**Problem 1** (a) Describe geometrically when $\mathbf{u} \cdot \mathbf{v}$ is negative, positive and zero.

(b) Simplify $(\mathbf{v} + 2\mathbf{w}) \cdot \mathbf{u} - \mathbf{u} \cdot \mathbf{v}$

(c) What is wrong with the expression $\mathbf{u} \cdot \mathbf{v} + \mathbf{v}$?

**Problem 2** If $\mathbf{e}$ and $\mathbf{f}$ are unit vectors such that $||\mathbf{e} + \mathbf{f}|| = \frac{3}{2}$, find $||\mathbf{e} - \mathbf{f}||$. *Hint: Use that* $||\boldsymbol{e} + \boldsymbol{f}||^2 = (\boldsymbol{e} + \boldsymbol{f}) \cdot (\boldsymbol{e} + \boldsymbol{f})$ *to first find* $\boldsymbol{e} \cdot \boldsymbol{f}$.

**Problem 3** (a) Why does $(\mathbf{u} \times \mathbf{v}) \cdot \mathbf{w}$ make sense, while $(\mathbf{u} \cdot \mathbf{v}) \times \mathbf{w}$ doesn't?

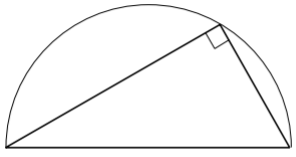
(b) Why does $\mathbf{u} \times \mathbf{v} + \mathbf{v} \times \mathbf{u} = 0$?

(c) Is it always true that $(\mathbf{u} \times \mathbf{v}) \times \mathbf{w} = \mathbf{u} \times (\mathbf{v} \times \mathbf{w})$?

**Problem 4** Find the two unit vectors orthogonal to $\mathbf{a} = \langle 3, 1, 1 \rangle$ and $\mathbf{b} = \langle -1, 2, 1 \rangle$.

**Problem 5** How can you use the cross and dot product to determine if three vectors lie on the same plane?

**Problem 6** [1]Suppose that one side of a triangle forms the diameter of a circle and the vertex opposite this side lies on a circle. Use the dot product to prove that this is a right triangle.



[1]From https://math.berkeley.edu/ hutching/teach/53-2015/53worksheets.pdf