1. Let trajectory be given by vector function $\vec{r}(t)=(t \cos (2 t), t \sin (2 t), 0)$. Find velocity vector $\vec{v}(t)=$ $\vec{r}^{\prime}$, angular momentum vector $\vec{L}(t)=\vec{r} \times \vec{v}$, acceleration vector $\vec{a}(t)=\vec{r}^{\prime \prime}$ and torque vector $\vec{\tau}(t)=\vec{r} \times \vec{a}$. Is there a moment of time where vectors $\vec{r}$ and $\vec{v}$ are perpendicular?
2. Let trajectory be given by vector function $\vec{r}(t)=(\cos (2 t), \sin (2 t), t)$. Find velocity vector $\vec{v}(t)=\vec{r}^{\prime}$, angular momentum vector $\vec{L}(t)=\vec{r} \times \vec{v}$, acceleration vector $\vec{a}(t)=\vec{r}^{\prime \prime}$ and torque vector $\vec{\tau}(t)=\vec{r} \times \vec{a}$.
3. (a) Is the curve $\vec{r}(t)=\left(t^{3}, t^{2}, t\right)$ smooth?
(b) Is it true of false that the curve given by $\vec{r}(t)=(f(t), g(t), t)$ is smooth regardless of what the functions $f(t)$ and $g(t)$ are, as long as they are differentiable?
4. Use definition of the cross product and the product rule for differentiation to show that

$$
(\vec{x} \times \vec{y})^{\prime}=\vec{x}^{\prime} \times \vec{y}+\vec{x} \times \vec{y}^{\prime} .
$$

5. Find the length of the curve
(a) $\vec{r}=\left(3 t^{2}, 12 t, 8 t^{3 / 2}\right)$ where $0 \leq t \leq 2$.
(b) $\vec{r}=(3 t, 4 \sin t, 4 \cos t)$ where $-1 \leq t \leq 10$
6. Find the curvature and normal and binormal vectors at given point
(a) $\vec{r}(t)=\left(t, t^{3}, 0\right)$ at $(1,1,0)$
(b) $\vec{r}(t)=\left(e^{t}, e^{t} \sin t, e^{t} \cos t\right)$ at $(1,0,1)$
7. Find and graph the osculating circle of the hyperbola $y=2 / x$ at point $(1,2)$.
