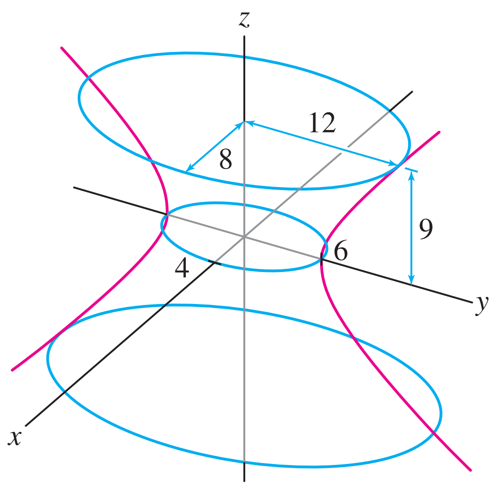
(1) State the type of the quadric surface and describe the trace obtained by intersection with the given plane.

$$4x^2 + \left(\frac{y}{3}\right)^2 - 2z^2 = -1, \qquad z = 1$$

(2) State the type of the quadric surface and describe the trace obtained by intersection with the given plane.

$$y = 3x^2, \qquad z = 27$$

(3) Find the equation of the hyperboloid shown in the following figure.

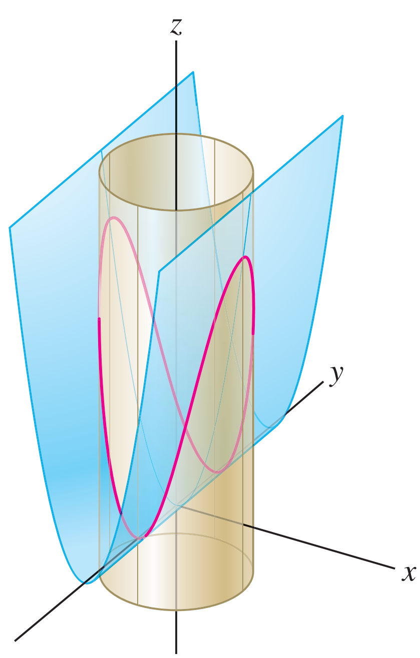


(4) Parameterize the intersection of the surfaces

$$y^2 - z^2 = x - 2, \qquad y^2 + z^2 = 9$$

(5) Parameterize the intersection of the surfaces

$$x^2 + y^2 = 1 \text{ and } z = 4x^2$$



(6) Find a parameterization of the curve.

(a) The line passing through $(1, 0, 4)$ and $(4, 1, 2)$.

(b) The horizontal circle of radius 1 with center $(2, -1, 4)$.

(c) The intersection of the surfaces

$$z = x^2 - y^2 \quad \text{and} \quad z = x^2 + xy - 1$$

(7) Evaluate the limit.

$$\lim_{t \to 0} \left\langle \frac{1}{t+1}, \frac{e^t - 1}{t}, 4t \right\rangle$$

(8) Find a parametrization of the tangent line at the point indicated.

$$\mathbf{r}(s) = (\ln s)\mathbf{i} + s^{-1}\mathbf{j} + 9s\mathbf{k}, \quad s = 1$$

(9) Compute the length of the curve over the given interval.

$$\mathbf{r}(t) = \langle t\cos t, t\sin t, 3t \rangle, \quad 0 \le t \le 2\pi$$

(10) Set up a definite integral to find the length of the curve of intersection of the cylinder $4x^2 + y^2 = 4$ and the plane $x + y + z = 2$.

(11) Find an arc length parameterization of $\mathbf{r}(t) = \langle e^t \sin t, e^t \cos t, e^t \rangle$

(12) Calculate the velocity and acceleration vectors and the speed at the time indicated.

$$\mathbf{r}(t) = \langle t^3, 1 - t, 4t^2 \rangle, \quad t = 1$$

(13) Find $\mathbf{r}(t)$ and $\mathbf{v}(t)$ given $\mathbf{a}(t)$ and the initial velocity and position.

$$\mathbf{a}(t) = \langle e^t, 2t, t + 1 \rangle, \quad \mathbf{v}(0) = \langle 1, 0, 1 \rangle, \quad \mathbf{r}(0) = \langle 2, 1, 1 \rangle$$

Let $\mathbf{r}(s)$ be an arc length parameterization and $\mathbf{T}$ the unit tangent vector. The **curvature** at $\mathbf{r}(s)$ is the quantity

$$\kappa(s) = \left| \frac{d\mathbf{T}}{ds} \right|$$

In practice, it is often impossible to find an arc length parametrization explicitly. Because of this reason, it is good to have a formula to compute curvature using any regular parametrization $\mathbf{r}(t)$.

If $\mathbf{r}(t)$ is a regular parameterization, then the curvature at $\mathbf{r}(t)$ is

$$\kappa(t) = \frac{|\mathbf{r}'(t) \times \mathbf{r}''(t)|}{|\mathbf{r}'(t)|^3}$$

(14) Compute the curvature $\kappa(t)$ of the twisted cubic

$$\mathbf{r}(t) = \langle t, t^2, t^3 \rangle$$