2. The component functions \( \frac{t - 2}{t + 2} \), \( \sin t \), and \( \ln(9 - t^2) \) are all defined when \( t \neq -2 \) and \( 9 - t^2 > 0 \) \( \Rightarrow \) \(-3 < t < 3\), so the domain of \( r \) is \((-3, -2) \cup (-2, 3)\).

4. \( \lim_{t \to 1} \frac{t^2 - t}{t - 1} = \lim_{t \to 1} \frac{(t - 1)}{t - 1} = \lim_{t \to 1} t = 1 \), \( \lim_{t \to -1} \sqrt{t + 8} = 3 \), \( \lim_{t \to 1} \frac{\sin \pi t}{\ln t} = \lim_{t \to 1} \frac{\pi \cos \pi t}{1/t} = -\pi \) [by l'Hospital's Rule].

Thus the given limit equals \( i + 3 j - \pi k \).

6. The corresponding parametric equations for this curve are \( x = t^2 \), \( y = t^2 \).
We can make a table of values, or we can eliminate the parameter:
\[ x = t^2 \implies t = \sqrt{x} \implies y = t^2 = \left( \sqrt{x} \right)^2 = x^{1/2}, \]
with \( t \in \mathbb{R} \) \( \Rightarrow \) \( x \in \mathbb{R} \). By comparing different values of \( t \), we find the direction in which \( t \) increases as indicated in the graph.

8. The corresponding parametric equations are \( x = \sin \pi t \), \( y = t \), \( z = \cos \pi t \).
Note that \( x^2 + z^2 = \sin^2 \pi t + \cos^2 \pi t = 1 \), so the curve lies on the circular cylinder \( x^2 + z^2 = 1 \). A point \((x, y, z)\) on the curve lies directly to the left or right of the point \((x, 0, z)\) which moves clockwise (when viewed from the left) along the circle \( x^2 + z^2 = 1 \) in the \(xz\)-plane as \( t \) increases. Since \( y = t \), the curve is a helix that spirals toward the right around the cylinder.

10. The parametric equations are \( x = t^2 \), \( y = t \), \( z = 2 \), so we have \( x = y^2 \) with \( z = 2 \).
Thus the curve is a parabola in the plane \( z = 2 \) with vertex \((0, 0, 2)\).

18. \( x = \cos t \), \( y = \sin t \), \( z = 1/(1 + t^2) \). At any point on the curve we have \( x^2 + y^2 = \cos^2 t + \sin^2 t = 1 \), so the curve lies on a circular cylinder \( x^2 + y^2 = 1 \) with axis the \( z \)-axis. Notice that \( 0 < z \leq 1 \) and \( z = 1 \) only for \( t = 0 \). A point \((x, y, z)\) on the curve lies directly above the point \((x, y, 0)\), which moves counterclockwise around the unit circle in the \(xy\)-plane as \( t \) increases, and \( z \to 0 \) as \( t \to \pm \infty \). The graph must be VI.

19. \( x = t \), \( y = 1/(1 + t^2) \), \( z = t^2 \). At any point on the curve we have \( z = x^2 \), so the curve lies on a parabolic cylinder parallel to the \( y \)-axis. Notice that \( 0 < y \leq 1 \) and \( y = 0 \) only when \( t = 0 \). Also the curve passes through \((0, 1, 0)\) when \( t = 0 \) and \( y \to \infty \), \( z \to \infty \) as \( t \to \pm \infty \), so the graph must be V.

22. \( x = \cos^2 t \), \( y = \sin^3 t \), \( z = t \). \( x + y = \cos^2 t + \sin^3 t = 1 \), so the curve lies in the vertical plane \( x + y = 1 \).

\( x \) and \( y \) are periodic, both with period \( \pi \), and \( z \) increases as \( t \) increases, so the graph is III.
24. Here $x^2 = \sin^2 t = z$ and $x^2 + y^2 = \sin^2 t + \cos^2 t = 1$, so the curve is contained in the intersection of the parabolic cylinder $z = x^2$ with the circular cylinder $x^2 + y^2 = 1$. We get the complete intersection for $0 \leq t \leq 2\pi$.

27. If $t = -1$, then $x = 1$, $y = 4$, $z = 0$, so the curve passes through the point $(1, 4, 0)$. If $t = 3$, then $x = 9$, $y = -8$, $z = 28$, so the curve passes through the point $(9, -8, 28)$. For the point $(4, 7, -6)$ to be on the curve, we require $y = 1 - 3t = 7 \Rightarrow t = -2$. But then $z = 1 + (-2)^2 = -7 \neq -6$, so $(4, 7, -6)$ is not on the curve.

29. Both equations are solved for $z$, so we can substitute to eliminate $z$: $\sqrt{x^2 + y^2} = 1 + y \Rightarrow x^2 + y^2 = 1 + 2y + y^2 \Rightarrow x^2 = 1 + 2y \Rightarrow y = \frac{1}{2}(x^2 - 1)$. We can form parametric equations for the curve $C$ of intersection by choosing a parameter $x = t$, then $y = \frac{1}{2}(t^2 - 1)$ and $z = 1 + y = 1 + \frac{1}{2}(t^2 - 1) = \frac{1}{2}(t^2 + 1)$. Thus a vector function representing $C$ is $r(t) = t \mathbf{i} + \frac{1}{2}(t^2 - 1) \mathbf{j} + \frac{1}{2}(t^2 + 1) \mathbf{k}$.

30. The projection of the curve $C$ of intersection onto the $xz$-plane is the circle $x^2 + z^2 = 1$, $y = 0$, so we can write $x = \cos t$, $z = \sin t$, $0 \leq t \leq 2\pi$. $C$ also lies on the surface $x^2 + y^2 + 4z^2 = 4$, and since $y > 0$ we can write

$$y = \sqrt{4 - x^2 - 4z^2} = \sqrt{4 - \cos^2 t - 4\sin^2 t} = \sqrt{4 - \cos^2 t - 4(1 - \cos^2 t)} = \sqrt{4 \cos^2 t} = 2\cos t$$

Thus parametric equations for $C$ are $x = \cos t$, $y = 2\cos t$, $z = \sin t$, $0 \leq t \leq 2\pi$, and the corresponding vector function is $r(t) = \cos t \mathbf{i} + 2\cos t \mathbf{j} + \sin t \mathbf{k}$, $0 \leq t \leq 2\pi$. 