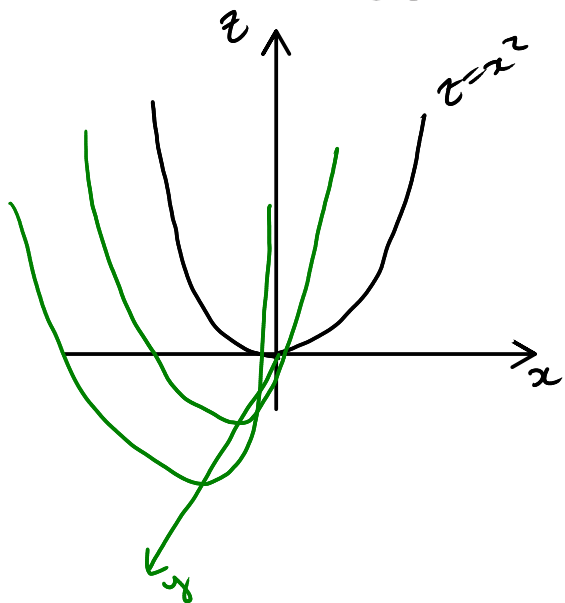


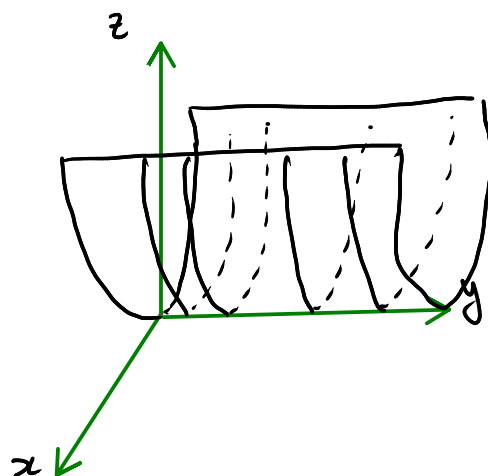
12.6 Cylinders and Quadric Surfaces.

Parabolic cylinders

EXAMPLE 1 Sketch the graph of the surface $z = x^2$.



$y = x^2 \rightarrow$ principle axis z
 $z = y^2 \rightarrow$ principle axis x

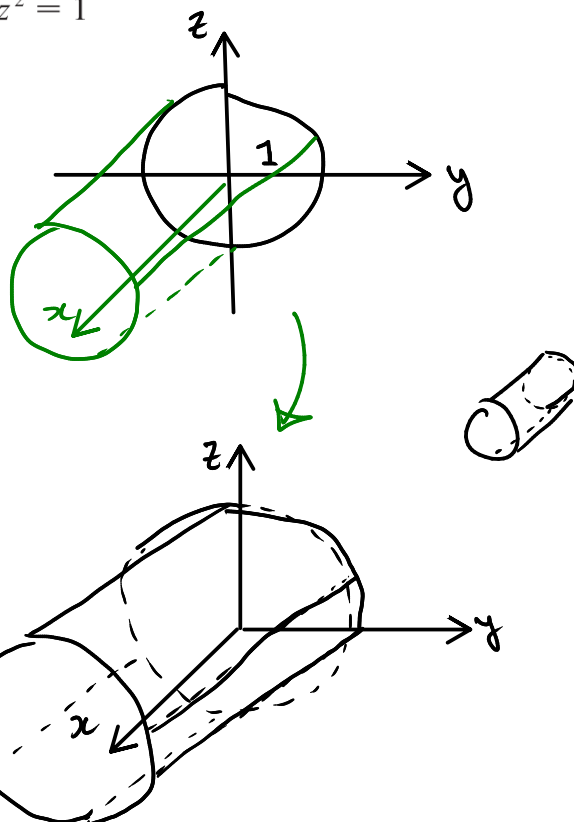
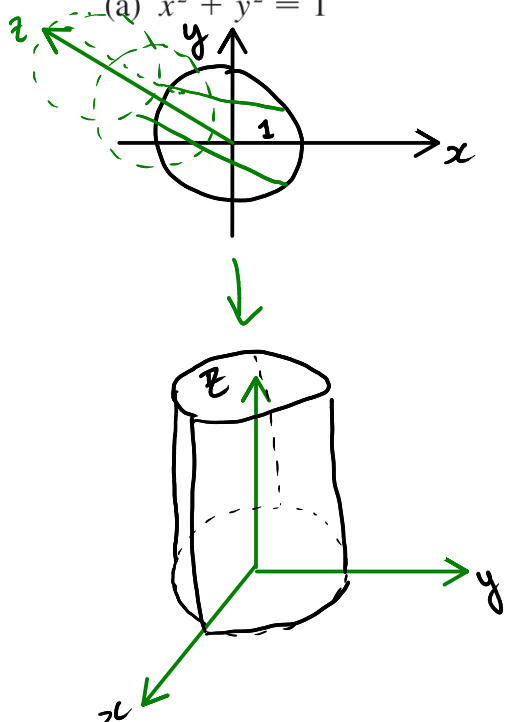


Cylinders.

