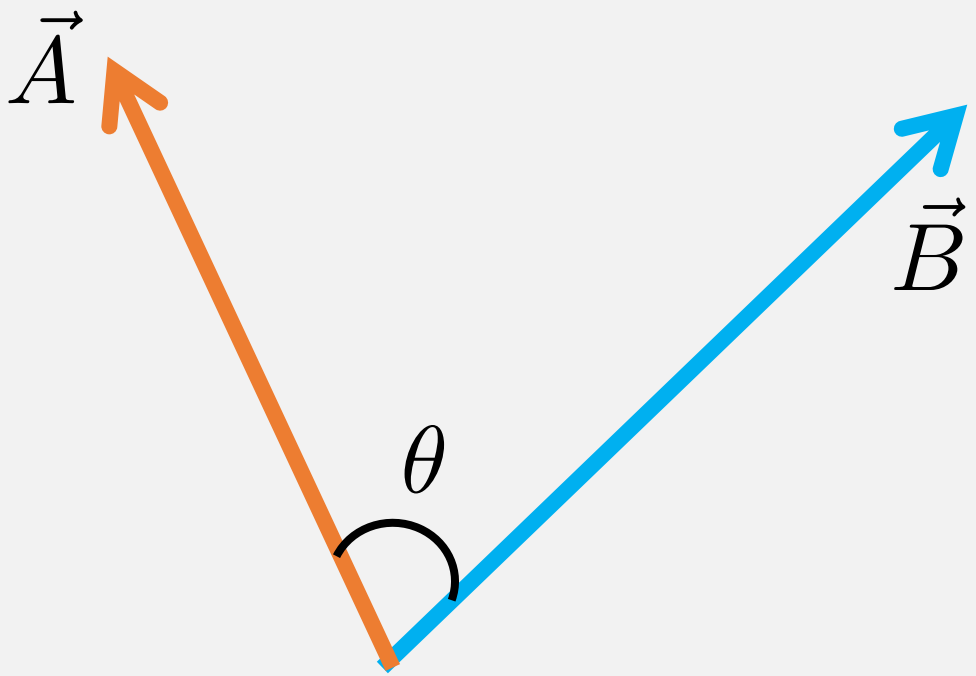
# Cross Products and the Right-Hand-Rule

