Today: Sections 1.9 & 1.10 $\boxed{L3}$

Vectors

Today: Sections 1.9 & 1.10 $\boxed{L3}$

Friday: Sections 2.1-2.3

1d Kinematics

Today: Sections 1.9 & 1.10 $\boxed{L3}$

Friday: Sections 2.1-2.3

HW #1: Due Friday

Unit vectors

Unit vector has magnitude 1 & NO units

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Unit vector just points.

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$\hat{i} \equiv$ unit vector pointing in x-direction

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Let

$\hat{i} \equiv$ unit vector pointing in x-direction

$\hat{j} \equiv$ unit vector pointing in y-direction

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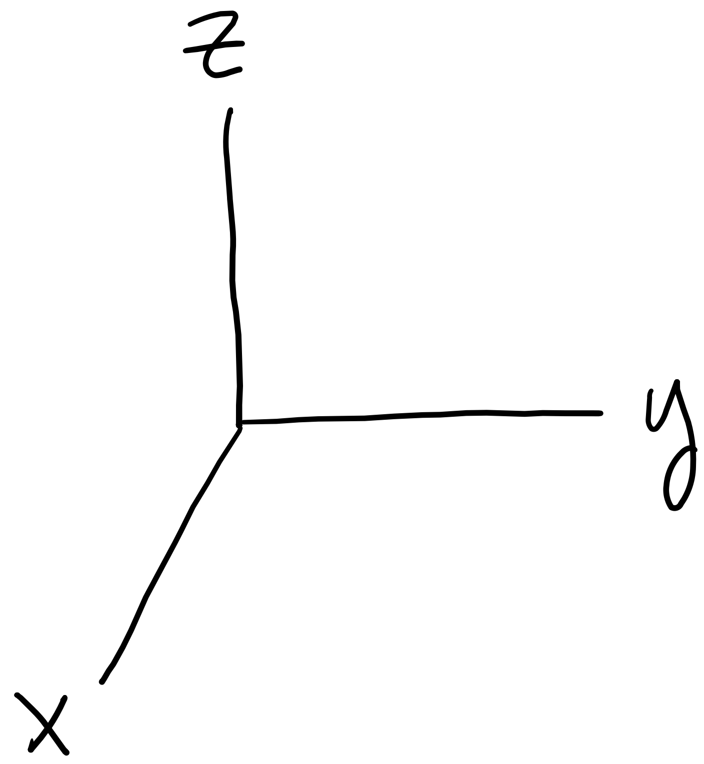
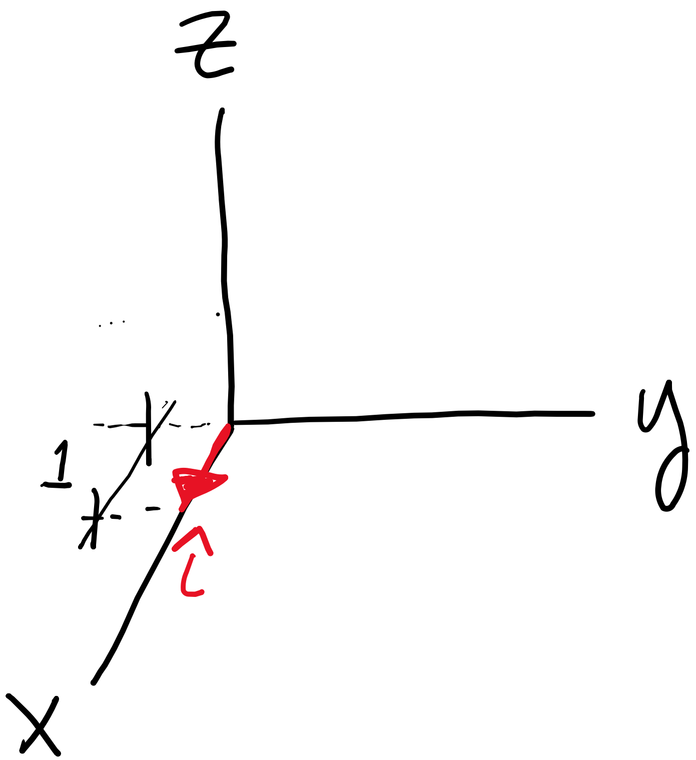
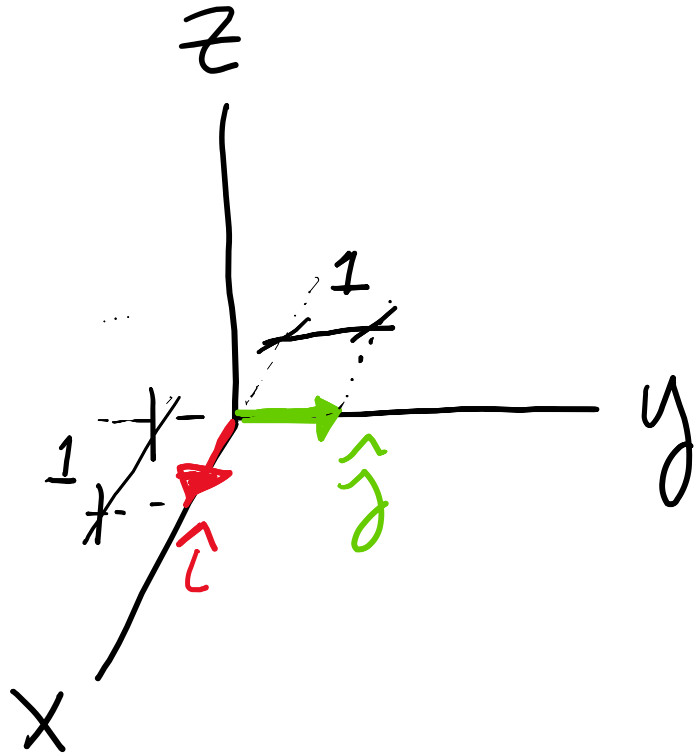
Let

$\hat{i} \equiv$ unit vector pointing in x-direction
$\hat{j} \equiv$ unit vector pointing in y-direction
$\hat{k} \equiv$ unit vector pointing in z-direction


