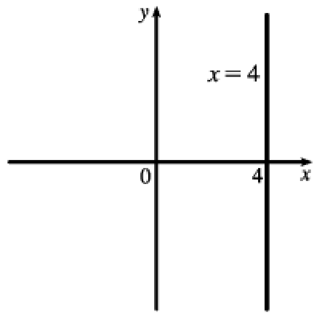
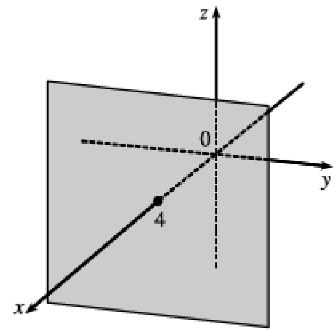
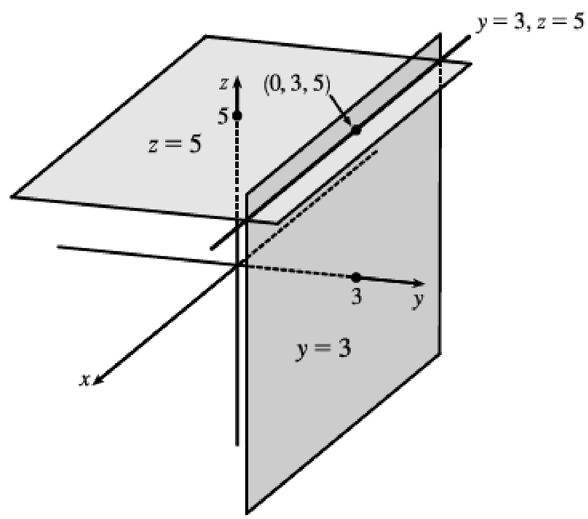
3. The distance from a point to the yz-plane is the absolute value of the x-coordinate of the point. $C(2,4,6)$ has the x-coordinate with the smallest absolute value, so C is the point closest to the yz-plane. $A(-4,0,-1)$ must lie in the xz-plane since the distance from A to the xz-plane, given by the y-coordinate of A, is 0.

6. (a) In $\mathbb{R}^2$, the equation $x=4$ represents a line parallel to the y-axis. In $\mathbb{R}^3$, the equation $x=4$ represents the set $\{(x,y,z) \mid x=4\}$, the set of all points whose x-coordinate is 4. This is the vertical plane that is parallel to the yz-plane and 4 units in front of it.





(b) In $\mathbb{R}^3$, the equation $y=3$ represents a vertical plane that is parallel to the xz-plane and 3 units to the right of it. The equation $z=5$ represents a horizontal plane parallel to the xy-plane and 5 units above it. The pair of equations $y=3$, $z=5$ represents the set of points that are simultaneously on both planes, or in other words, the line of intersection of the planes $y=3$, $z=5$. This line can also be described as the set $\{(x,3,5) \mid x \in \mathbb{R}\}$, which is the set of all points in $\mathbb{R}^3$ whose x-coordinate may vary but whose y- and z-coordinates are fixed at 3 and 5, respectively. Thus the line is parallel to the x-axis and intersects the yz-plane in the point $(0,3,5)$.



10. (a) The distance from a point to the xy-plane is the absolute value of the z-coordinate of the point. Thus, the distance is $|6| = 6$.

(b) Similarly, the distance to the yz-plane is the absolute value of the x-coordinate of the point: $|4| = 4$.

(c) The distance to the xz-plane is the absolute value of the y-coordinate of the point: $|-2| = 2$.

(d) The point on the x-axis closest to $(4, -2, 6)$ is the point $(4, 0, 0)$. (Approach the x-axis perpendicularly.)

The distance from $(4, -2, 6)$ to the x-axis is the distance between these two points:

$\sqrt{(4-4)^2 + (-2-0)^2 + (6-0)^2} = \sqrt{40} = 2\sqrt{10} \approx 6.32$.

(e) The point on the y-axis closest to $(4, -2, 6)$ is $(0, -2, 0)$. The distance between these points is

$\sqrt{(4-0)^2 + [-2-(-2)]^2 + (6-0)^2} = \sqrt{52} = 2\sqrt{13} \approx 7.21$.

(f) The point on the z-axis closest to $(4, -2, 6)$ is $(0, 0, 6)$. The distance between these points is

$\sqrt{(4-0)^2 + (-2-0)^2 + (6-6)^2} = \sqrt{20} = 2\sqrt{5} \approx 4.47$.

