1. a) The line traversed can be parametrized by \( t \to (-2 + 3t, 8 – 2t, -6 + 2t) \).
   b) The surface is reached when the z-coordinate, \(-6 + 2t\) is zero. Thus, \( t = 3 \) and the coordinates of the point in question are \((7, 2, 0)\).
   c) The closest point has distance 6 from the origin. (The point is \((4, 4, -2)\).)

2. a) The bug’s velocity is \( \mathbf{r}' = 2 \left( \frac{1}{t}, t, -\sqrt{2} \right) \).
   b) The bug’s speed is \( |\mathbf{r}'| = 2 \left( \frac{1}{t} + t \right) = 4 \left( \frac{1}{t^2} + t^2 + 2 \right) \).
   c) The path length is the integral from 1 to 2 of \( |\mathbf{r}'| \) which is \(3 + 2 \ln(2)\).
   d) The component is \( \frac{1}{3} \left(1 - 2\sqrt{2} \right) (1, 1, 1) \).

3. a) False, as \( \mathbf{w} = 0 \) when either \( \mathbf{u} \) or \( \mathbf{v} \) is zero, or when \( \mathbf{v} = r \mathbf{u} \) with \( r > 0 \).
   b) True, as the dot product between these two vectors is zero.
   c) False, as \( \mathbf{w} \) is parallel to the x-axis when \( \mathbf{u} = (1, 0, 0) \) and \( \mathbf{v} = (-1, 0, 0) \).

4. a) The line intersects the plane at the point \( \frac{1}{21} (267, -40, 2) \).
   b) The distance from the origin to \( \Pi \) is 9.
   c) \( \frac{-28}{3} \).

5. In Cartesian coordinates, \( r = 2 \cos \theta \) reads \( \sqrt{x^2 + y^2} = 2 \sqrt{x/\sqrt{x^2 + y^2}} \). Multiply through by \( \sqrt{x^2 + y^2} \) to find that \( x^2 + y^2 - 2x = 0 \). Add 1 to each side to find that \( x^2 - 2x + 1 + y^2 = 1 \) which is to say, \((x - 1)^2 + y^2 = 1\). Thus, the circle has its center at the point \((1, 0)\) and its radius is 1.

6. a) If \( \mathbf{u} \) is tangent to \( \Pi \), then \( \mathbf{u} \) is perpendicular to a normal vector to \( \Pi \). In our case, the vector \( \mathbf{n} = (1, 1, 1) \) is a normal vector to \( \Pi \) since it is perpendicular to both the vector that points from from A to B (which is \((-1, 1, 0)\)) and the vector, \((-1, 0, 1)\), which points from A to C. Meanwhile, \( \mathbf{u} \mathbf{n} = 1 + 2 - 3 = 0 \).
   b) \( \mathbf{v} \times \mathbf{u} = (-5, 4, 1) \) is such a vector.
   c) The vector \( \mathbf{w} - |\mathbf{u}|^2 (\mathbf{w} \mathbf{u}) \mathbf{u} \) is orthogonal to \( \mathbf{n} \) since both \( \mathbf{w} \) and \( \mathbf{u} \) are. Also, it is orthogonal to \( \mathbf{u} \) since its dot product with \( \mathbf{u} \) is zero. Thus, it must be a multiple of \( \mathbf{v} \) since \( \mathbf{v} \) is also orthogonal to both \( \mathbf{u} \) and \( \mathbf{n} \). You can think of \( \mathbf{n} \) and \( \mathbf{u} \) as pointing along two orthogonal axis in space and then \( \mathbf{v} \), being orthogonal to both \( \mathbf{n} \) and \( \mathbf{u} \), lies along the third axis. As \( \mathbf{w} \) has zero dot product with both \( \mathbf{n} \) and \( \mathbf{u} \), like \( \mathbf{v} \), it is parallel to the third axis and so is a multiple of \( \mathbf{v} \).