z
y
x

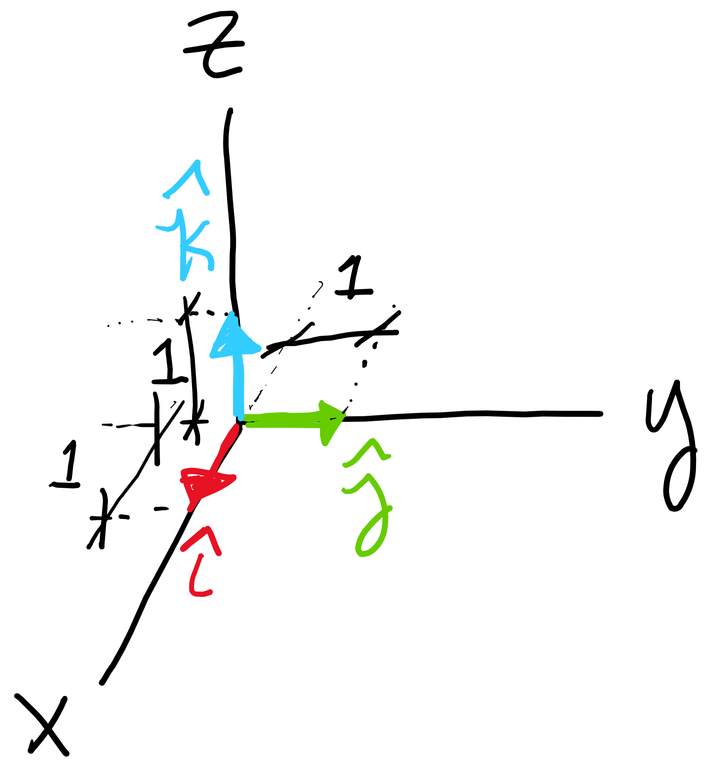


$\hat{i}$ UNIT Vector in X



$\hat{i}$ unit vector in x

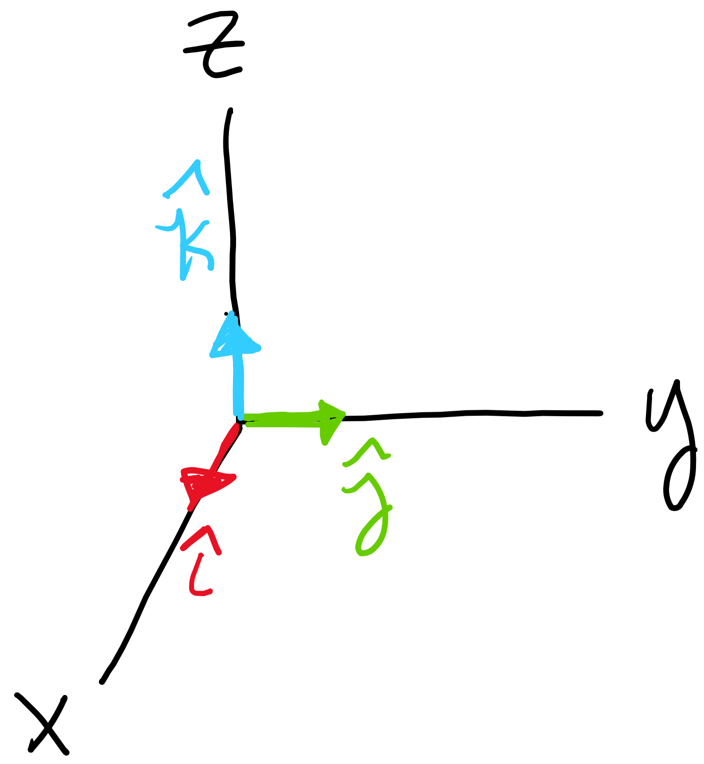
$\hat{j}$ unit vector in y



$\hat{i}$ unit vector in x

$\hat{j}$ unit vector in y

$\hat{k}$ unit vector in z



$\hat{i}$ unit vector in x

$\hat{j}$ unit vector in y

$\hat{k}$ unit vector in z

Unit vectors

Unit vector has magnitude 1 & NO units
Unit vector just points. That is the only purpose of a unit vector.

Let

$\hat{i} \equiv$ unit vector pointing in x-direction
$\hat{j} \equiv$ unit vector pointing in y-direction
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If A_x is x-component of $\vec{A}$

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If A_x is x-component of $\vec{A}$ &
A_y is y-component of $\vec{A}$

Unit vectors

Unit vector has magnitude 1 & NO units
Unit vector just points. That is the only purpose of a unit vector.

Let

$\hat{i} \equiv$ unit vector pointing in x-direction
$\hat{j} \equiv$ unit vector pointing in y-direction
$\hat{k} \equiv$ unit vector pointing in z-direction

If A_x is x-component of $\vec{A}$ & A_y is y-component of $\vec{A}$, then

$$\vec{A} = A_x\hat{i} + A_y\hat{j}$$

Vector sum $\vec{R}$ of $\vec{A}$ & $\vec{B}$

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$$\vec{A} = A_x \hat{i} + A_y \hat{j}$$

Vector sum $\vec{R}$ of $\vec{A}$ & $\vec{B}$

$\vec{A} = A_x\hat{i} + A_y\hat{j}$ & $\vec{B} = B_x\hat{i} + B_y\hat{j}$

Vector sum $\vec{R}$ of $\vec{A}$ & $\vec{B}$

$\vec{A} = A_x\hat{i} + A_y\hat{j}$ & $\vec{B} = B_x\hat{i} + B_y\hat{j}$ & $\vec{R} = R_x\hat{i} + R_y\hat{j}$

Vector sum $\vec{R}$ of $\vec{A}$ & $\vec{B}$

$\vec{A} = A_x\hat{i} + A_y\hat{j}$ & $\vec{B} = B_x\hat{i} + B_y\hat{j}$ & $\vec{R} = R_x\hat{i} + R_y\hat{j}$

So $\vec{R} = \vec{A} + \vec{B}$

Vector sum $\vec{R}$ of $\vec{A}$ & $\vec{B}$

$\vec{A} = A_x\hat{i} + A_y\hat{j}$ & $\vec{B} = B_x\hat{i} + B_y\hat{j}$ & $\vec{R} = R_x\hat{i} + R_y\hat{j}$

So $\vec{R} = \vec{A} + \vec{B} \Rightarrow$

$$R_x\hat{i} + R_y\hat{j} = A_x\hat{i} + A_x\hat{j} + B_x\hat{i} + B_y\hat{j}$$

Vector sum $\vec{R}$ of $\vec{A}$ & $\vec{B}$

$\vec{A} = A_x\hat{i} + A_y\hat{j}$ & $\vec{B} = B_x\hat{i} + B_y\hat{j}$ & $\vec{R} = R_x\hat{i} + R_y\hat{j}$

So $\vec{R} = \vec{A} + \vec{B} \Rightarrow$

$$R_x\hat{i} + R_y\hat{j} = A_x\hat{i} + A_x\hat{j} + B_x\hat{i} + B_y\hat{j} \Rightarrow$$

$$R_x\hat{i} + R_y\hat{j} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j}$$

Vector sum $\vec{R}$ of $\vec{A}$ & $\vec{B}$

$\vec{A} = A_x\hat{i} + A_y\hat{j}$ & $\vec{B} = B_x\hat{i} + B_y\hat{j}$ & $\vec{R} = R_x\hat{i} + R_y\hat{j}$

So $\vec{R} = \vec{A} + \vec{B} \Rightarrow$

$$R_x\hat{i} + R_y\hat{j} = A_x\hat{i} + A_x\hat{j} + B_x\hat{i} + B_y\hat{j} \Rightarrow$$

$$R_x\hat{i} + R_y\hat{j} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j}$$

If in 3D:

Vector sum $\vec{R}$ of $\vec{A}$ & $\vec{B}$

$\vec{A} = A_x\hat{i} + A_y\hat{j}$ & $\vec{B} = B_x\hat{i} + B_y\hat{j}$ & $\vec{R} = R_x\hat{i} + R_y\hat{j}$

So $\vec{R} = \vec{A} + \vec{B} \Rightarrow$

$$R_x\hat{i} + R_y\hat{j} = A_x\hat{i} + A_x\hat{j} + B_x\hat{i} + B_y\hat{j} \Rightarrow$$

$$R_x\hat{i} + R_y\hat{j} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j}$$

If in 3D:

$$\vec{R} = R_x\hat{i} + R_y\hat{j} + R_z\hat{k} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j} + (A_z + B_z)\hat{k}$$

Product of vectors

Product of vectors

We will use two types of vector products

Product of vectors

We will use two types of vector products:

* Scalar product

Product of vectors

We will use two types of vector products:

* Scalar product

* Vector product

Product of vectors

We will use two types of vector products:

* Scalar product

* Vector product

We will start with the scalar product

Scalar product

Scalar product {Dot product}

Scalar product {Dot product}

$\vec{A} \cdot \vec{B}$

Scalar product {Dot product}

$\vec{A} \cdot \vec{B}$: Scalar product notation

Scalar product {Dot product}

$$\underbrace{\vec{A} \cdot \vec{B}}_{\text{"Dot" product}}$$

Scalar product {Dot product}

$$\underbrace{\vec{A} \cdot \vec{B}}_{\text{"Dot product"}} = AB\cos\varphi$$

Scalar product {Dot product}

$$\underbrace{\vec{A}\cdot\vec{B}}_{\text{"Dot" product}} = \underbrace{A}_{\text{mag of } A} B\cos\varphi$$

