Cross Product

1. Compute \( \langle 0, -2, -3 \rangle \times \langle 4, 0, 2 \rangle \).

2. Compute \( \langle 4, 0, 2 \rangle \times \langle 0, -2, -3 \rangle \).

3. Notice the relationship between your answers in numbers (1) and (2). Does this relationship occur in general? To answer this, find expressions for \( \vec{a} \times \vec{b} \) and \( \vec{b} \times \vec{a} \). How are these two expressions related?

4. In this problem we will look for a geometrical picture for the cross product.
   a) Find \( \langle 8, 0, 0 \rangle \times \langle 3, 2, 0 \rangle \).

   b) Compute \( \left| \langle 8, 0, 0 \rangle \times \langle 3, 2, 0 \rangle \right| \).

   c) Draw these vectors. If we look at them as two sides of a parallelogram, draw in the other edges.

   d) Find the area of the parallelogram in part c.
**Torque**

5. What is the magnitude of the torque caused by a 4 N force applied perpendicularly at a distance 3 meters from the axis of rotation?

6. A 12 N force is applied at an angle $\pi/6$, 2 meters from the axis of rotation. At what distance $d$ does a 2 Newton (perpendicular) force cause a torque with the same magnitude?

7. A sphere with radius $R$ is rolling down a track, such that the center of mass is $b$ meters above the rails. If the translation kinetic energy is 10 Joules, find the rotational kinetic energy. (Assume no slipping.) Your answer should contain only $R$ and $b$ as undetermined constants.

8. In the lecture, we found that the acceleration of a sphere on a two-rail track is given by the equation

$$a_{CM} = \frac{g \sin \theta}{\frac{2R^2}{5b^2} + 1}.$$

a) What is the acceleration as $b \rightarrow R$?

b) What is the acceleration as $b \rightarrow 0$?