PHYS 2211 – Angular momentum, torque

PHYS 2212 – Magnetic fields, magnetic force, EMR

# Right Hand Rule with Two Vectors



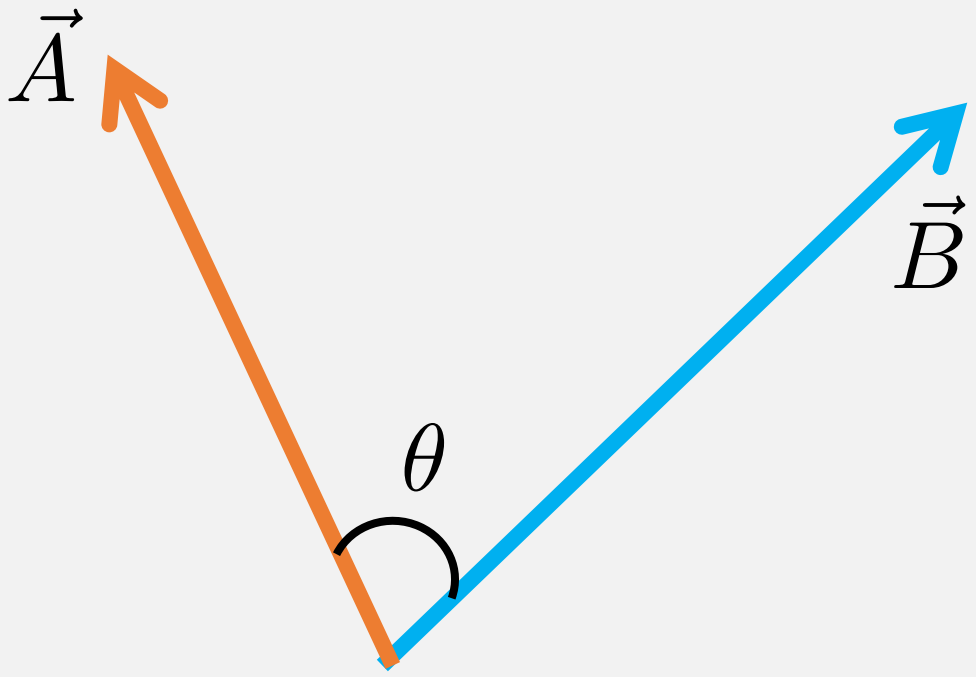

Put the fingers of your RIGHT HAND along the direction of the first vector

Curl your fingers towards the direction of the second vector

The cross product is indicated by the direction of your thumb

**The cross product does not commute:** $\vec{A} \times \vec{B} \neq \vec{B} \times \vec{A}$

# Right Hand Rule with Two Vectors




$\vec{A} \times \vec{B}$

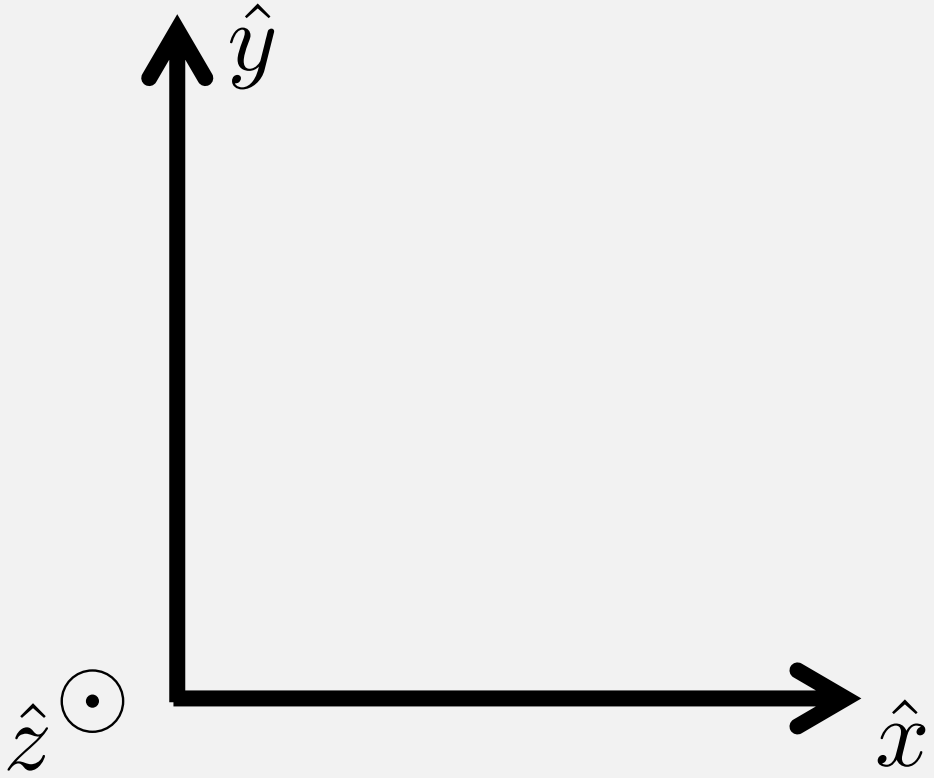
Direction: into the page $\otimes$

$\vec{B} \times \vec{A}$

Direction: out of the page $\odot$

Magnitude: $|\vec{A}||\vec{B}| \sin\theta$

# Cross Products of Unit Vectors




$$\hat{x} \times \hat{y} = \hat{z} \qquad \hat{y} \times \hat{x} = -\hat{z}$$

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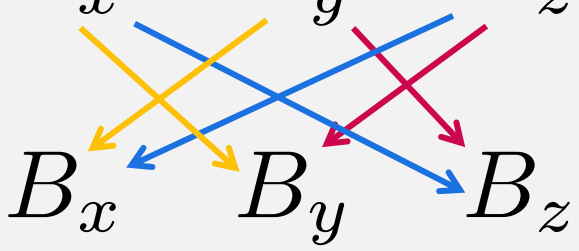
# The Determinant Method