Scalar product {Dot product}

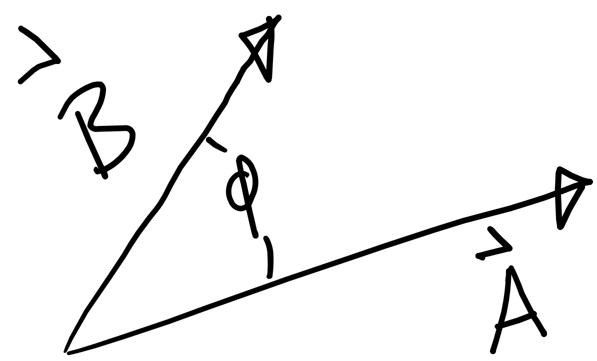
$$\underbrace{\vec{A}\cdot\vec{B}}_{\text{"Dot" product}} = \underbrace{A}_{\text{mag of } A}\,\underbrace{B}_{\text{mag of } B}\cos\varphi$$

Scalar product {Dot product}

$$\underbrace{\vec{A}\cdot\vec{B}}_{\text{"Dot" product}} = \underbrace{A}_{\text{mag of } A}\,\underbrace{B}_{\text{mag of } B}\cos\underbrace{\phi}_{\text{Angle beteen } \vec{A} \,\&\, \vec{B} \text{ when placed tail to tail}}$$

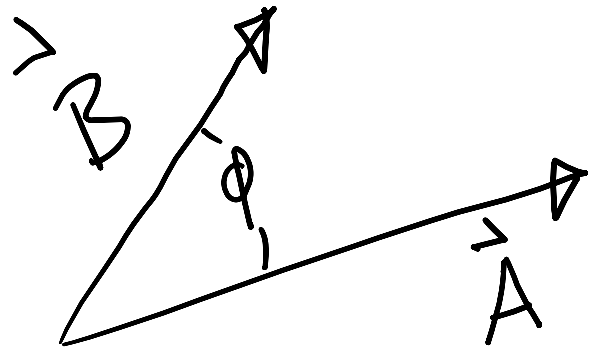
Scalar product {Dot product}

$$\underbrace{\vec{A}\cdot\vec{B}}_{\text{"Dot" product}} = \underbrace{A}_{\text{mag of }A}\,\underbrace{B}_{\text{mag of }B}\cos\underbrace{\phi}_{\text{Angle beteen }\vec{A}\,\&\,\vec{B}\text{ when placed tail to tail}}$$



Scalar product {Dot product}

$$\vec{A} \cdot \vec{B} = A\left(B\cos\phi\right)$$



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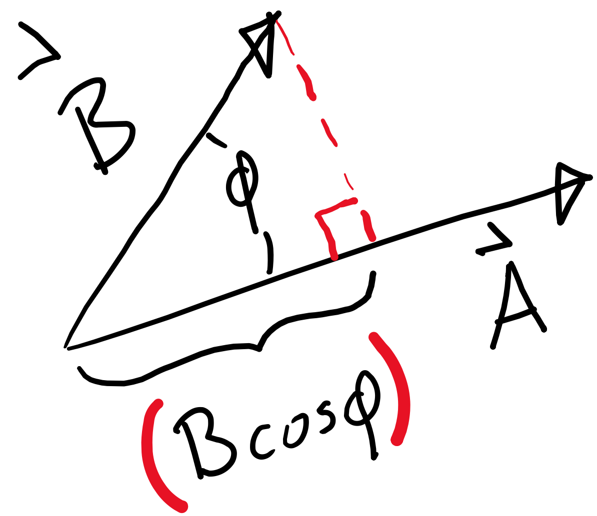
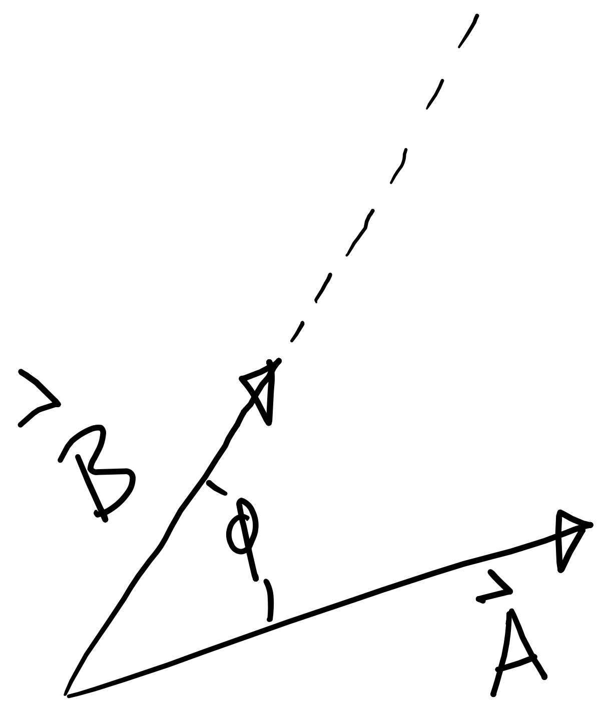


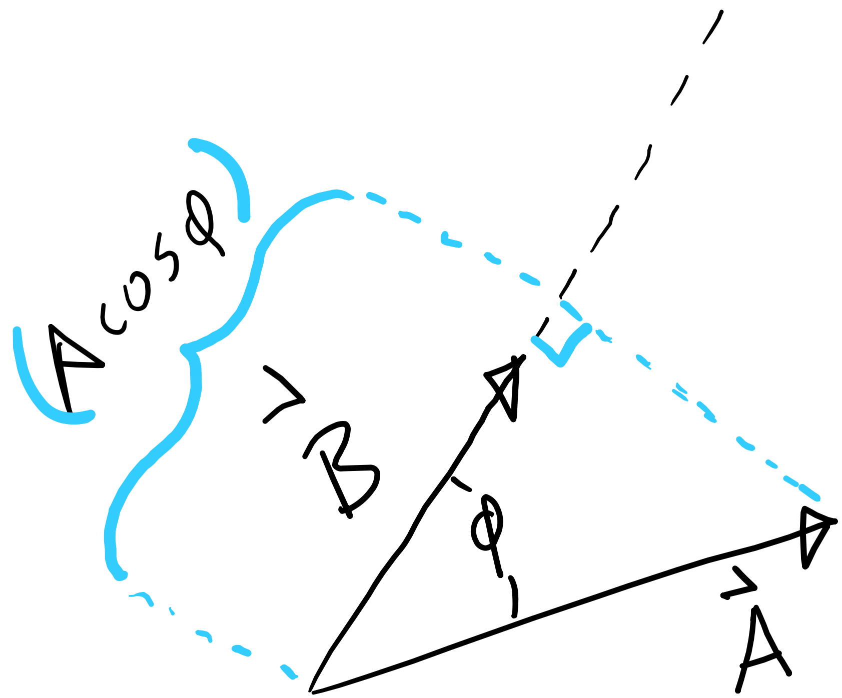
Scalar product {Dot product}

$$\vec{A}\cdot\vec{B} = A\left(B\cos\phi\right) = B\left(A\cos\phi\right)$$



Scalar product {Dot product}

$$\vec{A}\cdot\vec{B} = A(B\cos\varphi) = B(A\cos\varphi)$$



Scalar product {Dot product}

$$\vec{A}\cdot\vec{B} = A(B\cos\varphi) = B(A\cos\varphi) = \underline{\underline{\text{Scalar}}}$$

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* If $0 \leq \varphi < 90^\circ$ $\quad \vec{A}\cdot\vec{B} > 0$

Scalar product {Dot product}

$$\vec{A}\cdot\vec{B} = A(B\cos\phi) = B(A\cos\phi) = \text{Scalar}$$

$*$ If $0 \leq \phi < 90^\circ$ $\vec{A}\cdot\vec{B} > 0$

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Scalar product {Dot product}

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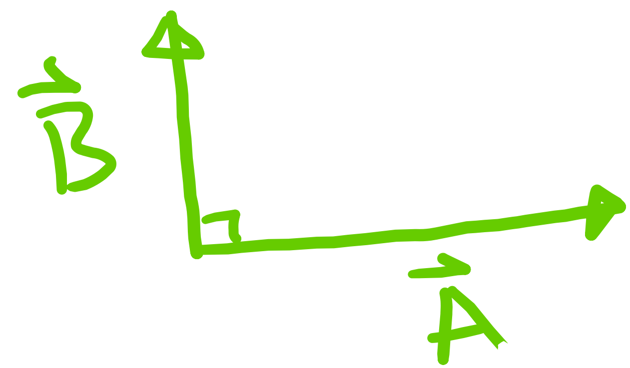

