1. $\vec{r}(t) = \langle t^2, \sin t - t\cos t, \cos t + t\sin t \rangle, \quad t > 0$

4pts

a.) $\vec{r}'(t) = \langle 2t, \cos t - \cos t + t\sin t, -\sin t + \sin t + t\cos t \rangle$

$= \langle 2t, t\sin t, t\cos t \rangle$

$|\vec{r}'(t)| = \sqrt{4t^2 + t^2\sin^2 t + t^2\cos^2 t} = t\sqrt{4 + \sin^2 t + \cos^2 t} = \sqrt{5}\, t$

$\hat{T}(t) = \langle \frac{2}{\sqrt{5}}, \frac{1}{\sqrt{5}}\sin t, \frac{1}{\sqrt{5}}\cos t \rangle$

4pts

b.) $\hat{T}'(t) = \langle 0, \frac{1}{\sqrt{5}}\cos t, -\frac{1}{\sqrt{5}}\sin t \rangle$

$|\hat{T}'(t)| = \sqrt{\frac{1}{5}\cos^2 t + \frac{1}{5}\sin^2 t} = \frac{1}{\sqrt{5}}$

$\hat{N}(t) = \langle 0, \cos t, -\sin t \rangle$

4pts

c.) $\hat{B}(t) = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ \frac{2}{\sqrt{5}} & \frac{1}{\sqrt{5}}\sin t & \frac{1}{\sqrt{5}}\cos t \\ 0 & \cos t & -\sin t \end{vmatrix} = \hat{\imath}\left(-\frac{1}{\sqrt{5}}\sin^2 t - \frac{1}{\sqrt{5}}\cos^2 t\right) - \hat{\jmath}\left(-\frac{2}{\sqrt{5}}\sin t\right) + \hat{k}\left(\frac{2}{\sqrt{5}}\cos t\right)$

$= -\frac{1}{\sqrt{5}}\hat{\imath} + \frac{2}{\sqrt{5}}\sin t\,\hat{\jmath} + \frac{2}{\sqrt{5}}\cos t\,\hat{k}$

3pts

2.) $\lim_{(x,y)\to(0,0)} \frac{x^8 - y^8}{x^4 - y^4} = \lim_{(x,y)\to(0,0)} \frac{(x^4+y^4)(x^4-y^4)}{(x^4-y^4)} = \lim_{(x,y)\to(0,0)} (x^4+y^4) = 0$

3pts

3.) $\lim_{(x,y)\to(0,0)} \frac{x^3}{x^3 - y^6}$

x-axis $y=0$: $\lim_{\substack{(x,y)\to(0,0)\\ y=0}} \frac{x^3}{x^3 - y^6} = \lim_{\substack{(x,y)\to(0,0)\\ y=0}} \frac{x^3}{x^3} = 1$

y-axis $x=0$: $\lim_{\substack{(x,y)\to(0,0)\\ x=0}} \frac{x^3}{x^3 - y^6} = \lim_{\substack{(x,y)\to(0,0)\\ x=0}} \frac{0}{-y^6} = 0$

∴ The limit DNE by the two paths test.

3pts

4.) $f(x,y) = 9x^2 + y^2$

$k=0$: $9x^2 + y^2 = 0$ point $(0,0)$

$k=1$: $9x^2 + y^2 = 1$

$\frac{x^2}{1/9} + \frac{y^2}{1} = 1$

$k=9$: $9x^2 + y^2 = 9$

$\frac{x^2}{1} + \frac{y^2}{9} = 1$