Example At 2:10 a 3-pound weight is hung from the end of the 3-foot long minute hand of a clock with a vertical clock face. Find the resulting torque (at the center of the clock).

First we need to set up a coordinate system. As it is traditional to consider the z-axis as pointing straight up, we will consider the clock face to be in the yz-plane, with the center at the origin, 12:00 on the positive z-axis, and 3:00 on the positive y-axis. We will label our axes in units of feet.

The minute hand is 3 feet long and at 2:10 it makes an angle of 30 degrees, or $\frac{\pi}{6}$, with the positive y-axis, so the coordinates of its tip are

$$\left(0,\, 3\cos\frac{\pi}{6},\, 3\sin\frac{\pi}{6}\right) = \left(0,\, \frac{3\sqrt{3}}{2},\, \frac{3}{2}\right).$$

These are also the coordinates of the vector $\vec{r}$ from the center of the clock (the origin) to the end of the minute hand:

$$\vec{r} = \left\langle 0,\, \frac{3\sqrt{3}}{2},\, \frac{3}{2} \right\rangle.$$

The force vector (the force in question being the gravitational force acting at the 3 pound weight) has magnitude 3 pounds and points straight downwards, so

$$\vec{F} = \langle 0,\, 0,\, -3 \rangle.$$

The torque is the cross product of $\vec{r}$ and $\vec{F}$ (in units of foot-pounds):

$$\vec{T} = \vec{R} \times \vec{F} = \left\langle 0,\, \frac{3\sqrt{3}}{2},\, \frac{3}{2} \right\rangle \times \langle 0,\, 0,\, -3 \rangle =$$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & \frac{3\sqrt{3}}{2} & \frac{3}{2} \\ 0 & 0 & -3 \end{vmatrix} = \left\langle -\frac{9\sqrt{3}}{2},\, 0,\, 0 \right\rangle.$$

Note that this has the correct direction, into the clock face, as the weight hung on the minute hand in that position tends to produce a clockwise rotation.