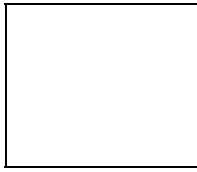
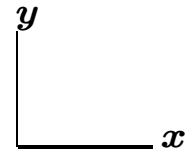


1.



$\odot \vec{B}_{\text{ext}}$

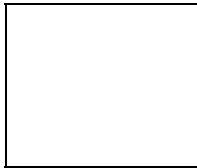


The magnitude B of the magnetic field is increasing.

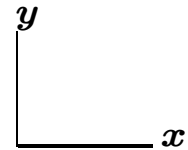
Flux: increasing due to increasing B .

\vec{B}_{loop} must be down (\otimes) to counteract upward increasing flux; current is then clockwise.

2.



$\otimes \vec{B}_{\text{ext}}$



The magnitude B of the magnetic field is increasing.

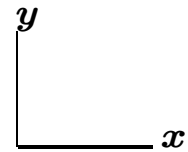
Flux: increasing due to increasing B .

\vec{B}_{loop} must be up (\odot) to counteract downward increasing flux; current is then counterclockwise.

3.



$\odot \vec{B}_{\text{ext}}$



The magnitude B of the magnetic field is decreasing.

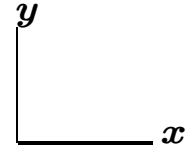
Flux: decreasing due to decreasing B .

\vec{B}_{loop} must be up (\odot) to counteract upward decreasing flux; current is then counterclockwise.

4.



$\otimes \vec{B}_{\text{ext}}$



The magnitude B of the magnetic field is decreasing.

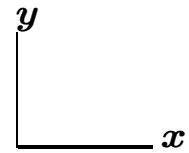
Flux: decreasing due to decreasing B .

\vec{B}_{loop} must be down (\otimes) to counteract downward decreasing flux; current is then clockwise.

5.



$\leftarrow \vec{B}_{\text{ext}}$



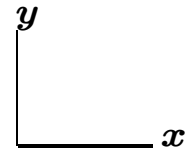
The magnitude B of the magnetic field is increasing.

Flux: zero at all times, since $\theta = 90^\circ$; no current flows

6.



$\rightarrow \vec{B}_{\text{ext}}$



The magnitude B of the magnetic field is decreasing.

Flux: zero at all times, since $\theta = 90^\circ$; no current flows

7.



$\odot \vec{B}_{\text{ext}}$ (initial)



\vec{B} is rotating through 90° to line up with the x axis.

Flux: decreasing since θ increases from 0° to 90° so $\cos \theta$ is always decreasing.

\vec{B}_{loop} must be up (\odot) to counteract upward decreasing flux; current is then counterclockwise.

8.

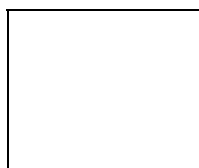
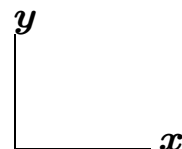

 $\odot \vec{B}_{\text{ext}} \text{ (initial)}$


\vec{B} is rotating through 90° to line up with the y axis.

Flux: decreasing since θ increases from 0° to 90° so $\cos \theta$ is always decreasing.

\vec{B}_{loop} must be up (\odot) to counteract upward decreasing flux; current is then counterclockwise.

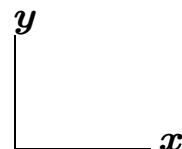
9.


 $\rightarrow \vec{B}_{\text{ext}} \text{ (initial)}$


\vec{B} is rotating through 90° to line up with the y axis.

Flux: zero at all times, since $\theta = 90^\circ$; no current flows

10.


 $\leftarrow \vec{B}_{\text{ext}} \text{ (initial)}$


\vec{B} is rotating through 90° to line up with the $-z$ direction.

Flux: increasing in magnitude from zero (because $\theta = 90^\circ$ so $\cos \theta = 0$) to some finite value.

\vec{B}_{loop} must be up (\odot) to counteract downward increasing flux; current is then counterclockwise.

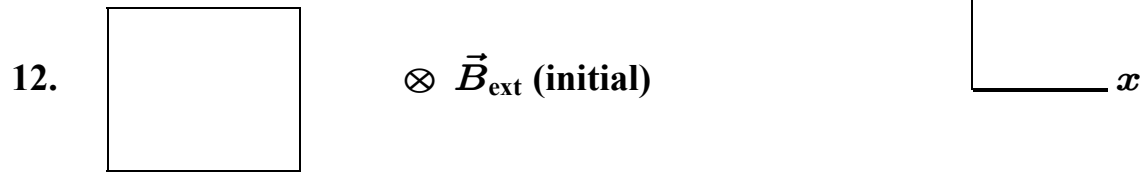
11.


 $\odot \vec{B}_{\text{ext}} \text{ (initial)}$


\vec{B} rotates through 90° to line up with the $-x$ direction and then continues through another 90° until it is lined up with the $-z$ direction.

Flux: decreasing during first half of the rotation since θ increases from 0° to 90° , and reversing but increasing in magnitude during second half of the rotation as θ decreases from 90° to 0° .

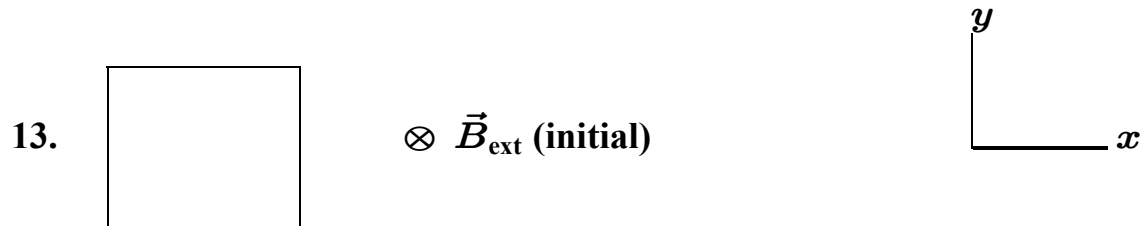
\vec{B}_{loop} must be up (\odot) during both halves; current is then counterclockwise.



\vec{B} is rotating through 90° to line up with the $+x$ direction and also decreasing in magnitude.

Flux: decreasing since the magnitude of \vec{B} is decreasing and since θ increases from 0° to 90° so $\cos \theta$ is also decreasing.

\vec{B}_{loop} must be down (\otimes) to counteract downward decreasing flux; current is then clockwise.



\vec{B} is rotating through 90° to line up with the $+y$ direction and also increasing in magnitude.

Flux: the increase in the magnitude of \vec{B} causes the flux to increase, while the increase in θ from 0° to 90° causes $\cos \theta$ to decrease. More information would be necessary to know, at least at the beginning, which of these effects is greater, and which direction the current flows.

However, overall, we can see that the flux decreases from some initial value which is not zero to a final value which is zero. Therefore, overall, the loop has gone from a situation in which there was downward flux to a situation in which there is zero flux. Therefore the average value of \vec{B}_{loop} must be down (in the original direction of the external magnetic field), so the average current is clockwise.

Depending on how fast the magnitude of the external field is increasing compared to the increase in angle, the current may have been clockwise the whole time or it may have been counterclockwise for a while and then clockwise for most of the change in the external magnetic field.