(1) Sketch the curve that is the image of the path $x = 2 \sin(t), \ y = 4 \cos(t)$, where $0 \leq t \leq 2\pi$.

(2) Suppose that a particle following the given path $c(t) = (e^t, e^{-t}, \cos(t))$ flies off on a tangent at $t = 1$. Compute the position of the particle at $t = 2$.

(3) The position vector for a particle moving on a helix is $c(t) = (\cos(t), \sin(t), t^2)$.
   (a) Find the speed of the particle at the time $t_0 = 4\pi$.
   (b) Is $c'(t)$ ever orthogonal to $c(t)$?
   (c) Find parametrization for the tangent line to $c(t)$ at $t_0 = 4\pi$.
   (d) Where will this line intersect the $xy$-plane?

(4) Prove that $f : U \subset \mathbb{R}^2 \rightarrow \mathbb{R}$, $(x,y) \mapsto \sqrt{1-x^2-y^2}$, where $U = \{(x,y) \in \mathbb{R}^2 \mid x^2 + y^2 < 1\}$, is differentiable and find its derivative at an arbitrary point.

(5) $f(x,y,z) = (3y + 2, \ x^2 + y^2, \ x + z^2)$. Let $c(t) = (\cos(t), \ \sin(t), \ t)$.
   (a) Find $p = f \circ c$ and the velocity vector $p'(\pi)$.
   (b) Find $c(\pi)$, $c'(\pi)$ and $Df(-1, 0, \pi)$.
   (c) Thinking of $Df(-1, 0, \pi)$ as a linear map, find $Df(-1, 0, \pi)(c'(\pi))$.

(6) Let $f : \mathbb{R}^4 \rightarrow \mathbb{R}$ and $c(t) : \mathbb{R} \rightarrow \mathbb{R}^4$. Suppose $\nabla f(1,1,\pi,e^6) = (0,1,3,-7)$, $c(\pi) = (1,1,\pi,e^6)$, and $c'(\pi) = (19,11,0,1)$. Find $\frac{d(f \circ c)}{dt}$ when $t = \pi$.

(7) Using chain rule, compute the derivative matrix for $z = \sin(u) \cos(v)$, where $u = 3x^2 - 2y$ and $v = x - 3y$. 