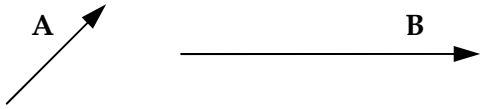
## 1. The Basics

a) Given vectors **A** and **B** as shown, draw the following:

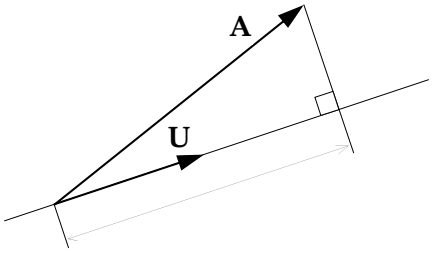



- **A** + **B**
- **A** – **B**
- –½ **A**

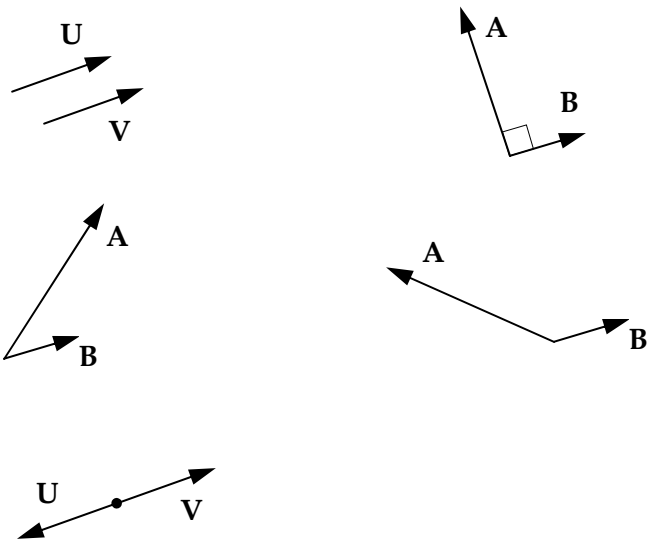
b) Write two equations for calculating the dot product **A** · **B**, where **A** = [ $A_x$ $A_y$ $A_z$ ] and **B** = [ $B_x$ $B_y$ $B_z$ ].

- **A** · **B** =
- **A** · **B** =

c) Draw **A** · **U** on the diagram, given that |**U**| = 1.

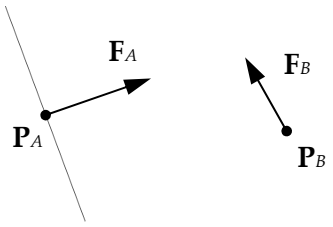



d) For each pair of vectors **A** and **B**, or **U** and **V**, write an inequality indicating the sign of the dot product… or if possible, write the exact value of the dot product. Note that |**U**| = |**V**| = 1, while |**A**| ≠ 1 and |**B**| ≠ 1.




## 2. Can you see me?

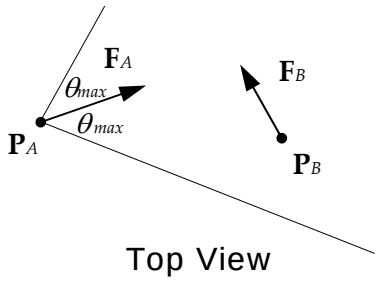
Two characters are standing on a roughly horizontal planar surface. The position of character A is $\mathbf{P}_A$ and its forward-facing unit vector is $\mathbf{F}_A$. Likewise the position and forward vector of character B are $\mathbf{P}_B$ and $\mathbf{F}_B$ respectively.




Top View

a) Use the sign of a dot product to determine whether character B is in front of or behind character A.

b) Assume both characters have a vision cone extending $\theta_{max}$ radians to either side of their **F** vectors. Write an expression (using a dot product) indicating whether or not character A can "see" character B.
BONUS: How can we avoid finding the inverse cosine, $\cos^{-1}(\theta_{max})$?



Top View

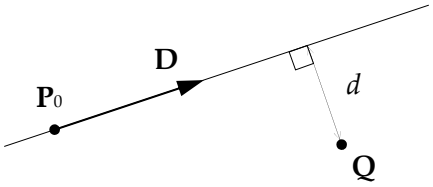
## 3. Wind Tunnel

The designers want to implement a shaft of wind that will affect any character or object that enters its cylindrical boundary.

a) You are given an arbitrary point **Q** in 3D space, and an infinite line represented by the locus of points $\mathbf{P}(t)$ defined as follows:

$$\mathbf{P}(t) = \mathbf{P}_0 + t\mathbf{D},$$

where $\mathbf{P}_0$ is a fixed point on the line, and **D** is a unit vector defining the line's direction. Find the perpendicular distance $d$ from **Q** to the line.


D
P0
d
Q

b) The cylindrical wind tunnel can be defined by adding a radius *r* and length *L* to the infinite line from part (a). Assuming the position of our object or character is **Q**, write an expression that can be used to determine whether it will be affected by the wind or not.