14. If the sphere passes through the origin, the radius of the sphere must be the distance from the origin to the point $(1, 2, 3)$:

$r = \sqrt{(1-0)^2 + (2-0)^2 + (3-0)^2} = \sqrt{14}$. Then an equation of the sphere is $(x-1)^2 + (y-2)^2 + (z-3)^2 = 14$.

30.

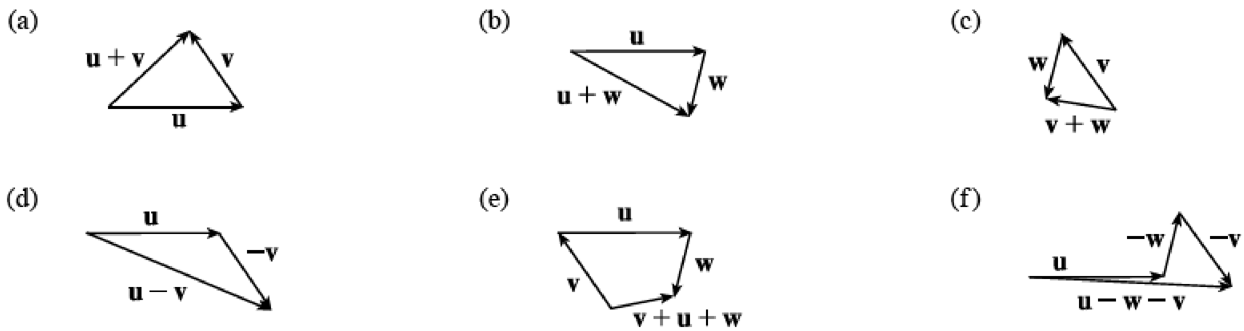
Here $y^2 + z^2 = 16$ with no restrictions on x, so a point in the region must lie on a circle of radius 4, center on the x-axis, but it could be in any vertical plane $x = k$ (parallel to the yz-plane). Thus the region consists of all possible circles $y^2 + z^2 = 16$, $x = k$ and is therefore a circular cylinder with radius 4 whose axis is the x-axis.

31.

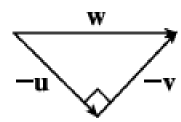
The inequality $x^2 + y^2 + z^2 \leq 3$ is equivalent to $\sqrt{x^2 + y^2 + z^2} \leq \sqrt{3}$, so the region consists of those points whose distance from the origin is at most $\sqrt{3}$. This is the set of all points on or inside the sphere with radius $\sqrt{3}$ and center $(0, 0, 0)$.

38. The solid sphere itself is represented by $\sqrt{x^2 + y^2 + z^2} \leq 2$. Since we want only the upper hemisphere, we restrict the z-coordinate to nonnegative values. Then inequalities describing the region are $\sqrt{x^2 + y^2 + z^2} \leq 2$, $z \geq 0$, or $x^2 + y^2 + z^2 \leq 4$, $z \geq 0$.

5.



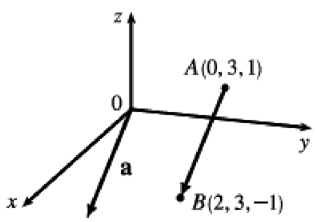
8. We are given $\mathbf{u}+\mathbf{v}+\mathbf{w}=\mathbf{0}$, so $\mathbf{w}=(-\mathbf{u})+(-\mathbf{v})$. (See the figure.)



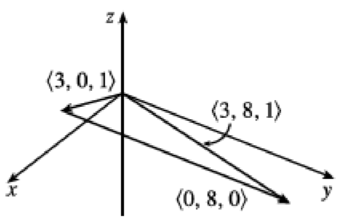
Vectors $-\mathbf{u}$, $-\mathbf{v}$, and $\mathbf{w}$ form a right triangle, so from the Pythagorean Theorem

we have $|-\mathbf{u}|^2+|-\mathbf{v}|^2=|\mathbf{w}|^2$. But $|-\mathbf{u}|=|\mathbf{u}|=1$ and $|-\mathbf{v}|=|\mathbf{v}|=1$ so $|\mathbf{w}|=\sqrt{|-\mathbf{u}|^2+|-\mathbf{v}|^2}=\sqrt{2}$.

