Name: Solutions **ID:**

1. Determine a **unit** vector that is perpendicular to $\mathbf{a} = \langle 1, -2, 1\rangle$ and $\mathbf{b} = \langle 4, 2, 3\rangle$

1) Compute $\vec{a} \times \vec{b}$: $\begin{matrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -2 & 1 \\ 4 & 2 & 3 \end{matrix}$ $\hat{i}(-6-2) - \hat{j}(3-4) + \hat{k}(2+8$

$\vec{a} \times \vec{b} = \langle -8, 1, 10\rangle$ $\|\vec{a} \times \vec{b}\|^2 = 64 + 1 + 100 = 165$

Unit vector: $\frac{1}{\sqrt{165}}\langle -8, 1, 10\rangle$

2. Consider the line in symmetric form

$$\frac{x-1}{2} = \frac{y+2}{2} = z - 3.$$

a. Determine a vector parallel to this line.

b. Determine two points that lie on this line.

c. Determine the distance from this line to the origin.

a) $\vec{v} = \langle 2, 2, 1\rangle$ ← by inspection

b) $P = (1, -2, 3)$ (by inspection

$P + V = (3, 0, 4)$

c) Distance: $\frac{\|\vec{v} \times \vec{OP}\|}{\|\vec{v}\|}$

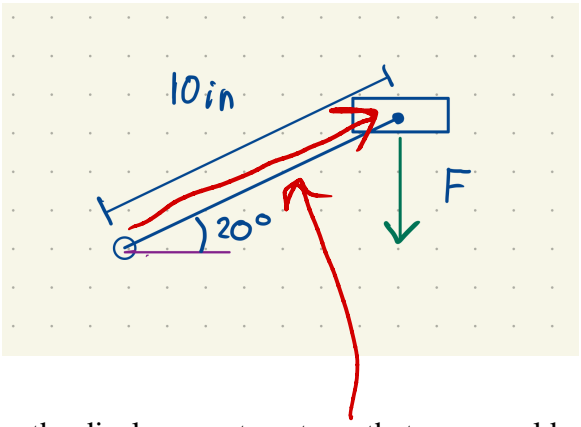
$\begin{matrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 2 & 1 \\ 1 & -2 & 3 \end{matrix}$ $\hat{i}(6+2) - \hat{j}(6-1) + \hat{k}(-6)$

$\|\vec{v} \times \vec{OP}\| = \sqrt{64 + 25 + 36} = \sqrt{125}$

$\|\vec{v}\| = \sqrt{5}$

dist: $\frac{\sqrt{125}}{5} = 5$ $\langle 8, -5, -6\rangle$

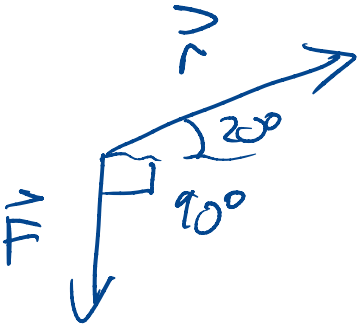
3. A bike rider applies 200 pounds of force, straight down, onto a pedal that is 10 inches from the crankshaft. The arm between the pedal and the crankshaft is angled 20 degrees above horizontal as shown in the diagram below.



a. Add to the diagram the displacement vector **r** that you would use for computing the torque exerted on the crankshaft.

b. Determine the angle between **r** and **F**.

c. Determine magnitude of the torque vector, and determine if it points into or out of the page.

b) 

$110°$

c) $\|\vec{r} \times \vec{F}\| = 10\text{ in} \cdot 200\text{ lb} \cdot \sin(110°)$

$= \frac{2000}{12} \sin(110°)$ ft lb

By right handed rule, points into page $(\vec{r} \times \vec{F})$