Scalar product {Dot product}

$$\vec{A}\cdot\vec{B} = A(B\cos\varphi) = B(A\cos\varphi) = \underline{\underline{\text{Scalar}}}$$

* If $0 \leq \varphi < 90^\circ$ $\quad \vec{A}\cdot\vec{B} > 0$
* If $\varphi = 90^\circ$ $\quad \vec{A}\cdot\vec{B} = 0$
* If $90^\circ < \varphi \leq 180$ $\quad \vec{A}\cdot\vec{B} < 0$

ASU

Scalar product {Dot product}

$$\vec{A}\cdot\vec{B} = A(B\cos\varphi) = B(A\cos\varphi) = \text{Scalar}$$

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Scalar product {Dot product}

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* If $90^\circ < \varphi \leq 180$ $\quad \vec{A}\cdot\vec{B} < 0$

Since $\quad AB\cos\varphi = BA\cos\varphi$

Scalar product {Dot product}

$$\vec{A}\cdot\vec{B} = A(B\cos\varphi) = B(A\cos\varphi) = \underline{\underline{\text{Scalar}}}$$

* If $0 \leq \varphi < 90^\circ$ $\vec{A}\cdot\vec{B} > 0$
* If $\varphi = 90^\circ$ $\vec{A}\cdot\vec{B} = 0$
* If $90^\circ < \varphi \leq 180$ $\vec{A}\cdot\vec{B} < 0$

Since $AB\cos\varphi = BA\cos\varphi$ then

$$\vec{A}\cdot\vec{B} = \vec{B}\cdot\vec{A}$$

Scalar product {Dot product}

$$\vec{A}\cdot\vec{B} = A(B\cos\varphi) = B(A\cos\varphi) = \underline{\underline{\text{Scalar}}}$$

* If $0 \leq \varphi < 90^\circ$ $\vec{A}\cdot\vec{B} > 0$

* If $\varphi = 90^\circ$ $\vec{A}\cdot\vec{B} = 0$

* If $90^\circ < \varphi \leq 180$ $\vec{A}\cdot\vec{B} < 0$

Since $AB\cos\varphi = BA\cos\varphi$ then

$$\vec{A}\cdot\vec{B} = \vec{B}\cdot\vec{A}$$

Obeys commutative law

Dot product of unit vectors

Dot product of unit vectors

$\hat{i} \cdot \hat{i} =$

Dot product of unit vectors

$$\hat{i} \cdot \hat{i} = \hat{j} \cdot \hat{j} =$$

Dot product of unit vectors

$$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} =$$

ASU

Dot product of unit vectors

$$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1*1\cos(0^\circ)$$

Dot product of unit vectors

$$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1*1\cos(0°) = 1$$

Dot product of unit vectors

$$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1*1\cos(0^\circ) = 1$$

$$\hat{i}\cdot\hat{j} =$$

Dot product of unit vectors

$$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1*1\cos(0^\circ) = 1$$

$$\hat{i}\cdot\hat{j} = \hat{i}\cdot\hat{k} =$$

ASU

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$$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1*1\cos(0^\circ) = 1$$

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Dot product of unit vectors

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Dot product of unit vectors

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Scalar product using components

Dot product of unit vectors

$$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1*1\cos(0°) = 1$$

$$\hat{i}\cdot\hat{j} = \hat{i}\cdot\hat{k} = \hat{j}\cdot\hat{k} = 1*1\cos(90°) = 0$$

Scalar product using components

$$\vec{A}\cdot\vec{B} = (A_x\hat{i} + A_y\hat{j} + A_z\hat{k})\cdot(B_x\hat{i} + B_y\hat{j} + B_z\hat{k})$$

ASU

Dot product of unit vectors

$$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1*1\cos(0^\circ) = 1$$

$$\hat{i}\cdot\hat{j} = \hat{i}\cdot\hat{k} = \hat{j}\cdot\hat{k} = 1*1\cos(90^\circ) = 0$$

Scalar product using components

$$\vec{A}\cdot\vec{B} = (A_x\hat{i} + A_y\hat{j} + A_z\hat{k})\cdot(B_x\hat{i} + B_y\hat{j} + B_z\hat{k})$$

But $\hat{i}\cdot\hat{i}$, $\hat{j}\cdot\hat{j}$ & $\hat{k}\cdot\hat{k}$ terms survive

Dot product of unit vectors

$$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1*1\cos(0^\circ) = 1$$

$$\hat{i}\cdot\hat{j} = \hat{i}\cdot\hat{k} = \hat{j}\cdot\hat{k} = 1*1\cos(90^\circ) = 0$$

Scalar product using components

$$\vec{A}\cdot\vec{B} = (A_x\hat{i} + A_y\hat{j} + A_z\hat{k})\cdot(B_x\hat{i} + B_y\hat{j} + B_z\hat{k})$$

But $\hat{i}\cdot\hat{i}$, $\hat{j}\cdot\hat{j}$ & $\hat{k}\cdot\hat{k}$ terms survive

So $\vec{A}\cdot\vec{B} = A_xB_x + A_yB_y + A_zB_z$

Dot product of unit vectors

$$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1*1\cos(0^\circ) = 1$$

$$\hat{i}\cdot\hat{j} = \hat{i}\cdot\hat{k} = \hat{j}\cdot\hat{k} = 1*1\cos(90^\circ) = 0$$

Scalar product using components

$$\vec{A}\cdot\vec{B} = (A_x\hat{i} + A_y\hat{j} + A_z\hat{k})\cdot(B_x\hat{i} + B_y\hat{j} + B_z\hat{k})$$

But $\hat{i}\cdot\hat{i}$, $\hat{j}\cdot\hat{j}$ & $\hat{k}\cdot\hat{k}$ terms survive

So $$\boxed{\vec{A}\cdot\vec{B} = A_xB_x + A_yB_y + A_zB_z}$$

Finding angle using Dot product

Finding angle using Dot product

Since $\vec{A}\cdot\vec{B} = AB\cos\phi$

Finding angle using Dot product

Since $\vec{A} \cdot \vec{B} = AB\cos\varphi$, then

$$\cos\varphi = \frac{\vec{A} \cdot \vec{B}}{AB}$$

Finding angle using Dot product

Since $\vec{A}\cdot\vec{B} = AB\cos\phi$, then

$$\cos\phi = \frac{\vec{A}\cdot\vec{B}}{AB}$$

$$= \frac{A_x B_x + A_y B_y + A_z B_z}{\sqrt{A_x^2 + A_y^2 + A_z^2}\sqrt{B_x^2 + B_y^2 + B_z^2}}$$

Product of vectors

We will use two types of vector products:

* Scalar product ✓

* Vector product

Product of vectors

We will use two types of vector products:

* Scalar product

* Vector product

We will now define the vector product

Vector product

Vector product {cross product}

Vector product {cross product}

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

Vector product {cross product}

$\vec{A} \times \vec{B}$: Vector product notation

Vector product {cross product}

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

"cross" product

Vector product {cross product}

$$\underbrace{|\vec{A} \times \vec{B}|}_{\text{"cross" product magnitude}} = AB\sin\phi$$

Vector product {cross product}

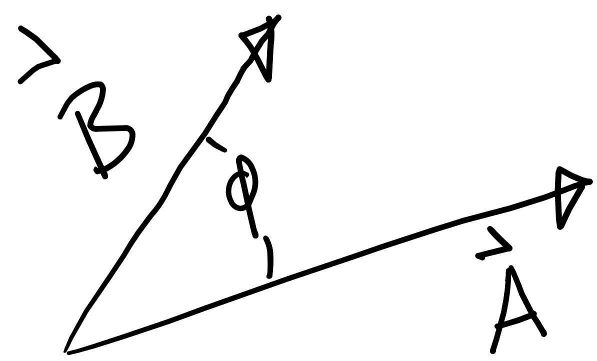
$$\underbrace{|\vec{A} \times \vec{B}|}_{\text{"cross" product magnitude}} = \underbrace{A}_{\text{mag of A}} B \sin\phi$$

