65. The problem asks that we put the origin of coordinates at point O but compute all the angular momenta and torques relative to point A. This requires some care in defining $\vec{r}$ (which occurs in the angular momentum and torque formulas). If $\vec{r}_O$ locates the point (where the block is) in the prescribed coordinates, and $\vec{r}_{OA} = -1.2\,\hat{\jmath}$ points from O to A, then $\vec{r} = \vec{r}_O - \vec{r}_{OA}$ gives the position of the block relative to point A. SI units are used throughout this problem.

(a) Here, the momentum is $\vec{p}_0 = m\vec{v}_0 = 1.5\,\hat{\imath}$ and $\vec{r}_0 = 1.2\,\hat{\jmath}$, so that

$$\vec{\ell}_0 = \vec{r}_0 \times \vec{p}_0 = -1.8\,\hat{k}\ \text{kg}\cdot\text{m}^2/\text{s}\ .$$

(b) The horizontal component of momentum doesn't change in projectile motion (without friction), and its vertical component depends on how far its fallen. From either the free-fall equations of Ch. 2 or the energy techniques of Ch. 8, we find the vertical momentum component after falling a distance h to be $-m\sqrt{2gh}$. Thus, with $m = 0.50$ and $h = 1.2$, the momentum just before the block hits the floor is $\vec{p} = 1.5\,\hat{\imath} - 2.4\,\hat{\jmath}$. Now, $\vec{r} = R\,\hat{\imath}$ where R is figured from the projectile motion equations of Ch. 4 to be $R = v_0\sqrt{\frac{2h}{g}} = 1.5$ m. Consequently,

$$\vec{\ell} = \vec{r} \times \vec{p} = -3.6\,\hat{k}\ \text{kg}\cdot\text{m}^2/\text{s}\ .$$

(c) and (d) The only force on the object is its weight $m\vec{g} = -4.9\,\hat{\jmath}$. Thus,

$$\begin{aligned}\vec{\tau}_0 &= \vec{r}_0 \times \vec{F} = 0\\ \vec{\tau} &= \vec{r} \times \vec{F} = -7.3\,\hat{k}\ \text{N}\cdot\text{m}\ .\end{aligned}$$