1. Consider a particle moving along the path $\mathbf{P}(t) = \begin{pmatrix} 3\sin(2t) \\ 3\cos(2t) \\ -6t \end{pmatrix}$

   (a) Identify the graph of the path of the particle and its direction of travel.

   (b) Find the velocity an acceleration of the particle.

   (c) Is t the arc length parameter? Why/why not?

   (d) Find the unit tangent, the curvature, and the unit normal vectors.

   (e) Find the length of the path from T to $T + 4\pi$.

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2. (a) Sketch the surface $f(x, y) = -x^2 - y^2 + 2$ and label at least one point on the surface.

   (b) Draw at least three level sets for the surface.

   (c) What is the domain of f?

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3. Find a unit vector that is perpendicular to the plane determined by the three points $A(2, 1, -3)$, $B(0, 2, 4)$ and $C(1, 5, -1)$.

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4. Let $z = \ln(x - y^2) + y\cos(xy)$. Compute $\partial z/\partial x$, $\partial z/\partial y$.

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5. Find a parametrization of the tangent line to the curve of intersection of the plane $x = 1$ and the surface $z = \sqrt{4 - x^2 + e^y}$ at the point $(1, 0, 2)$.

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6. Let $f(x, y) = x^2 + y^2$.

   (a) Sketch the level set corresponding to $c = 1$.

   (b) Find a parametrization $\mathbf{r}(t)$ for this level set.

   (c) Evaluate $f(\mathbf{r}(t))$. If you remember what a level set is, this is easier than you might think!

   (d) Compute $\frac{d}{dt} f(\mathbf{r}(t))$.

   (e) Repeat the above for $f(x, y) = x^2 + 4y^2$.

   (f) In general, if $\mathbf{r}(t)$ is a parametrization of a level set for $f(x, y)$, what can you say about $\nabla f \cdot \mathbf{r}'$? What does this tell you about the relationship between a line tangent to a level set and the gradient vector?