Vector product {cross product}

$$\underbrace{|\vec{A} \times \vec{B}|}_{\text{"cross" product magnitude}} = \underbrace{A}_{\text{mag of } A}\,\underbrace{B}_{\text{mag of } B}\sin\phi$$

Vector product {cross product}

$$\underbrace{|\vec{A} \times \vec{B}|}_{\text{"cross" product magnitude}} = \underbrace{A}_{\text{mag of A}}\underbrace{B}_{\text{mag of B}}\sin\underbrace{\phi}_{\text{Angle between }\vec{A}\,\&\,\vec{B}\text{ when placed tail to tail}}$$



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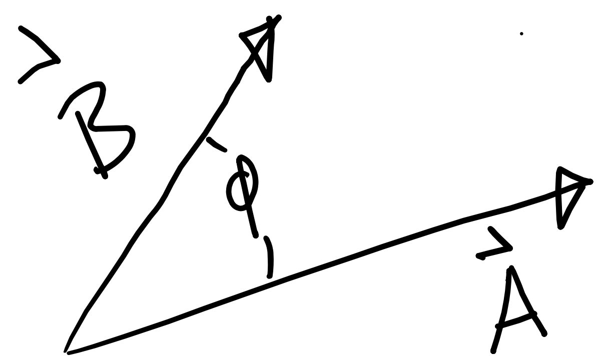
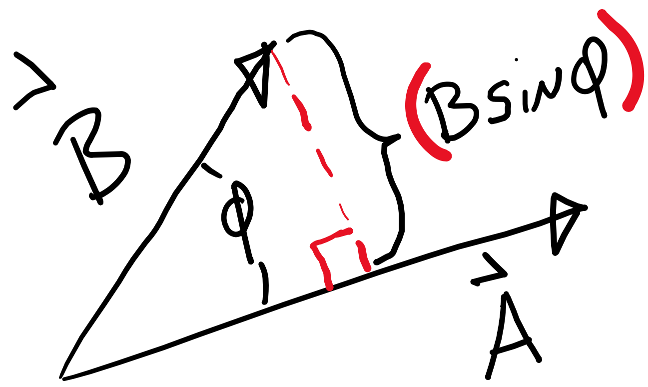
Vector product {cross product}

$$|\vec{A} \times \vec{B}| = A(B\sin\phi)$$



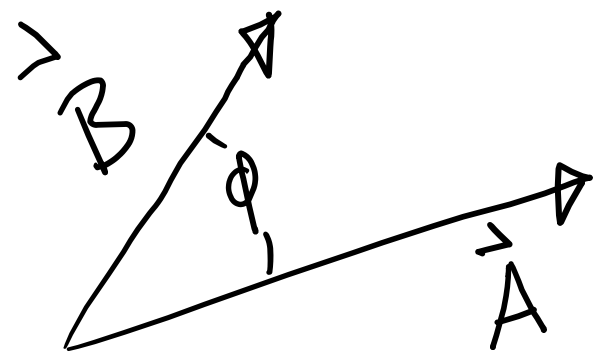
Vector product {cross product}

$$|\vec{A} \times \vec{B}| = A(B\sin\phi)$$



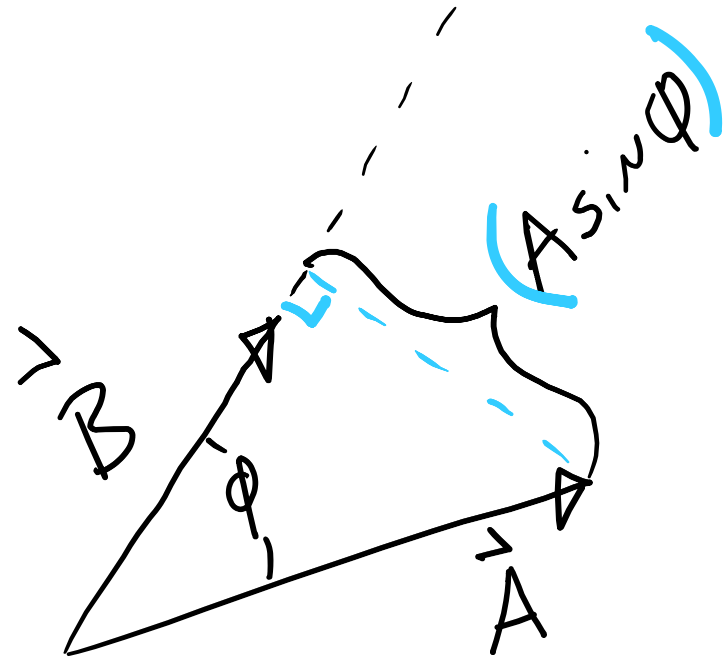
Vector product {cross product}

$$|\vec{A} \times \vec{B}| = A(B\sin\phi) = B(A\sin\phi)$$



Vector product {cross product}

$$|\vec{A} \times \vec{B}| = A(B\sin\phi) = B(A\sin\phi)$$



Vector product {cross product}

$$|\vec{A} \times \vec{B}| = A(B\sin\phi) = B(A\sin\phi)$$

$$= \text{Scalar}$$

Vector product {cross product}

$$|\vec{A} \times \vec{B}| = A(B\sin\phi) = B(A\sin\phi)$$

$$= \text{Scalar}$$

But

Vector product {cross product}

$$|\vec{A} \times \vec{B}| = A(B\sin\phi) = B(A\sin\phi)$$

$$= \text{Scalar}$$

But

$$\vec{A} \times \vec{B} = \text{Vector}$$

Vector product {cross product}

$$|\vec{A} \times \vec{B}| = A(B\sin\phi) = B(A\sin\phi)$$

$$= \text{Scalar}$$

But

$$\vec{A} \times \vec{B} = \text{Vector}$$

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

determined by

right-hand-rule

Vector product {cross product}

$$|\vec{A}\times\vec{B}| = A(B\sin\phi) = B(A\sin\phi)$$

$$= \text{Scalar}$$

But

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

Direction of $\vec{A}\times\vec{B}$ determined by Right-Hand-Rule

Vector product {cross product}

$$|\vec{A} \times \vec{B}| = A(B\sin\phi) = B(A\sin\phi)$$

$$= \text{Scalar}$$

But

$$\vec{A} \times \vec{B} = \text{Vector}$$

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

determined by

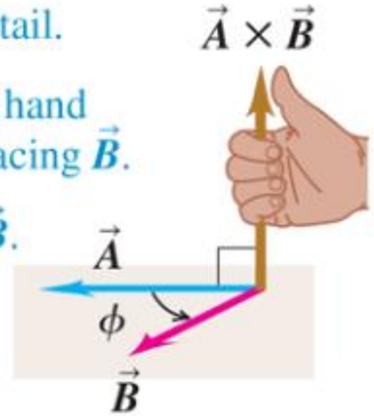
Right-Hand-Rule {RHR}

RHR

Copied from the book

(a) Using the right-hand rule to find the direction of $\vec{A} \times \vec{B}$

1. Place $\vec{A}$ and $\vec{B}$ tail to tail.
2. Point fingers of right hand along $\vec{A}$, with palm facing $\vec{B}$.
3. Curl fingers toward $\vec{B}$.
4. Thumb points in direction of $\vec{A} \times \vec{B}$.

