The time dependence of the position of a particle of mass $m = 2$ is given by $\mathbf{r}(t) = 2t\hat{\mathbf{i}} - 3t^2\hat{\mathbf{j}}$. Its angular momentum, with respect to the origin, at time $t = 2$ is

(a) $36\,\hat{\mathbf{k}}$

(b) $-34\,(\hat{\mathbf{k}} - \hat{\mathbf{i}})$

(c) $-48\,\hat{\mathbf{k}}$

(d) $48\,(\hat{\mathbf{i}} + \hat{\mathbf{j}})$

Sol:

$$r(t) = 2t\,\hat{i} - 3t^2\,\hat{j}$$

$$\vec{v}(t) = \frac{d\,\vec{r}(t)}{dt} = 2\hat{i} - 6t\,\hat{j}$$

$$\vec{L} = \vec{r} \times m\vec{v}$$

$$= m\,(\vec{r} \times \vec{v})$$

$$= m \begin{vmatrix} i & j & k \\ 2t & -3t^2 & 0 \\ 2 & -6t & 0 \end{vmatrix}$$

$$\vec{L} = m\,(-6t^2)\,\hat{k}$$

$$\vec{L} = -12\,t^2\,\hat{k}$$

$$\vec{L}\Big|_{t=2\,sec} = -48\,\hat{k}$$