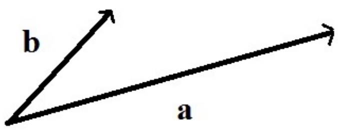
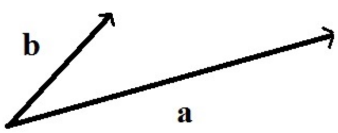
Warm-Up: Find a vector of length 3 in the same direction as $\mathbf{a} = \langle 2, 1, -1 \rangle$.

Warm-Up: Given the vectors **a** and **b** below, make an educated guess and sketch the vector projection of **b** onto **a**.



Let $\mathbf{a} = \overrightarrow{PQ}$ and let $\mathbf{b} = \overrightarrow{PR}$.



Def The vector projection of **b** onto **a** is found by sketching a __________ from the end of **b** (i.e. at R) ____________________ to the line containing **a**.

Let S be the intersection point.

The vector __________ is the vector projection of **b** onto **a** and is denoted as

Def The ______________________________ is given by

Also called the ______________________ of **b** onto **a**.

Using trig and the figure above, $\cos\theta = \dfrac{\text{comp}_{\mathbf{a}}\mathbf{b}}{|\mathbf{b}|}$ $\Rightarrow$

But if we are not given the angle θ how do we find $\text{comp}_{\mathbf{a}}\mathbf{b}$? And, how do we find $\text{proj}_{\mathbf{a}}\mathbf{b}$?

Recall, $\mathbf{a} \cdot \mathbf{b} =$

So now we know the length of the **<u>vector</u>** given by $\text{proj}_{\mathbf{a}}\mathbf{b} \Rightarrow$ length: __________

We also know that the **<u>vector</u>** given by $\text{proj}_{\mathbf{a}}\mathbf{b}$ points in the direction of vector ________ .

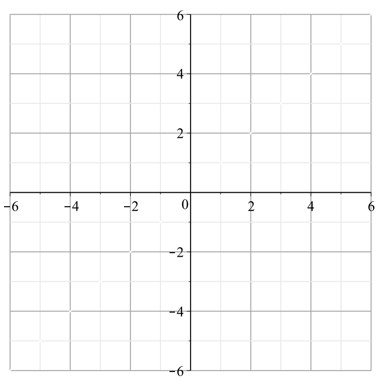
$\Rightarrow$ So we need a ________________ in the direction of ________ $\Rightarrow$ $\mathbf{u} =$

Then multiply the unit vector by the desired length __________

$\Rightarrow$ $\text{proj}_{\mathbf{a}}\mathbf{b} =$

<u>Ex</u> Given $\mathbf{v} = \langle 3, 2 \rangle$ and $\mathbf{w} = \langle -2, -5 \rangle$,

(a). Sketch $\mathbf{v}, \mathbf{w}$, and $\text{proj}_{\mathbf{v}}\mathbf{w}$.



(b). Find $\text{proj}_{\mathbf{v}}\mathbf{w}$.

<u>Ex</u> Given $\mathbf{a} = \langle -1, -2, 2 \rangle$ and $\mathbf{b} = \langle 3, 3, 4 \rangle$, find the scalar and vector projections of $\mathbf{b}$ onto $\mathbf{a}$.

Applications to Work

Previously, the work W done by a ______________ force F moving an object through a distance d is given by

______________ .

Units of work are

[But this formula is only valid if the force is acting in the same linear direction as the motion.]

But if the force acts in a direction different than the motion, we need to use ______________

Ex To close a sliding barn door, a person pulls on a rope with a constant force of 50 lbs at an angle of 60° declination. Find the work done in moving the door 12 ft to a closed position. [Do both ways to show that the angle formula is easier.]

Ex A wagon is pulled a horizontal distance of 100 m by a constant 50 N force. The handle is held at an angle of 30° above the horizontal. Find the work done.