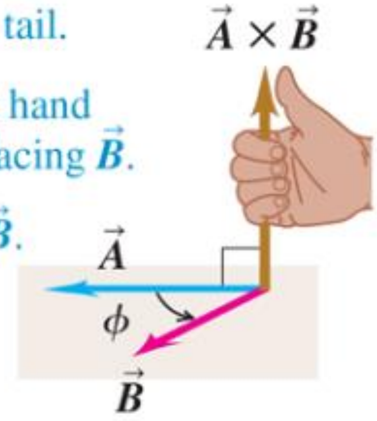


RHR

Copied from the book

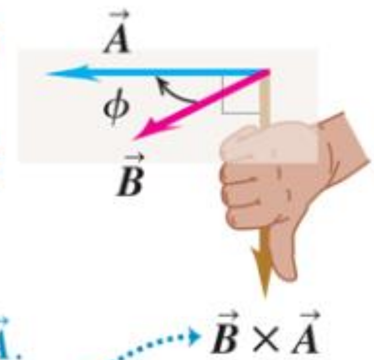
(a) Using the right-hand rule to find the direction of $\vec{A} \times \vec{B}$

1. Place $\vec{A}$ and $\vec{B}$ tail to tail.
2. Point fingers of right hand along $\vec{A}$, with palm facing $\vec{B}$.
3. Curl fingers toward $\vec{B}$.
4. Thumb points in direction of $\vec{A} \times \vec{B}$.



(b) Using the right-hand rule to find the direction of $\vec{B} \times \vec{A} = -\vec{A} \times \vec{B}$ (vector product is anticommutative)

1. Place $\vec{B}$ and $\vec{A}$ tail to tail.
2. Point fingers of right hand along $\vec{B}$, with palm facing $\vec{A}$.
3. Curl fingers toward $\vec{A}$.
4. Thumb points in direction of $\vec{B} \times \vec{A}$.
5. $\vec{B} \times \vec{A}$ has same magnitude as $\vec{A} \times \vec{B}$ but points in opposite direction.

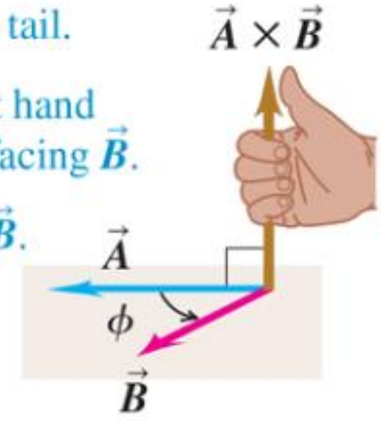


RHR

Copied from the book

(a) Using the right-hand rule to find the direction of $\vec{A} \times \vec{B}$

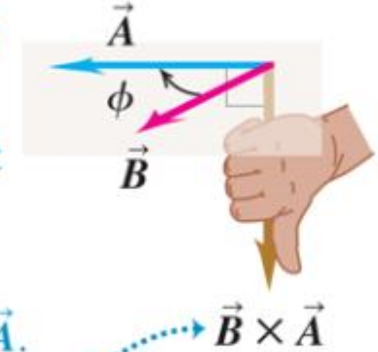
1. Place $\vec{A}$ and $\vec{B}$ tail to tail.
2. Point fingers of right hand along $\vec{A}$, with palm facing $\vec{B}$.
3. Curl fingers toward $\vec{B}$.
4. Thumb points in direction of $\vec{A} \times \vec{B}$.



Does not commute!

(b) Using the right-hand rule to find the direction of $\vec{B} \times \vec{A} = -\vec{A} \times \vec{B}$ (vector product is anticommutative)

1. Place $\vec{B}$ and $\vec{A}$ tail to tail.
2. Point fingers of right hand along $\vec{B}$, with palm facing $\vec{A}$.
3. Curl fingers toward $\vec{A}$.
4. Thumb points in direction of $\vec{B} \times \vec{A}$.
5. $\vec{B} \times \vec{A}$ has same magnitude as $\vec{A} \times \vec{B}$ but points in opposite direction.

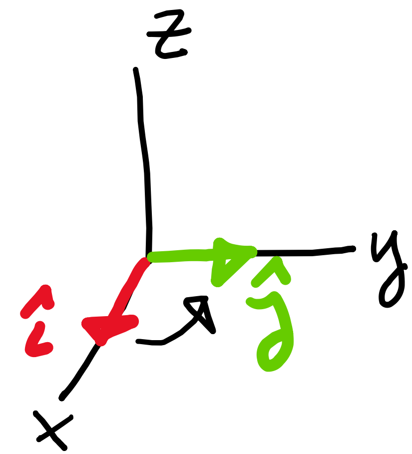


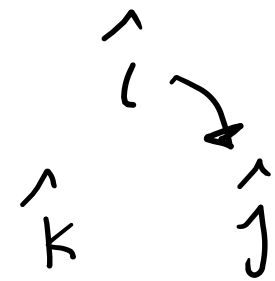
ASU

Cross product of unit vectors

Cross product of unit vectors

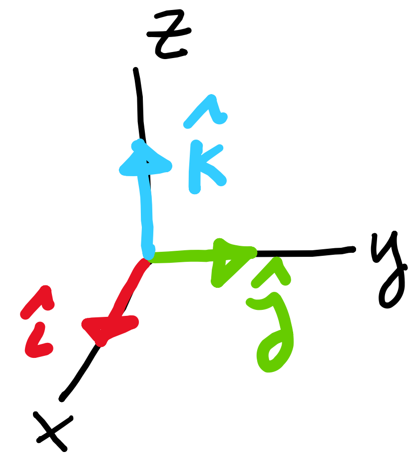
$\hat{i} \times \hat{j} =$





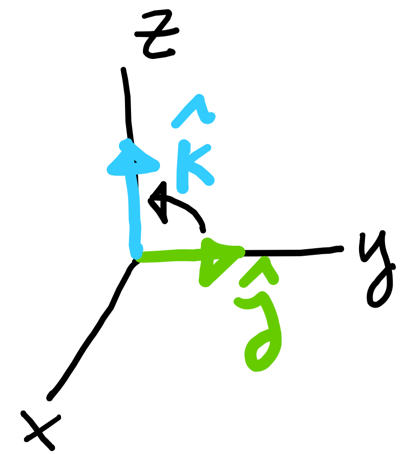
Cross product of unit vectors

$\hat{i} \times \hat{j} = \hat{k}$



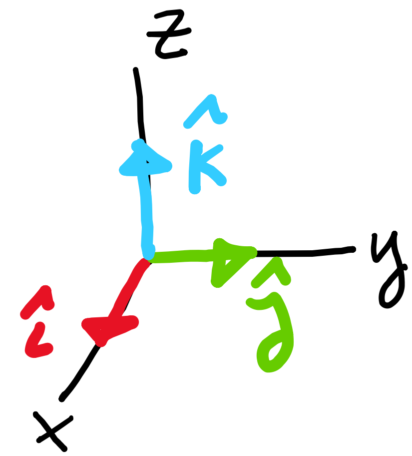
Cross product of unit vectors

$\hat{i} \times \hat{j} = \hat{k}\,,\quad \hat{j} \times \hat{k} =$



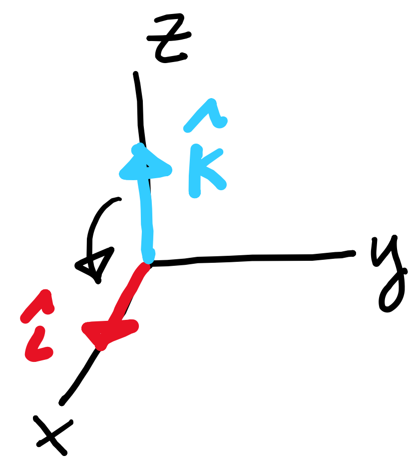
Cross product of unit vectors

$\hat{i} \times \hat{j} = \hat{k}, \quad \hat{j} \times \hat{k} = \hat{i}$



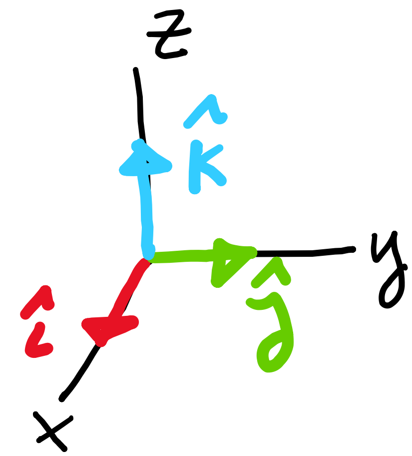
Cross product of unit vectors

$\hat{i} \times \hat{j} = \hat{k}, \quad \hat{j} \times \hat{k} = \hat{i}, \quad \hat{k} \times \hat{i} =$



