#4: (a)  \(11i - 4j + k\)  \(\sqrt{14}\)  \(-1\)  \(-3, -7, -5\)  
(c)  \(3\sqrt{35}\)  (f) 18  
(g) 0  (h) \(33i - 21j + 6k\)  
(i) \(\text{comp}_a b = -\frac{1}{\sqrt{6}}\)  (j) \(\text{proj}_a b = -\frac{1}{6}(i + j - 2k)\)  (k) \(\approx 96^\circ\)

#6: Let \(a = j + 2k\) and \(b = i - 2j + 3k\). The two unit vectors are given by \(\pm \frac{a \times b}{|a \times b|} = \pm \frac{1}{3\sqrt{6}}(7i + 2j - k)\)

#10: The volume is given by the absolute value of the scalar triple product: \(|\overrightarrow{AB} \cdot (\overrightarrow{AC} \times \overrightarrow{AD})| = 6\)

#12: The displacement vector between the two points is \(\overrightarrow{D} = <4, 3, 6>\), thus the work is \(W = \overrightarrow{F} \cdot \overrightarrow{D} = 87\) J

#16: \(x = 1 + 3t\), \(y = 2t\), \(z = -1 + t\)

#18: Since the plane is parallel to \(x + 4y - 3z = 1\), it must have the same normal vector. Hence the equation is \((x - 2) + 4(y - 1) - 3z = 0\). Simplifying gives \(x + 4y - 3z = 6\).

#20: Since the given line lies in the plane, its direction vector \(a = <2, -1, 3>\) is one vector in the plane. The point \(P(0, 3, 1)\) is on the line (obtained by putting \(t = 0\)) and hence in the plane. Since \((1, 2, -2)\) is also a point on the plane, it follows that the vector \(b = <0 - 1, -3 - 2, -2 - (-2)> = <-1, 1, 3>\) lies in the plane and a normal vector is \(n = a \times b = <-6, -9, 1>\). Thus the equation of the plane is given by 
\(-6(x - 1) - 9(y - 2) + (z + 2) = 0\) or \(6x + 9y - z = 26\)

#22: Let \(a = <-1, -1, 2>\) be the direction vector of the line. A point on the line is \(P(1, 2, -1)\) (setting \(t = 0\)). Let \(b = \overrightarrow{OP} = <-1, 2, -1>\) and let \(\theta\) be the angle between the vectors \(a\) and \(b\).

The distance is given by \(d = |b| \sin \theta = |b| \left| \frac{a \times b}{|a||b|} \right| = \frac{|a \times b|}{|a|} = \frac{3}{\sqrt{2}}\).

#24: (a) The normal vectors are \(n_1 = <1, 1, -1>\) and \(n_2 = <2, -3, 4>\). Since these vectors are not parallel, neither are the planes. Also \(n_1 \cdot n_2 = -5 \neq 0\) so the normal vectors, and thus the planes, are not perpendicular.

(b) \(\cos \theta = \frac{n_1 \cdot n_2}{|n_1||n_2|} = -\frac{5}{\sqrt{87}}\) and \(\theta \approx 122^\circ\) (or \(\approx 58^\circ\))

#36: The distance from the point \(P(x, y, z)\) to the plane \(y = 1\) is \(|y - 1|\), so the given condition becomes \(|y - 1| = 2\sqrt{(x - 0)^2 + (y + 1)^2 + (z - 0)^2}\).

Squaring both sides and simplifying gives \(\frac{3}{4}x^2 + \frac{9}{16}(y + \frac{5}{3})^2 + \frac{3}{4}z^2 = 1\).

This is the equation of an ellipsoid whose center is \((0, -5/3, 0)\)

#38: (a) \((-1, 0) \cup (0, 2]\)
(b) \(<\sqrt{2}, 1, 0>\) (note that the limit of the second component was found using l'Hospital's rule).
(c) \(<-\frac{1}{2\sqrt{2-t}}, \frac{te^{-e+1}}{t^2}, \frac{1}{t+1}>\)
The point \((1, \sqrt{3}, 2)\) corresponds to \(t=\pi/6\). We have \(\mathbf{r}'(t) = <2 \cos(t), 4 \cos(2t), 6 \cos(3t)>\) and \(\mathbf{r}'(\pi/6) = <\sqrt{3}, 2, 0>\). Thus the tangent line has direction vector \(<\sqrt{3}, 2, 0>\) and includes the point \((1, \sqrt{3}, 2)\) so the parametric equations are
\[x = 1 + \sqrt{3}t, \quad y = \sqrt{3} + 2t, \quad z = 2\]

(a) C intersects the \(xz\)-plane when \(y = 0 \Rightarrow 2t - 1 = 0 \Rightarrow t = \frac{1}{2}\), so the point is
\[\left(2 - \left(\frac{1}{2}\right)^2, 0, \ln \left(\frac{1}{2}\right)\right) = \left(\frac{15}{8}, 0, -\ln 2\right)\]

(b) The point \((1,1,0)\) corresponds to \(t = 1\). We have \(\mathbf{r}'(t) = <-3t^2, 2, 1/t>\) and \(\mathbf{r}'(1) = <-3, 2, 1>\). Hence the tangent line has direction vector \(<-3, 2, 1>\) and includes the point \((1,1,0)\), so parametric equations are:
\[x = 1 - 3t, \quad y = 1 + 2t, \quad z = t\]

(c) The normal plane has normal vector \(\mathbf{r}'(1) = <-3, 2, 1>\) and equation
\[-3(x - 1) + 2(y - 1) + z = 0 \quad \text{or} \quad 3x - 2y - z = 1\]

\[\mathbf{r}'(t) = <3t^{1/2}, -2 \sin(2t), 2 \cos(2t)>, \quad |\mathbf{r}'(t)| = \sqrt{9t + 4(\sin^2(2t) + \cos^2(2t))} = \sqrt{9t + 4}\]
Thus \[L = \int_0^2 \sqrt{9t + 4} \ dt = \frac{2}{27}(13^{3/2} - 8)\]

\[\mathbf{r}(t) = (t^3 + t)\mathbf{i} + (t^4 - t)\mathbf{j} + (3t - t^3)\mathbf{k}\]