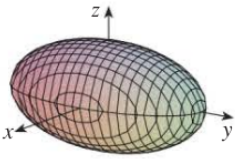
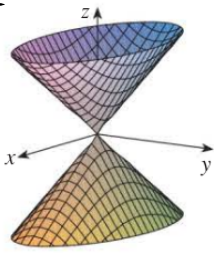
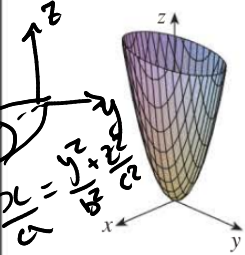
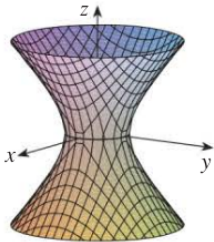
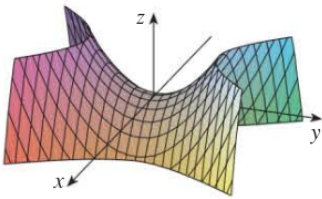
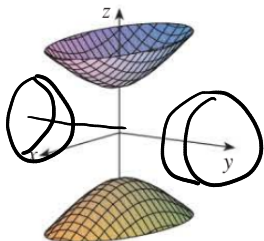
EXAMPLE 2 Identify and sketch the surfaces.

(a) $x^2 + y^2 = 1$

(b) $y^2 + z^2 = 1$



Quadric surfaces.

Surface	Equation	Surface	Equation
<u>Ellipsoid</u> 	$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$ <p>All traces are ellipses.</p> <p>If $a = b = c$, the ellipsoid is a sphere.</p> <p><i>Radius</i></p>	<u>Cone</u> 	$\frac{z^2}{c^2} = \frac{x^2}{a^2} + \frac{y^2}{b^2}$ <p>Horizontal traces are ellipses.</p> <p>Vertical traces in the planes $x = k$ and $y = k$ are hyperbolas if $k \neq 0$ but are pairs of lines if $k = 0$.</p>
<u>Elliptic Paraboloid</u> 	$\frac{z}{c} = \frac{x^2}{a^2} + \frac{y^2}{b^2}$ <p>Horizontal traces are ellipses.</p> <p>Vertical traces are parabolas.</p> <p>The variable raised to the first power indicates the axis of the paraboloid.</p>	<u>Hyperboloid of One Sheet</u> 	$\frac{x^2}{a^2} + \frac{y^2}{b^2} - \frac{z^2}{c^2} = 1$ <p>Horizontal traces are ellipses.</p> <p>Vertical traces are hyperbolas.</p> <p>The axis of symmetry corresponds to the variable whose coefficient is negative.</p>
<u>Hyperbolic Paraboloid</u> 	$\frac{z}{c} = \frac{x^2}{a^2} - \frac{y^2}{b^2}$ <p>Horizontal traces are hyperbolas.</p> <p>Vertical traces are parabolas.</p> <p>The case where $c < 0$ is illustrated.</p>	<u>Hyperboloid of Two Sheets</u> 	$-\frac{x^2}{a^2} - \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$ <p>Horizontal traces in $z = k$ are ellipses if $k > c$ or $k < -c$.</p> <p>Vertical traces are hyperbolas.</p> <p>The two minus signs indicate two sheets.</p>

EXAMPLE 3 Identify and ~~Use traces to~~ sketch the quadric surface with equation

$$x^2 + \frac{y^2}{9} + \frac{z^2}{4} = 1$$

EXAMPLE 4 Identify and ~~Use traces to sketch~~ the surface $z = 4x^2 + y^2$.

EXAMPLE 5 Sketch the surface $z = y^2 - x^2$.

EXAMPLE 6 Sketch the surface $\frac{x^2}{4} + y^2 - \frac{z^2}{4} = 1$.

EXAMPLE 7 Identify and sketch the surface $4x^2 - y^2 + 2z^2 + 4 = 0$.

EXAMPLE 8 Classify the quadric surface $x^2 + 2z^2 - 6x - y + 10 = 0$.