1. (a) Put the following equation into standard form (hint: complete the square in \(x, y, z\))

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

(b) What type of surface is given in part (a)

(c) Sketch the \((x, y)\) trace of the surface on the axes below.
2. Graph the following plane on the axes below, be sure to include all intercepts.

\[ 2x + 3y - 4z = 12 \]
3. Find the general solution to the following differential equations. You must show your work and you must check your answer.

(a) \( \frac{dx}{dt} = 3(x + 1) \)

(b) \( \frac{dy}{dt} = ky^2 \)

(c) \( \frac{dA}{dt} + 3t^2 A = 4t^2 \)

4. Newton’s law of cooling states that the rate of change in the temperature \( T \) of an object is proportional to the difference between the temperature of the object \( (T) \) and the surrounding temperature \( T_0 \). This can be expressed by the differential equation:

\[
\frac{dT}{dt} = k(T - T_0).
\]

A room is kept at a constant temperature of 75°F. A cake is taken out of a 375°F oven and placed on the counter. If the cake has reduced in temperature to 275°F in 1 hour, when will the cake reach 100°F? (Hint: First find the particular solution, and then solve the problem given.)

5. Suppose that you know a population grows according to the logistic growth model, in other words the population is bounded above by a maximum \( L \) and the population grows proportional to the size of the population times the difference between the population and the maximum. What model below describes this type of growth? Circle the correct answer, no justification is necessary.

(a) \( \frac{dA}{dt} = A(L - A) \)

(b) \( \frac{dA}{dt} = kA(L - A) \)

(c) \( \frac{dA}{dt} = k(L - A)^2 \)

(d) \( \frac{dA}{dt} = kLA^2 \)

(e) None of the above
6. For the following, match each of the contour maps below (a, b, c, d) to a possible corresponding quadric surface.

   i) $x^2 + (y/2)^2 = z^2$
   ii) $x^2 - \frac{1}{2}y^2 = z$
   iii) $x^2 + y^2 - z^2 = 1$
   iv) $z = x^2 + y^2$

   ![Contour Maps](image)

7. Find the domain and range of the following functions. Also evaluate the functions at the specified point.

   (a) $f(x, y) = \frac{1}{x + 4y}$, $(x, y) = (1, 2)$
   (b) $f(x, y, z) = \ln(|x - y + 2z|)$, $(x, y, z) = (1, 4, -1)$
   (c) $f(x, y) = \sqrt{9 - x^2 - y^2}$, $(x, y) = (1, 1)$