1. A surface is given by

\[ y = x^2 + 4z^2. \]

Please sketch the surface. What is this surface?

**Answer:** It is an elliptic paraboloid. See Section 12.6 for detail. Below is the surface sketched by Mathematica.

![Figure 1](image.png)

**Figure 1.** The surface of \( y = x^2 + 4z^2 \). The vertical axis is \( z \), the axis surrounded by the surface is \( y \), the other is \( x \).

2. Please find parametric equations for the tangent line to the curve with the equation at the specified point.

\[ \mathbf{r}(t) = \langle t^3 - t, 1 + 2\sqrt{t}, t^3 + t \rangle; \quad (0, 3, 2) \]

**Answer:** We first find the parameter \( t \) that corresponds the point \((0, 3, 2)\). Set

\[ t^3 - 1 = 0, \quad 1 + 2\sqrt{t} = 3, \quad t^3 + t = 2. \]

From above we have \( t = 1 \). Thus we evaluate

\[ \mathbf{r}'(t) = \langle 3t^2 - 1, \frac{1}{\sqrt{t}}, 3t^2 + 1 \rangle \]

at \( t = 1 \), and obtain a direction vector \( \mathbf{v} \) for the tangent line:

\[ \mathbf{v} = \mathbf{r}'(1) = \langle 2, 1, 4 \rangle. \]

Hence we have the following parametric equations for the line:

\[ x = 2s, \quad y = 3 + s, \quad z = 2 + 4s. \]
3. Please find the domain of \( f(x, y) = \ln \left[ \sqrt[3]{16 - x^2 - y^2} \right] \). Then sketch the domain.

**Answer:** The argument of a square root function must be nonnegative, and the argument of a logarithmic function must be (strictly) positive. Thus we have

\[
y \geq 0, \quad e^\sqrt[3]{16 - x^2 - y^2} > 0,
\]

from which we derive

\[
y \geq 0, \quad x^2 + y^2 < 16.
\]

Therefore, the domain is

\[D = \{(x, y) \in \mathbb{R}^2 : y \geq 0, x^2 + y^2 < 16\} .\]

The graph of the domain is the upper half of the disc centered at the origin with radius 4, in which the curved part of boundary is excluded.