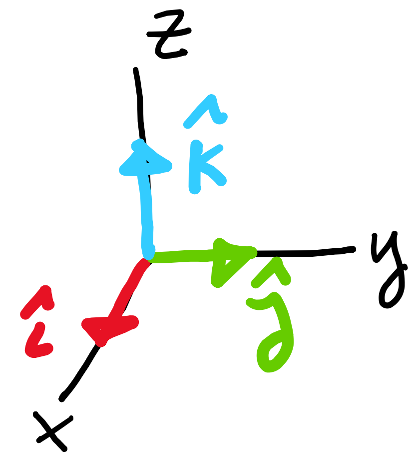
Cross product of unit vectors

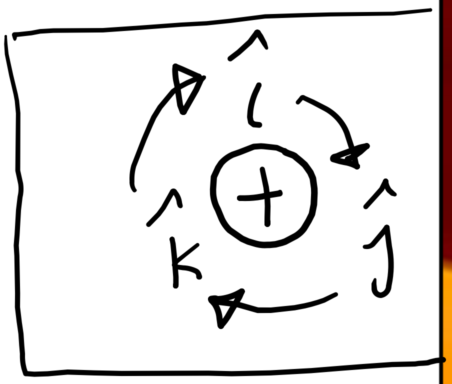
$\hat{i} \times \hat{j} = \hat{k}, \quad \hat{j} \times \hat{k} = \hat{i}, \quad \hat{k} \times \hat{i} = \hat{j}$



Cross product of unit vectors

$\hat{i} \times \hat{j} = \hat{k}, \quad \hat{j} \times \hat{k} = \hat{i}, \quad \hat{k} \times \hat{i} = \hat{j}$

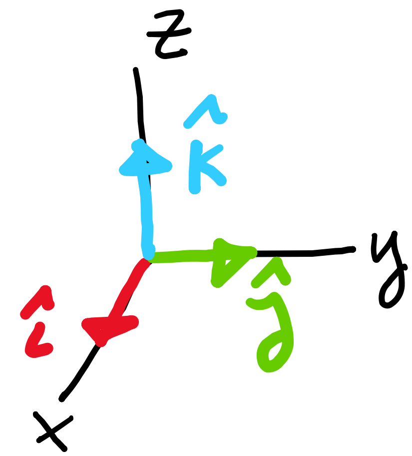




Cross product of unit vectors

$\hat{i} \times \hat{j} = \hat{k}$, $\hat{j} \times \hat{k} = \hat{i}$, $\hat{k} \times \hat{i} = \hat{j}$

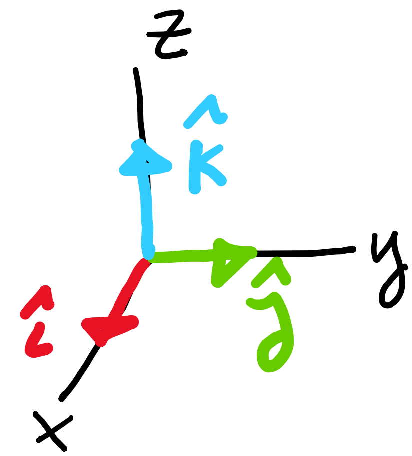
$\hat{j} \times \hat{i} = -\hat{k}$,



Cross product of unit vectors

$\hat{i} \times \hat{j} = \hat{k}$, $\hat{j} \times \hat{k} = \hat{i}$, $\hat{k} \times \hat{i} = \hat{j}$

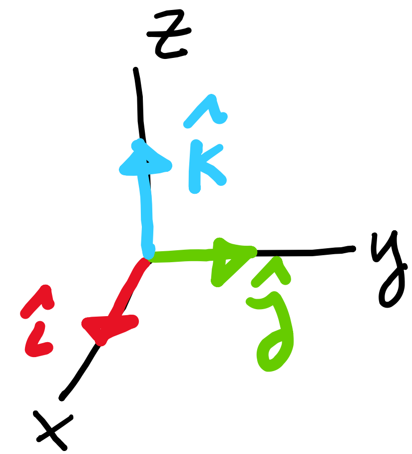
$\hat{j} \times \hat{i} = -\hat{k}$, $\hat{k} \times \hat{j} = -\hat{i}$,



Cross product of unit vectors

$\hat{i} \times \hat{j} = \hat{k}$, $\hat{j} \times \hat{k} = \hat{i}$, $\hat{k} \times \hat{i} = \hat{j}$

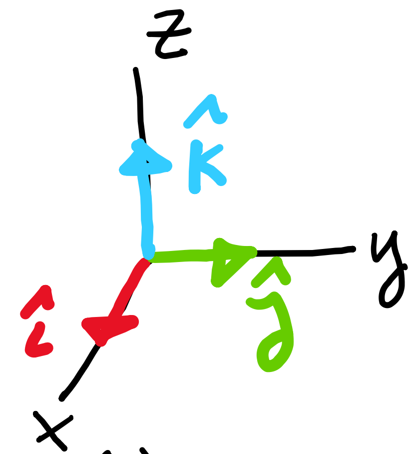
$\hat{j} \times \hat{i} = -\hat{k}$, $\hat{k} \times \hat{j} = -\hat{i}$, $\hat{i} \times \hat{k} = -\hat{j}$



Cross product of unit vectors

$\hat{i} \times \hat{j} = \hat{k}, \quad \hat{j} \times \hat{k} = \hat{i}, \quad \hat{k} \times \hat{i} = \hat{j}$

$\hat{j} \times \hat{i} = -\hat{k}, \quad \hat{k} \times \hat{j} = -\hat{i}, \quad \hat{i} \times \hat{k} = -\hat{j}$



So

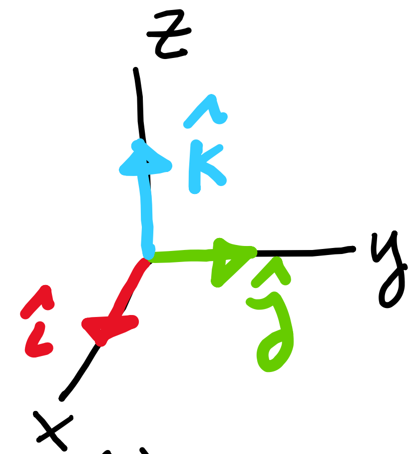
$\vec{A} \times \vec{B} = (A_x \hat{i} + A_y \hat{j} + A_z \hat{k}) \times (B_x \hat{i} + B_y \hat{j} + B_z \hat{k})$

$=$

Cross product of unit vectors

$\hat{i}\times\hat{j}=\hat{k}$, $\boxed{\hat{j}\times\hat{k}=\hat{i}}$, $\hat{k}\times\hat{i}=\hat{j}$

$\hat{j}\times\hat{i}=-\hat{k}$, $\boxed{\hat{k}\times\hat{j}=-\hat{i}}$, $\hat{i}\times\hat{k}=-\hat{j}$



So

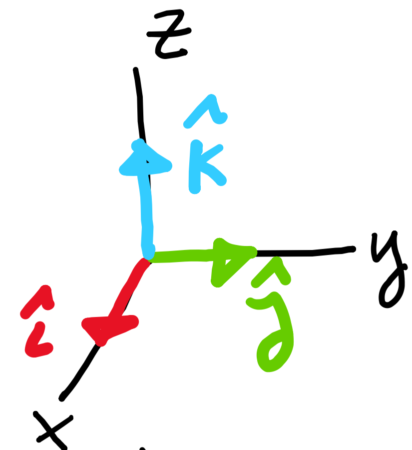
$$\vec{A}\times\vec{B}=(A_x\hat{i}+A_y\hat{j}+A_z\hat{k})\times(B_x\hat{i}+B_y\hat{j}+B_z\hat{k})$$

$$=(A_yB_z-A_zB_y)\hat{i}+$$

Cross product of unit vectors

$\hat{i} \times \hat{j} = \hat{k}$, $\hat{j} \times \hat{k} = \hat{i}$, $\boxed{\hat{k} \times \hat{i} = \hat{j}}$