$$\begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$



$$\hat{x} \rightarrow A_y B_z - A_z B_y$$

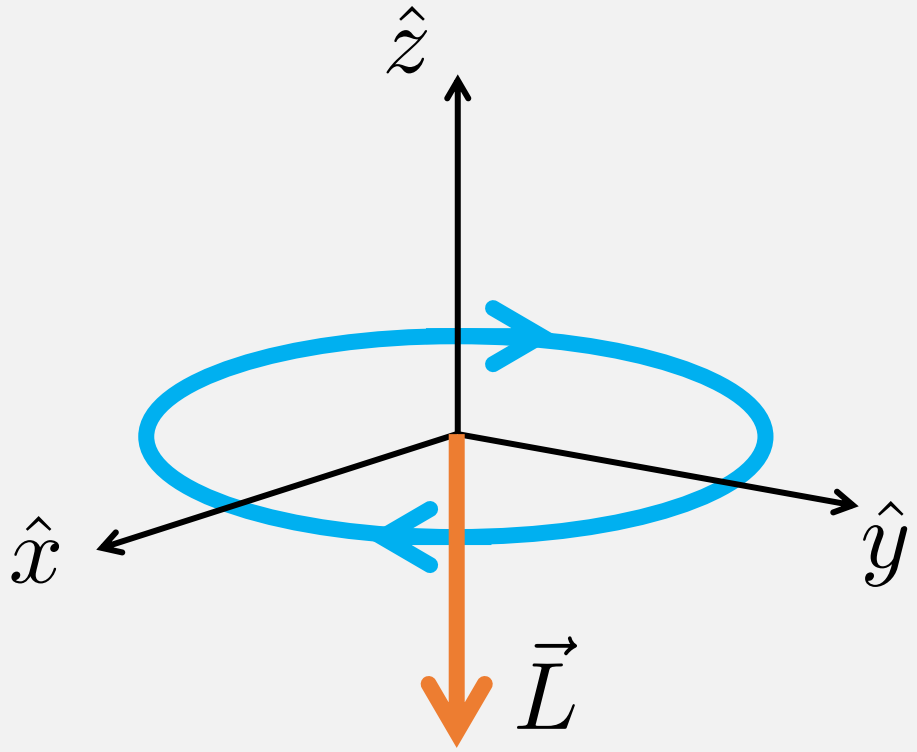
$$\hat{y} \rightarrow A_z B_x - A_x B_z$$

$$\hat{z} \rightarrow A_x B_y - A_y B_x$$

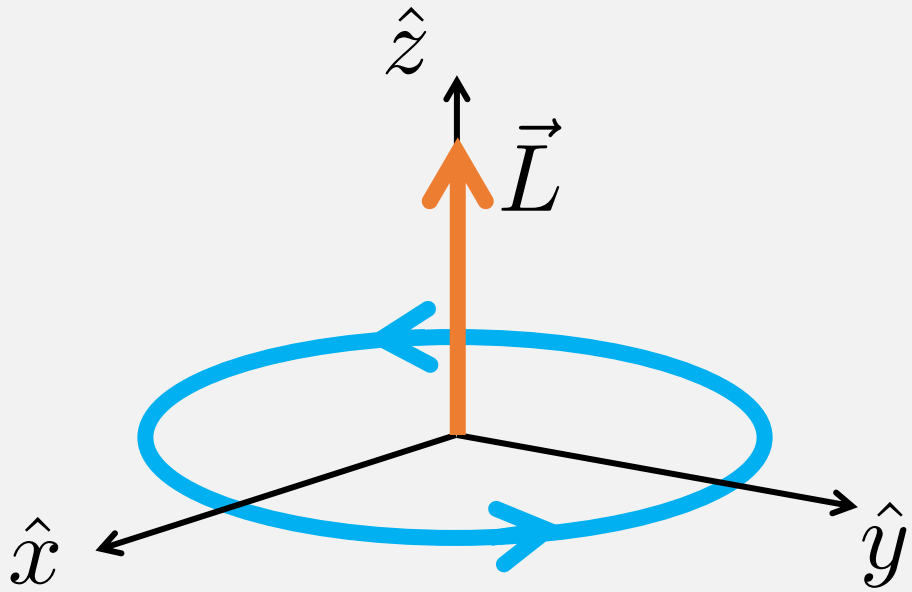
$$\vec{A} \times \vec{B} = < A_y B_z - A_z B_y, A_z B_x - A_x B_z, A_x B_y - A_y B_x >$$

