1. Defined the dot product: \( \mathbf{a} \cdot \mathbf{b} = a_1 b_1 + a_2 b_2 + a_3 b_3 \).
   
   Example: Make one up.

2. Basic properties:
   
   (a) \( \mathbf{a} \cdot \mathbf{b} = \mathbf{b} \cdot \mathbf{a} \)
   
   (b) \( \mathbf{a} \cdot (\mathbf{b} \pm \mathbf{c}) = \mathbf{a} \cdot \mathbf{b} \pm \mathbf{a} \cdot \mathbf{c} \)
   
   (c) \( \alpha (\mathbf{a} \cdot \mathbf{b}) = (\alpha \mathbf{a}) \cdot \mathbf{b} = \mathbf{a} \cdot (\alpha \mathbf{b}) \)

3. Advanced properties:
   
   (a) \( \mathbf{a} \cdot \mathbf{b} = ||\mathbf{a}|| ||\mathbf{b}|| \cos \theta \) where \( \theta \) is the angle between them. This follows from the Law of Cosines and is sometimes (physics especially) used as an alternate definition of the dot product.
   
   (b) \( \mathbf{a} \perp \mathbf{b} \) iff \( \mathbf{a} \cdot \mathbf{b} = 0 \) and how this follows from the previous.
   
   (c) \( \cos(\theta) = \frac{\mathbf{a} \cdot \mathbf{b}}{||\mathbf{a}|| ||\mathbf{b}||} \)
   
   (d) \( \mathbf{a} \cdot \mathbf{a} = ||\mathbf{a}||^2 \) and \( ||\mathbf{a}|| = \sqrt{\mathbf{a} \cdot \mathbf{a}} \)

4. Definition of projection and the formula

   \[ \text{Pr}_\mathbf{b} \mathbf{a} = \left( \frac{\mathbf{a} \cdot \mathbf{b}}{\mathbf{b} \cdot \mathbf{b}} \right) \mathbf{b} \]

   Example: Make one up.

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Note: Questions like 15-17 in the homework can be confusing. All you’re doing is writing the original vector as a sum of two vectors, those two vectors perpendicular to one another.