5.11 Applications of the Dot and Cross product!

Dot Product:

$\vec{a}\cdot\vec{b} = |\vec{a}||\vec{b}|\cos\theta$

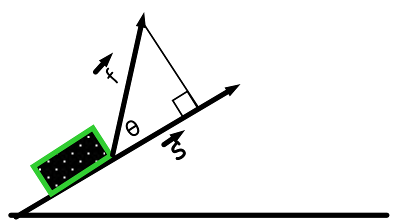
Scalar

Cross product:

$|\vec{a}\times\vec{b}| = |\vec{a}||\vec{b}|\sin\theta$

Vector

Application of Dot product:



WORK-> work is defined as the product of the displacement , $\vec{s}$, under an applied force, $\vec{f}$, along the line of displacement.

The component of $\vec{f}$ in the direction of $\vec{s}$ can be calculated as the scalar projection of $\vec{f}$ onto $\vec{s}$, $|\vec{f}|\cos\theta$.

$$\text{Work} = (|\vec{f}|\cos\theta)(|\vec{s}|)$$

$$\boxed{W = \vec{f}\cdot\vec{s}}$$

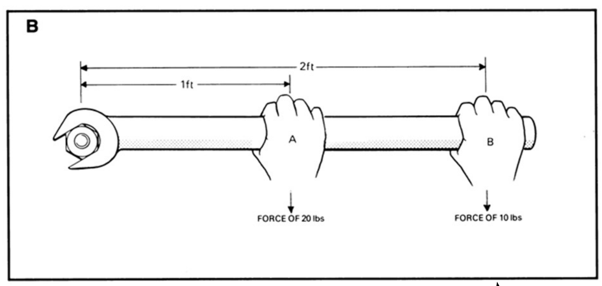
* measured in joules (J)

Ex. 1 A crate on a ramp is hauled 8m up the ramp under a constant force of 20 N applied at an angle of 30^0 to the ramp. Find the work done.

Application of Cross product

Cross product can be used for forces that involve rotation or turning around a point or axis.

An example is a threaded bolt that is tightened by a force applied to the wrench (called torque or turning effect)



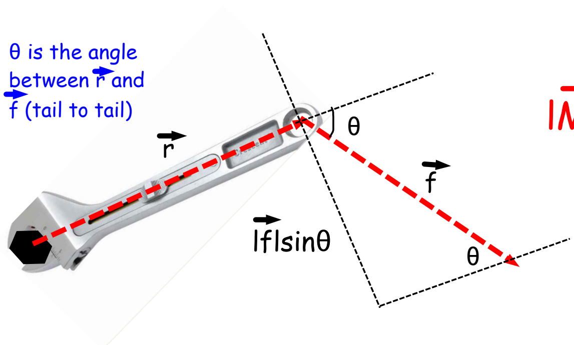
Smaller force needed if the distance between the bolt and force is larger

The magnitude of the turning effect depends on 2 things:

(1) the distance between the force and the point of rotation (bolt)

(2) the force directed perpendicular to the wrench

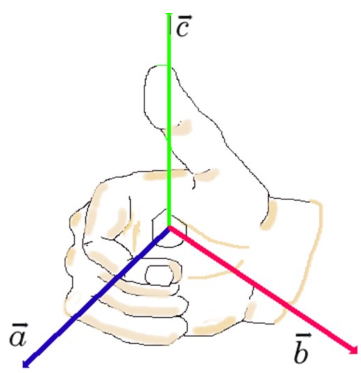
θ is the angle between $\vec{r}$ and $\vec{f}$ (tail to tail)



$|\vec{M}| = |\vec{r}|(|\vec{f}|\sin\theta)$

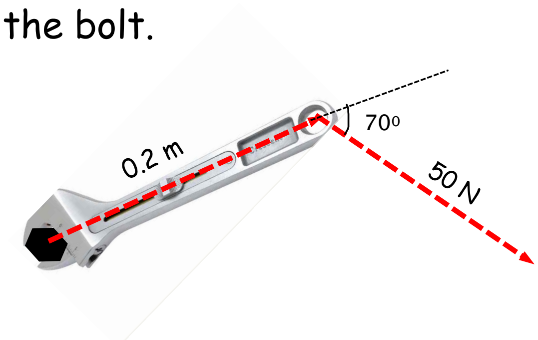
component of the force perpendicular to $\vec{r}$

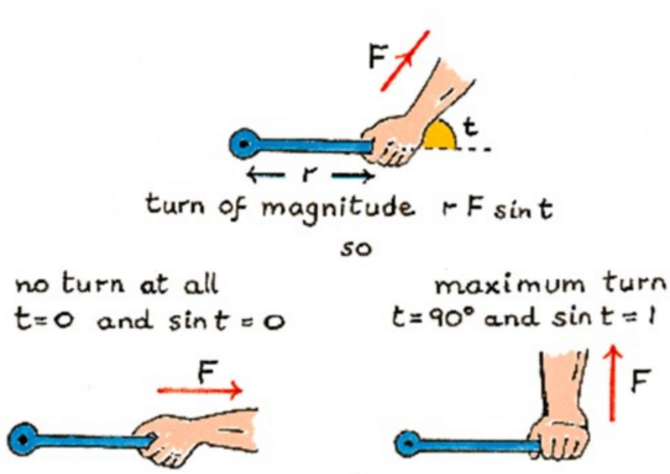
$$\boxed{\vec{M} = \vec{r} \times \vec{f}}$$

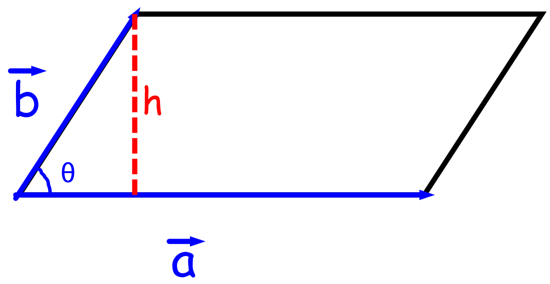


Remember the right hand rule. The direction of the turning effect is perpendicular to the plane containing $\vec{r}$ and $\vec{f}$. The direction of the moment of force would be into the page.

Ex.2 A bolt is tightened by applying a 50N force to a 0.2 m wrench as shown in the diagram. Find the moment of force about the centre of the bolt.







Area of a parallelogram= base x height

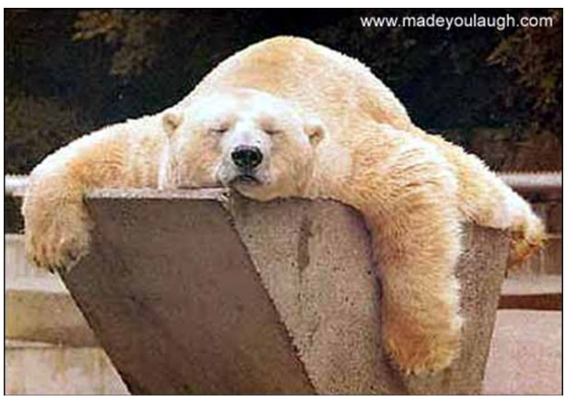
$= |\vec{a}||\vec{b}|\sin\theta$

$= |\vec{a} \times \vec{b}|$

Similarily,
Area of a triangle = $\frac{1}{2}|a \times b|$

Ex. 3 Calculate the area of a parallelogram determined by the vectors $\vec{a} = (1,-2,3)$ and $\vec{b} = (1,2,4)$.

That's it for the unit!!!



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