13. $\mathbf{a}=\langle 2-0, 3-3, -1-1\rangle=\langle 2,0,-2\rangle$



17. $\langle 3,0,1\rangle+\langle 0,8,0\rangle=\langle 3+0, 0+8, 1+0\rangle$
$=\langle 3,8,1\rangle$



21. $\mathbf{a}+\mathbf{b}=(\mathbf{i}+2\,\mathbf{j}-3\,\mathbf{k})+(-2\,\mathbf{i}-\mathbf{j}+5\,\mathbf{k})=-\,\mathbf{i}+\mathbf{j}+2\mathbf{k}$

$2\mathbf{a}+3\mathbf{b}=2\,(\mathbf{i}+2\,\mathbf{j}-3\,\mathbf{k})+3\,(-2\,\mathbf{i}-\mathbf{j}+5\,\mathbf{k})=2\,\mathbf{i}+4\,\mathbf{j}-6\,\mathbf{k}-6\,\mathbf{i}-3\,\mathbf{j}+15\,\mathbf{k}=-\,4\,\mathbf{i}+\mathbf{j}+9\mathbf{k}$

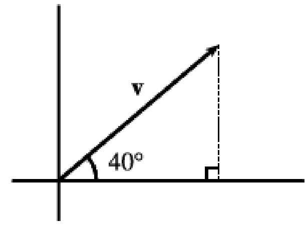
$|\mathbf{a}|=\sqrt{1^2+2^2+(-3)^2}=\sqrt{14}$

$|\mathbf{a}-\mathbf{b}|=|(\mathbf{i}+2\,\mathbf{j}-3\,\mathbf{k})-(-2\,\mathbf{i}-\mathbf{j}+5\,\mathbf{k})|=|3\,\mathbf{i}+3\,\mathbf{j}-8\,\mathbf{k}|=\sqrt{3^2+3^2+(-8)^2}=\sqrt{82}$

26. $|\langle -2,4,2\rangle|=\sqrt{(-2)^2+4^2+2^2}=\sqrt{24}=2\sqrt{6}$, so a unit vector in the direction of $\langle -2,4,2\rangle$ is $\mathbf{u}=\dfrac{1}{2\sqrt{6}}\langle -2,4,2\rangle$.

A vector in the same direction but with length 6 is $6\mathbf{u}=6\cdot\dfrac{1}{2\sqrt{6}}\langle -2,4,2\rangle=\left\langle -\dfrac{6}{\sqrt{6}}, \dfrac{12}{\sqrt{6}}, \dfrac{6}{\sqrt{6}}\right\rangle$ or $\langle -\sqrt{6}, 2\sqrt{6}, \sqrt{6}\rangle$.

31. The velocity vector $\mathbf{v}$ makes an angle of 40° with the horizontal and has magnitude equal to the speed at which the football was thrown. From the figure, we see that the horizontal component of $\mathbf{v}$ is $|\mathbf{v}|\cos 40^\circ = 60\cos 40^\circ \approx 45.96$ ft/s and the vertical component is $|\mathbf{v}|\sin 40^\circ = 60\sin 40^\circ \approx 38.57$ ft/s.



32. The given force vectors can be expressed in terms of their horizontal and vertical components as $20\cos 45^\circ\,\mathbf{i} + 20\sin 45^\circ\,\mathbf{j} = 10\sqrt{2}\,\mathbf{i} + 10\sqrt{2}\,\mathbf{j}$ and $16\cos 30^\circ\,\mathbf{i} - 16\sin 30^\circ\,\mathbf{j} = 8\sqrt{3}\,\mathbf{i} - 8\,\mathbf{j}$. The resultant force $\mathbf{F}$ is the sum of these two vectors: $\mathbf{F} = \left(10\sqrt{2} + 8\sqrt{3}\right)\mathbf{i} + \left(10\sqrt{2} - 8\right)\mathbf{j} \approx 28.00\,\mathbf{i} + 6.14\,\mathbf{j}$. Then we have $|\mathbf{F}| \approx \sqrt{(28.00)^2 + (6.14)^2} \approx 28.7$ lb and, letting θ be the angle $\mathbf{F}$ makes with the positive x-axis,

$$\tan\theta = \frac{10\sqrt{2} - 8}{10\sqrt{2} + 8\sqrt{3}} \quad \Rightarrow \quad \theta = \tan^{-1}\left(\frac{10\sqrt{2} - 8}{10\sqrt{2} + 8\sqrt{3}}\right) \approx 12.4^\circ.$$