$\hat{j} \times \hat{i} = -\hat{k}$, $\hat{k} \times \hat{j} = -\hat{i}$, $\boxed{\hat{i} \times \hat{k} = -\hat{j}}$



So

$$\vec{A} \times \vec{B} = (A_x\hat{i} + A_y\hat{j} + A_z\hat{k}) \times (B_x\hat{i} + B_y\hat{j} + B_z\hat{k})$$

$$= (A_yB_z - A_zB_y)\hat{i} +$$

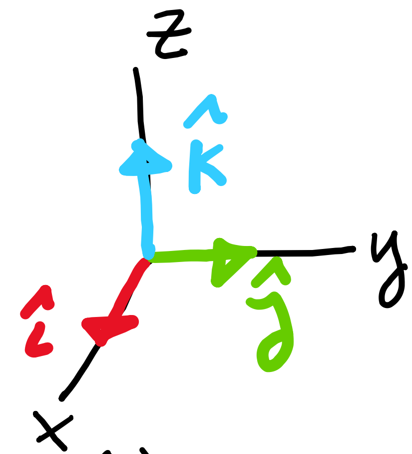
$$(A_zB_x - A_xB_z)\hat{j} +$$

ASU

Cross product of unit vectors

$$\hat{i}\times\hat{j}=\hat{k},\quad \hat{j}\times\hat{k}=\hat{i},\quad \hat{k}\times\hat{i}=\hat{j}$$

$$\hat{j}\times\hat{i}=-\hat{k},\quad \hat{k}\times\hat{j}=-\hat{i},\quad \hat{i}\times\hat{k}=-\hat{j}$$



So

$$\vec{A}\times\vec{B}=(A_x\hat{i}+A_y\hat{j}+A_z\hat{k})\times(B_x\hat{i}+B_y\hat{j}+B_z\hat{k})$$

$$=(A_yB_z-A_zB_y)\hat{i}+$$

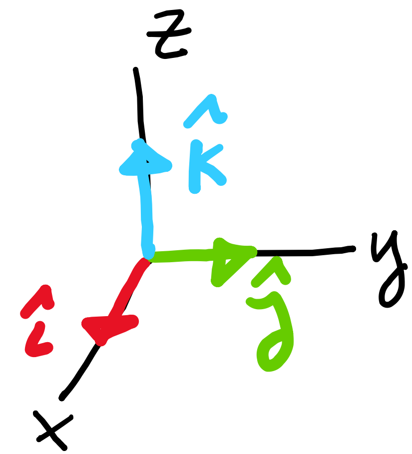
$$(A_zB_x-A_xB_z)\hat{j}+$$

$$(A_xB_y-A_yB_x)\hat{k}$$

Cross product of unit vectors

$\hat{i}\times\hat{j}=\hat{k}, \quad \hat{j}\times\hat{k}=\hat{i}, \quad \hat{k}\times\hat{i}=\hat{j}$

$\hat{j}\times\hat{i}=-\hat{k}, \quad \hat{k}\times\hat{j}=-\hat{i}, \quad \hat{i}\times\hat{k}=-\hat{j}$



So

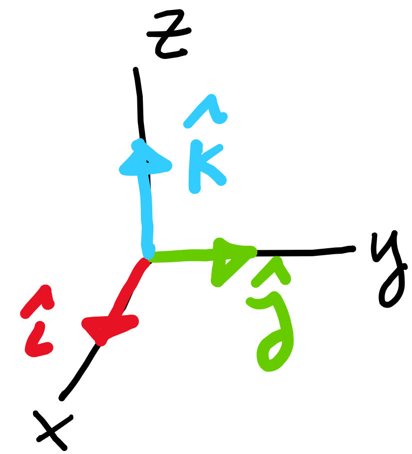
$$\boxed{\vec{A}\times\vec{B}=(A_yB_z-A_zB_y)\hat{i}+(A_zB_x-A_xB_z)\hat{j}+(A_xB_y-A_yB_x)\hat{k}}$$

So, if $\vec{C}=\vec{A}\times\vec{B}$

Cross product of unit vectors

$\hat{i} \times \hat{j} = \hat{k}, \; \hat{j} \times \hat{k} = \hat{i}, \; \hat{k} \times \hat{i} = \hat{j}$

$\hat{j} \times \hat{i} = -\hat{k}, \; \hat{k} \times \hat{j} = -\hat{i}, \; \hat{i} \times \hat{k} = -\hat{j}$



So

$$\boxed{\vec{A} \times \vec{B} = (A_y B_z - A_z B_y)\hat{i} + (A_z B_x - A_x B_z)\hat{j} + (A_x B_y - A_y B_x)\hat{k}}$$

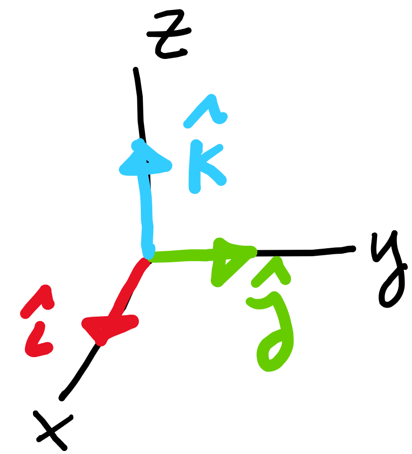
So, if $\vec{C} = \vec{A} \times \vec{B}$, then

$C_x = (A_y B_z - A_z B_y)$,

Cross product of unit vectors

$\hat{i} \times \hat{j} = \hat{k}$, $\hat{j} \times \hat{k} = \hat{i}$, $\hat{k} \times \hat{i} = \hat{j}$

$\hat{j} \times \hat{i} = -\hat{k}$, $\hat{k} \times \hat{j} = -\hat{i}$, $\hat{i} \times \hat{k} = -\hat{j}$



So

$$\boxed{\vec{A} \times \vec{B} = (A_y B_z - A_z B_y)\hat{i} + (A_z B_x - A_x B_z)\hat{j} + (A_x B_y - A_y B_x)\hat{k}}$$

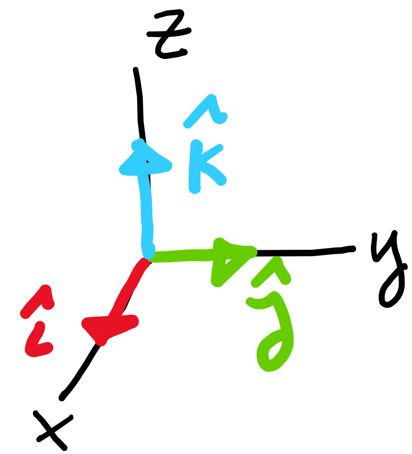
So, if $\vec{C} = \vec{A} \times \vec{B}$, then

$C_x = (A_y B_z - A_z B_y)$, $C_y = (A_z B_x - A_x B_z)$

Cross product of unit vectors

$\hat{i} \times \hat{j} = \hat{k}$, $\hat{j} \times \hat{k} = \hat{i}$, $\hat{k} \times \hat{i} = \hat{j}$

$\hat{j} \times \hat{i} = -\hat{k}$, $\hat{k} \times \hat{j} = -\hat{i}$, $\hat{i} \times \hat{k} = -\hat{j}$



So

$$\boxed{\vec{A} \times \vec{B} = (A_y B_z - A_z B_y)\hat{i} + (A_z B_x - A_x B_z)\hat{j} + (A_x B_y - A_y B_x)\hat{k}}$$

So, if $\vec{C} = \vec{A} \times \vec{B}$, then

$C_x = (A_y B_z - A_z B_y)$, $C_y = (A_z B_x - A_x B_z)$ &

$C_z = (A_x B_y - A_y B_x)$

ASU