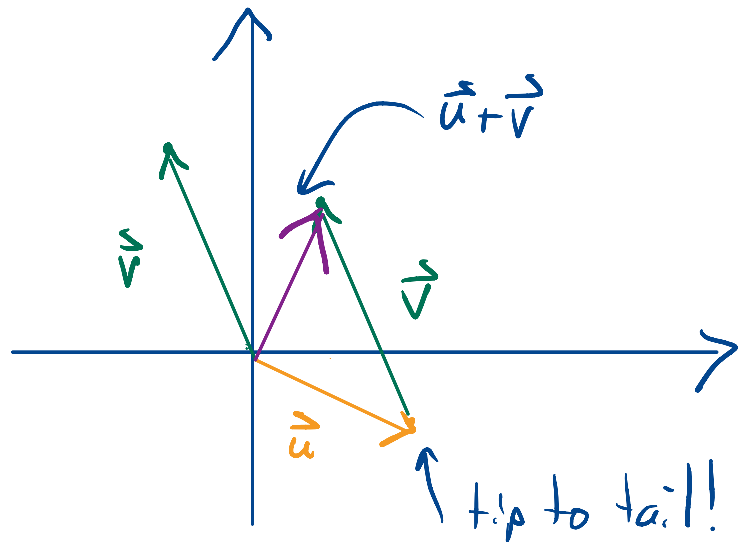
Name: Solutions **ID:** .

1. Find the sum of the vectors $\mathbf{u} = \langle 2, -1\rangle$ and $\mathbf{v} = \langle -1, 3\rangle$ and illustrate this operation geometrically.

$$\vec{u} + \vec{v} = \langle 2, -1\rangle + \langle -1, 3\rangle$$

$$= \langle 1, 2\rangle$$



2. A model rocket experiences a force due to gravity $\mathbf{W} = \langle 0, -1\rangle$ pounds and a force from its engine $\mathbf{F} = \langle 1, 5\rangle$ pounds. Find the total force vector $\mathbf{T}$ acting on the rocket and the total scalar amount of force as well. Units please.

$$\vec{T} = \vec{W} + \vec{F} = \langle 0, -1\rangle + \langle 1, 5\rangle$$

$$= \boxed{\langle 1, 4\rangle \text{ lb}}$$

$$\|\vec{T}\| = \sqrt{1^2 + 4^2} = \boxed{\sqrt{17} \text{ lb}}$$

3. Find the angle between the vectors $\mathbf{a} = \langle 1, 2, 1\rangle$ and $\mathbf{b} = \langle 2, 2, 3\rangle$. You are welcome to leave your answer in terms of an inverse trig function.

$$\vec{a} \cdot \vec{b} = 2 + 4 + 3 = 9$$

$$\|\vec{a}\|^2 = 1 + 4 + 1 = 6$$

$$\|\vec{b}\|^2 = 4 + 4 + 9 = 17$$

$$\vec{a} \cdot \vec{b} = \|\vec{a}\|\,\|\vec{b}\| \cos\theta \Rightarrow \cos\theta = \frac{\vec{a} \cdot \vec{b}}{\|\vec{a}\|\,\|\vec{b}\|}$$

$$\theta = \arccos\left(\frac{9}{\sqrt{6}\sqrt{17}}\right)$$

4. For the same vectors $\mathbf{a} = \langle 1, 2, 1\rangle$ and $\mathbf{b} = \langle 2, 2, 3\rangle$ as in the previous problem, compute the orthogonal projection of $\mathbf{a}$ onto $\mathbf{b}$. Using your book's notation, this projection is $\text{proj}_{\mathbf{b}}\mathbf{a}$. You do not need to simplify your work, but your answer must be in a form where a person with a calculator could easy compute the numerical values of the components of the vector. Note that you may have already done some of the computations needed to solve this problem...

$$\text{proj}_{\vec{b}}\vec{a} = \frac{\vec{a} \cdot b}{\|\vec{b}\|^2} \vec{b} = \frac{9}{17} \vec{b} \quad \text{(from above!)}$$

$$= \frac{9}{17} \langle 2, 2, 3 \rangle$$

$$= \left\langle \frac{18}{17}, \frac{18}{17}, \frac{27}{17} \right\rangle$$