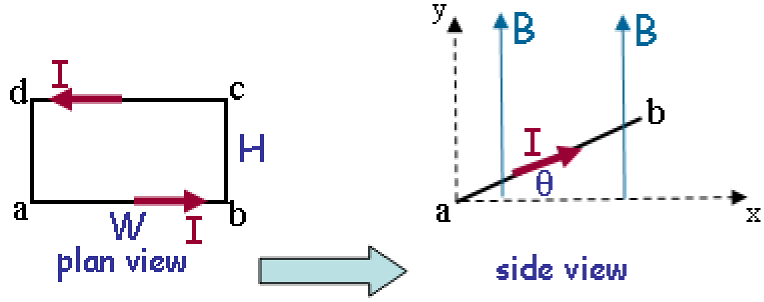
A rectangular loop of wire with sides H = 27 cm and W = 66 cm is located in a region containing a constant magnetic field B = 0.63 T that is aligned with the positive y-axis as shown. The loop carries current I = 341 mA. The plane of the loop is inclined at an angle θ = 38° with respect to the x-axis.



1) What is μ_x, the x-component of the magnetic moment vector of the loop?

$$\mu = IA = IWH \Rightarrow \mu_x = -\mu \sin\theta = -IWH \sin\theta$$

-note that the x component of u points in the neg x direction

Ux=-.341Ax.66mx.27mxsin(d38)=-.037 Am^2

2) What is μ_y, the y-component of the magnetic moment vector of the loop?

-note that the y component of u points in the positive y direction

$$\mu_y = +\mu\cos\theta = IWH\cos\theta$$

Uy=.341Ax.66mx.27mxcos(d38)=.0478 Am^2

3) What is τ_z, the z-component of the torque exerted on the loop?

$$\vec{\tau} = \vec{\mu} \times \vec{B} \Rightarrow \tau_z = -\mu B\sin\theta = -IWHB\sin\theta = \mu_x B$$

τz= (-.037Am^2)(.63T)=-.023Nm

4) What is F_{bc}, the magnitude of the force exerted on segment bc of the loop?

$$F_{bc} = IHB \text{ OR } \tau = IWHB\sin\theta, \; \tau = WF\sin\theta \Rightarrow F = IHB$$

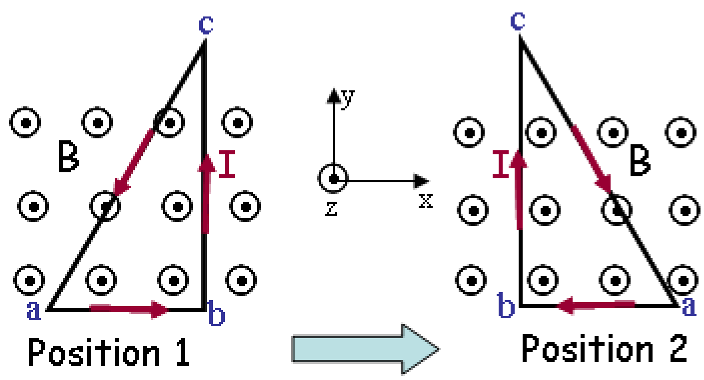
Derived either from the Lorentz force law in terms of currents, the first, or from the definition of the torque, the second.

F=(.341A)(.27m)(.63T)=.058N

From IxB:

5) 3
6) **Feedback:**
7) Your answer is correct! The current in segment bc flows in the negative z-direction. When you cross that current vector into the magnetic field vector (positive y-direction), you obtain a vector in the positive x-direction

A wire formed in the shape of a right triangle with base L_{ab} = 26 cm and height L_{bc} = 67 cm carries current I = 769 mA as shown in Position 1. The wire is located in a region containing a constant magnetic field B = 1.26 T aligned with the positive z-axis.



8)
1) What is $F_{ac,x}$, the x-component of the force on the segment of the wire that connects points a and c in Position 1?

$$F_{ac} = IL_{ac}B = IB\sqrt{L_{ab}^2 + L_{bc}^2}$$

$$F_{ac,x} = -F_{ac}\sin\theta = -IB\sqrt{L_{ab}^2 + L_{bc}^2} \cdot \frac{L_{bc}}{\sqrt{L_{ab}^2 + L_{bc}^2}} = -IBL_{bc}$$

Be sure the sign in correct from the cross product

Fac,x=-(.769 A)(1.26 T)(.67 m)=-.649 N

2) What is $F_{ac,y}$, the y-component of the force on the segment of the wire that connects points a and c in Position 1?

$$F_{ac,y} = F_{ac}\cos\theta = IBL_{ab}$$

Fac,y=(.769 A)(1.26 T)(.26 m)=.251 N

3) The wire is now rotated 180^{o} about the y-axis to Position 2, as shown. What is ΔU_{12}, the change in potential energy of the wire? Note that ΔU_{12} is a signed number. ΔU_{12} is positive if the potential energy in Position 2 is higher than the potential energy in Position 1.

$$U_i = -\vec{\mu}_i \cdot \vec{B}$$

$$\Delta U_{12} = U_2 - U_1 = -(\vec{\mu}_2 - \vec{\mu}_1) \cdot \vec{B} = -(-2\mu B) = 2I\tfrac{1}{2}L_{ab}L_{bc}B = IL_{ab}L_{bc}B$$

Where u is from I*A

ΔU=(.769 A)1.26 m)(.67 m)(1.26 T)=.168 J

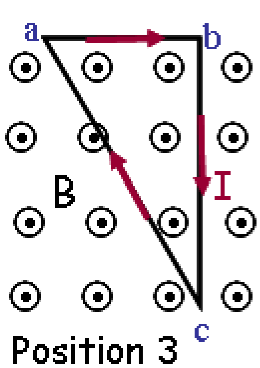
4) The wire is now rotated back 90^{o} about the y-axis towards position 1. If the wire is released from this position, how would it move?

- It would rotate towards Position 1
- It would rotate towards Position 2
- It would remain stationary

Right Answer:
1

Feedback:
Your answer is correct! When the loop is positioned halfway between Positions 1 and 2, the magnetic moment vector points in the positive x-direction. The torque is given by the cross product of the magnetic moment vector and the magnetic field. Since the magnetic field is in positive z-direction, the cross product will point in the negative y-direction. A torque in the negative y-direction will cause the loop to rotate towards Position 1.
You can also reach this result from energy considerations. Namely, Position 1 is at a lower energy than Position 2. When released the loop will move towards the lower potential energy.

5)



The wire is now returned to Position 1 and then rotated 180^{o} about the x-axis to Position 3, as shown. What is ΔU_{13}, the change in potential energy of the wire? If the potential energy increases in going from Position 1 to Position 3, the change in potential energy is positive.

$$\Delta U_{31} = U_3 - U_1 = -(\vec{\mu}_3 - \vec{\mu}_1) \cdot \vec{B} = -(-2\mu B) = 2I\frac{1}{2}L_{ab}L_{bc}B = IL_{ab}L_{bc}B$$

ΔU=(.769 A)1.26 m)(.67 m)(1.26 T)=.168 J