# Angular Momentum and Angular Velocity

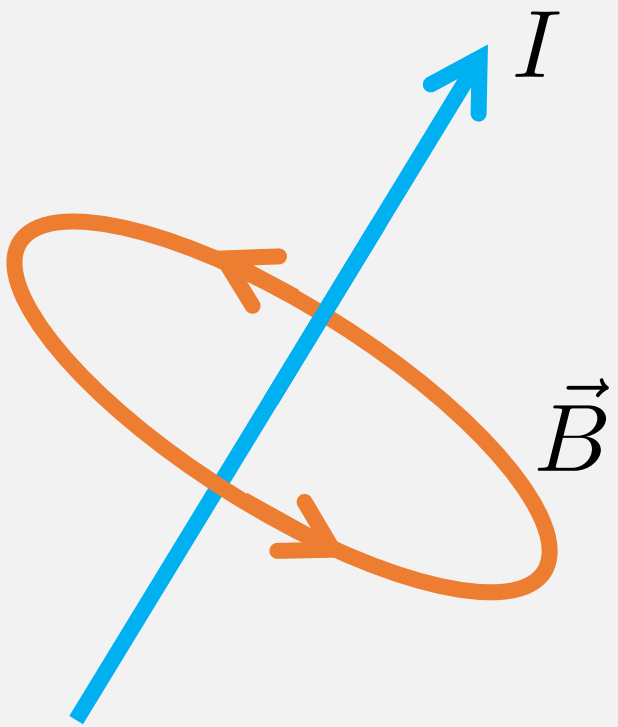
If something is spinning **clockwise** angular momentum and angular velocity point **into the page**




If something is spinning **counterclockwise** angular momentum and angular velocity point **out of the page**

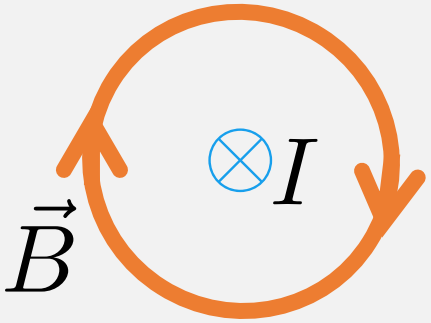


# Magnetic Fields from Line Currents

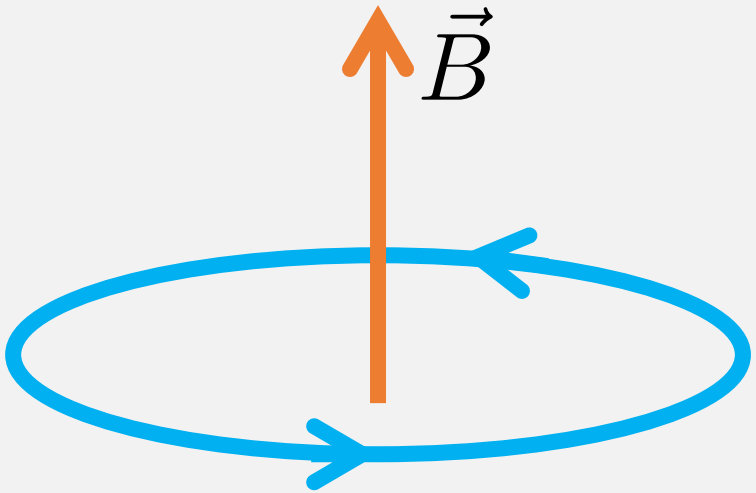



Point your thumb in the direction of the (conventional) current

The curl of your fingers indicates the direction of the magnetic field

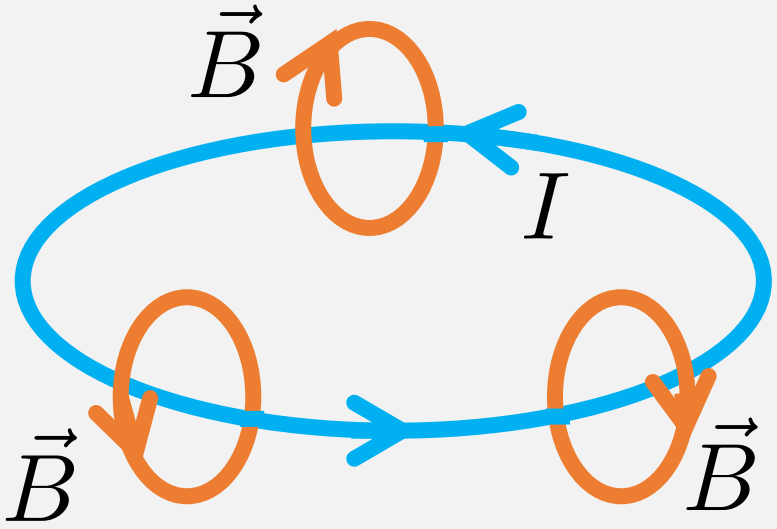


# Magnetic Fields from Current Loops




Curl your fingers in the direction of the current

The direction of your thumb indicates the B-field on axis




To get the direction of the B-field inside or outside the loop, follow the current with your thumb and the curl of your fingers says the direction of the magnetic field