1. a. $-3$  
   b. $\sqrt{37}$  
   c. $(5, 3, 17)$  
   d. $\frac{3\pi}{4}$  
   e. any vector of form $(-4b, b, 0)$

2. a. $\mathbf{l}(t) = (4 - 3t, -3 + 5t, 5 + 3t)$  
   b. $x = 3 + 5t$  
   $y = -2 + t$  
   $z = 4 - 3t$  
   or $\mathbf{l}(t) = (1 - 3t, 2 + 5t, 8 + 3t)$

3. a. $4x - 3y + 5z = 7$  
   b. Area $\frac{\|((1,3,1) \times (2,1,-1))\|}{2} = \sqrt{50}$

4. a. $\mathbf{c}'(t) = (2t - 4, 3, 6t)$
   b. $\mathbf{l}(t) = (-3 - 2t, 5 + 3t, 4 + 6t)$ or $\mathbf{l}(t) = (-2t - 1, 3t + 2, 6t - 2)$
   c. $(-3, 11, 28)$

5. a. $g\left(\frac{\pi}{2}, 4\right) = (1, 4, 8\pi)$
   b. $\begin{bmatrix} 2y & 2x & 2z \\ -3z & 2y & -3x \end{bmatrix}$
   c. $\begin{bmatrix} -v \sin(uv) & -u \sin(uv) \\ v \cos u & \sin u \\ v^2 & 2uv \end{bmatrix}$
   d. $\begin{bmatrix} 2y & 2x & 2z \\ -3z & 2y & -3x \end{bmatrix}_{(1,4,8\pi)} \cdot \begin{bmatrix} -v \sin(uv) & -u \sin(uv) \\ v \cos u & \sin u \\ v^2 & 2uv \end{bmatrix}_{(\frac{\pi}{2},4)}$

\[ \begin{bmatrix} 8 & 2 & 16\pi \\ -24\pi & 8 & -3 \end{bmatrix} \cdot \begin{bmatrix} 0 & 0 \\ 0 & 1 \\ 16 & 4\pi \end{bmatrix} = \begin{bmatrix} 256\pi & 2 + 64\pi^2 \\ -48 & -48 - 12\pi \end{bmatrix} \]

6. a. $\nabla f(1, 2, -1) = (-14, 5, 10)$
   b. $\nabla f(1, 2, -1) \cdot \frac{\mathbf{v}}{\|\mathbf{v}\|} = (-14, 5, 10) \cdot \frac{(-3, 2, 6)}{7} = 16$
   c. $-14x + 5y + 10z = -14$