1. By looking at the definition, Property: $\mathbf{a} \times \mathbf{a} =$ **0**

2. Given $\mathbf{a} = -3\mathbf{i} + 2\mathbf{j} + 2\mathbf{k}$ and $\mathbf{b} = 6\mathbf{i} + 3\mathbf{j} + \mathbf{k}$,

(a). Find $\mathbf{a} \times \mathbf{b}$

(b). Find $\mathbf{b} \times \mathbf{a}$

State a property of the cross product that you expect to be true from parts **(a)** and **(b)**.

Property: $\mathbf{a} \times \mathbf{b} = -(\mathbf{b} \times \mathbf{a})$

Using your result of 2(a), find

(c). $(\mathbf{a} \times \mathbf{b}) \cdot \mathbf{a}$

(d). $(\mathbf{a} \times \mathbf{b}) \cdot \mathbf{b}$

Write down the two properties from parts **(c)** and **(d)**.

Property: $(\mathbf{a} \times \mathbf{b}) \cdot \mathbf{a} =$ 0 $(\mathbf{a} \times \mathbf{b}) \cdot \mathbf{b} =$ 0

Fill in the blanks below for the property implied by the previous property.

Property: The *vector* $\mathbf{a} \times \mathbf{b}$ is orthogonal to both vectors $\mathbf{a}$ and $\mathbf{b}$ since the dot product is 0 .

3. Property: If θ is the angle between $\mathbf{a}$ and $\mathbf{b}$, then $|\mathbf{a} \times \mathbf{b}| = |\mathbf{a}||\mathbf{b}| \sin\theta$. See book for proof.

i.e. The *magnitude* of the cross product equals the magnitude of $\mathbf{a}$ times the magnitude of $\mathbf{b}$ times $\sin\theta$.

(a). Suppose $\mathbf{a}$ and $\mathbf{b}$ are nonzero vectors such that $\mathbf{a} \times \mathbf{b} = \mathbf{0}$. What are the possible angles θ between $\mathbf{a}$ and $\mathbf{b}$?

Fill in the blank for a property of the cross product that you expect to be true from part **(a)**.

Property: The vectors $\mathbf{a}$ and $\mathbf{b}$ are ___parallel___ if and only if $\mathbf{a} \times \mathbf{b} = \mathbf{0}$.

4. Recall that the general formula for the area of a parallelogram is $A =$ base $\cdot$ height.
Given the parallelogram formed from two vectors $\mathbf{a}$ and $\mathbf{b}$ [See board]

(a). What is the length of the base of the parallelogram? [Don't over think it.]

(b). Write an expression for the height of the parallelogram using the angle θ and magnitudes of the vectors $\mathbf{a}$ and/or $\mathbf{b}$. [Think right triangle and trig.]

(c). Using parts **(a)** & **(b)**, what is the area of the parallelogram ($A =$ base $\cdot$ height) in terms of the vector magnitudes and angles?

(d). Rewrite the formula for the area of a parallelogram in terms of the cross product.

(e). Find the area of a parallelogram with vertices $P(0,0,0), Q(5,0,0), R(2,6,6)$ and $S(-3,6,6)$.