Unit Exam III: Problem #1 (Spring '16)

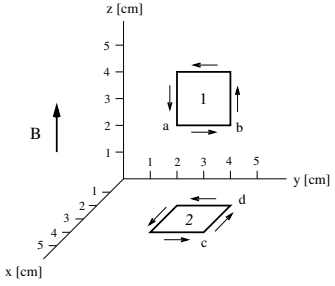
Conducting squares 1 and 2, each of side 2cm, are positioned as shown. A current $I = 3\text{A}$ is flowing around each square in the direction shown. A uniform magnetic field $\vec{B} = 5\text{mT}\hat{\mathbf{k}}$ exists in the entire region.

(a) Find the forces $\vec{F}_{ab}$ and $\vec{F}_{cd}$ acting on sides ab and cd, respectively.

(b) Find the magnetic moments $\vec{\mu}_1$ and $\vec{\mu}_2$ of squares 1 and 2, respectively.

(c) Find the torques $\vec{\tau}_1$ and $\vec{\tau}_2$ acting on squares 1 and 2, respectively.

Remember that vectors have components or magnitude and direction.



Unit Exam III: Problem #1 (Spring '16)

Conducting squares 1 and 2, each of side 2cm, are positioned as shown. A current $I = 3\text{A}$ is flowing around each square in the direction shown. A uniform magnetic field $\vec{B} = 5\text{mT}\hat{\mathbf{k}}$ exists in the entire region.

(a) Find the forces $\vec{F}_{ab}$ and $\vec{F}_{cd}$ acting on sides ab and cd, respectively.

(b) Find the magnetic moments $\vec{\mu}_1$ and $\vec{\mu}_2$ of squares 1 and 2, respectively.

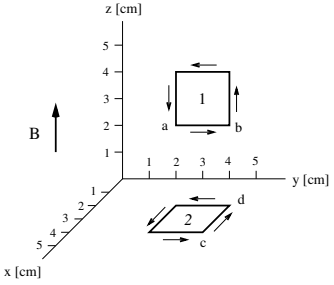
(c) Find the torques $\vec{\tau}_1$ and $\vec{\tau}_2$ acting on squares 1 and 2, respectively.

Remember that vectors have components or magnitude and direction.

Solution:

(a) $\vec{F}_{ab} = (3\text{A})(2\text{cm}\hat{\mathbf{j}}) \times (5\text{mT}\hat{\mathbf{k}}) = 3 \times 10^{-4}\text{N}\hat{\mathbf{i}}.$

$\vec{F}_{cd} = (3\text{A})(-2\text{cm}\hat{\mathbf{i}}) \times (5\text{mT}\hat{\mathbf{k}}) = 3 \times 10^{-4}\text{N}\hat{\mathbf{j}}.$



Unit Exam III: Problem #1 (Spring '16)

Conducting squares 1 and 2, each of side 2cm, are positioned as shown. A current $I = 3\text{A}$ is flowing around each square in the direction shown. A uniform magnetic field $\vec{B} = 5\text{mT}\hat{\mathbf{k}}$ exists in the entire region.

(a) Find the forces $\vec{F}_{ab}$ and $\vec{F}_{cd}$ acting on sides ab and cd, respectively.

(b) Find the magnetic moments $\vec{\mu}_1$ and $\vec{\mu}_2$ of squares 1 and 2, respectively.

(c) Find the torques $\vec{\tau}_1$ and $\vec{\tau}_2$ acting on squares 1 and 2, respectively.

Remember that vectors have components or magnitude and direction.

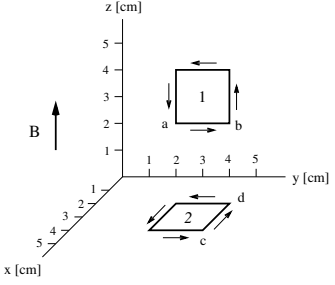
Solution:

(a) $\vec{F}_{ab} = (3\text{A})(2\text{cm}\hat{\mathbf{j}}) \times (5\text{mT}\hat{\mathbf{k}}) = 3 \times 10^{-4}\text{N}\hat{\mathbf{i}}.$

$\vec{F}_{cd} = (3\text{A})(-2\text{cm}\hat{\mathbf{i}}) \times (5\text{mT}\hat{\mathbf{k}}) = 3 \times 10^{-4}\text{N}\hat{\mathbf{j}}.$

(b) $\vec{\mu}_1 = (2\text{cm})^2(3\text{A})\hat{\mathbf{i}} = 1.2 \times 10^{-3}\text{Am}^2\hat{\mathbf{i}}.$

$\vec{\mu}_2 = (2\text{cm})^2(3\text{A})\hat{\mathbf{k}} = 1.2 \times 10^{-3}\text{Am}^2\hat{\mathbf{k}}.$



Unit Exam III: Problem #1 (Spring '16)

Conducting squares 1 and 2, each of side 2cm, are positioned as shown. A current $I = 3\text{A}$ is flowing around each square in the direction shown. A uniform magnetic field $\vec{B} = 5\text{mT}\hat{\mathbf{k}}$ exists in the entire region.

(a) Find the forces $\vec{F}_{ab}$ and $\vec{F}_{cd}$ acting on sides ab and cd, respectively.

(b) Find the magnetic moments $\vec{\mu}_1$ and $\vec{\mu}_2$ of squares 1 and 2, respectively.

(c) Find the torques $\vec{\tau}_1$ and $\vec{\tau}_2$ acting on squares 1 and 2, respectively.

Remember that vectors have components or magnitude and direction.

Solution:

(a) $\vec{F}_{ab} = (3\text{A})(2\text{cm}\hat{\mathbf{j}}) \times (5\text{mT}\hat{\mathbf{k}}) = 3 \times 10^{-4}\text{N}\hat{\mathbf{i}}.$

$\vec{F}_{cd} = (3\text{A})(-2\text{cm}\hat{\mathbf{i}}) \times (5\text{mT}\hat{\mathbf{k}}) = 3 \times 10^{-4}\text{N}\hat{\mathbf{j}}.$

(b) $\vec{\mu}_1 = (2\text{cm})^2(3\text{A})\hat{\mathbf{i}} = 1.2 \times 10^{-3}\text{Am}^2\hat{\mathbf{i}}.$

$\vec{\mu}_2 = (2\text{cm})^2(3\text{A})\hat{\mathbf{k}} = 1.2 \times 10^{-3}\text{Am}^2\hat{\mathbf{k}}.$

(c) $\vec{\tau}_1 = (1.2 \times 10^{-3}\text{Am}^2\hat{\mathbf{i}}) \times (5\text{mT}\hat{\mathbf{k}}) = -6 \times 10^{-6}\text{Nm}\hat{\mathbf{j}}.$

$\vec{\tau}_2 = (1.2 \times 10^{-3}\text{Am}^2\hat{\mathbf{k}}) \times (5\text{mT}\hat{\mathbf{k}}) = 0.$