1. Draw a possible contour diagram for the function whose graph is shown below. Label your contours with reasonable z-values.

The contour curves are circles that appear to be getting farther apart.

2. Write the equation of the linear function whose contour diagram is shown below. Show work or briefly justify your answer.

The slope in the y-direction is
\[
\frac{\Delta z}{\Delta y} = \frac{12-6}{3-1} = \frac{6}{2} = 3
\]

The slope in the x-direction is
\[
\frac{\Delta z}{\Delta x} = \frac{0-2}{1.5-2.5} = \frac{2}{-1} = -2
\]

The z-intercept is 3

So the equation is
\[z = -2x + 3y + 3\]

3. True or False: If \( f \) is a linear function, then \( f(3,2) - f(3,1) = f(0,2) - f(0,1) \). Briefly justify your answer.

**TRUE**

The paths from \((3,2)\) to \((3,1)\) and \((0,2)\) to \((0,1)\) are parallel and the same length. Hence the change in \( z \) from start to finish on each path is the same, because \( f \) is a linear function.

If \( f(x,y) = mx+ny+c \) then
\[f(3,2) - f(3,1) = 3m+2n+c-(3m+n+c) = n \geq 0\]
\[f(0,2) - f(0,1) = 0m+2n+c-(0m+n+c) = n \geq 0\]
4. Some level surfaces of the functions \( g_1(x, y, z) \), \( g_2(x, y, z) \) and \( g_3(x, y, z) \) are shown below.

(a) Which function takes the value 0 at \((0, 0, 0)\)? Briefly justify your answer.

\( g_3(x, y, z) \) b/c this is only function for which the \( c=0 \) level surface passes through \((0,0,c)\).

(b) Which function is decreasing in the positive \( z \)-direction? Briefly justify your answer.

\( g_3(x, y, z) \) b/c as we move up on the \( z \)-axis we pass through level surfaces w/ decreasing \( c \) values.