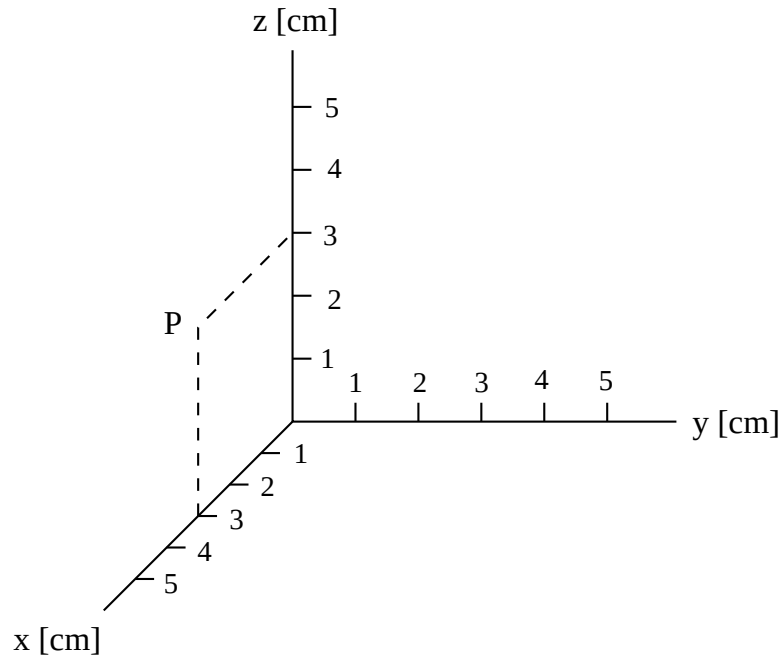
In a region of uniform magnetic field $\mathbf{B}$ a proton $(m = 1.67 \times 10^{-27}\text{kg},\ q = 1.60 \times 10^{-19}\text{C})$ experiences a force $\mathbf{F} = 8.0 \times 10^{-19}\text{N}\,\hat{\mathbf{i}}$ as it passes through point P with velocity $\mathbf{v}_0 = 2000\text{m/s}\,\hat{\mathbf{k}}$ on a circular path.

(a) Find the magnetic field $\mathbf{B}$ (magnitude and direction).

(b) Calculate the radius r of the circular path.

(c) Locate the center C of the circular path in the coordinate system on the page.



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(a) Find the magnetic field $\mathbf{B}$ (magnitude and direction).
(b) Calculate the radius r of the circular path.
(c) Locate the center C of the circular path in the coordinate system on the page.

Solution:

(a) $B = \dfrac{F}{qv_0} = 2.50 \times 10^{-3}\text{T}, \quad \hat{\mathbf{i}} = \hat{\mathbf{k}} \times (-\hat{\mathbf{j}})$

$\Rightarrow\ \mathbf{B} = -2.50 \times 10^{-3}\text{T}\,\hat{\mathbf{j}}.$

(b) $F = \dfrac{mv_0^2}{r} = qv_0B$

$\Rightarrow\ r = \dfrac{mv_0^2}{F} = \dfrac{mv_0}{qB} = 0.835\text{cm}.$

(c) $C = 3.84\text{cm}\,\hat{\mathbf{i}} + 3.00\text{cm}\,\hat{\mathbf{k}}.$