12.1, Problem # 10. $x^2+y^2+z^2=25$ is the sphere centered at $(0,0,0)$ of radius 5. The plane $y=-4$ (parallel to the xz-plane) intersects this sphere in a circle. The center of this circle is $(0,-4,0)$, the radius of the circle is $\sqrt{5^2-4^2}=3$.

12.1, Problem # 16. Begin with (c).

(c) $x^2+y^2\le 1$ is a solid cylinder whose axis is the z-axis and whose radius is 1.

(a) $x^2+y^2\le 1,\ z=0$ is the intersection of the cylinder in (c) with the plane $z=0$ which is the xy-plane. This intersection is the disc in the xy-plane centered at $(0,0)$ of radius 1.

(b) Same, but in the plane $z=3$ which is a horizontal plane 3 units above the xy-plane.

12.1, Problem # 20. (a) $x=3$; (b) $y=-1$; (c) $z=2$.

12.1, Problem # 22. (a) $x^2+y^2=4,\ z=0$; (b) $y^2+z^2=4,\ x=0$; (c) $x^2+z^2=4,\ y=0$.

12.1, Problem # 44. Center $\left(0,-\frac{1}{3},\frac{1}{3}\right)$, radius $\sqrt{\frac{29}{9}}$.

12.1, Problem # 50. The equation

$$x^2+y^2+z^2-6y+8z=0$$

can be transformed to

$$x^2+(y-3)^2+(z+4)^2=25;$$

this is a sphere centered at $(0,3,-4)$ of radius 5.

12.2, Problem # 20. $\overrightarrow{AB}=\langle -1-1,4-0,5-3\rangle=\langle -2,4,2\rangle=-2\mathbf{i}+4\mathbf{j}+2\mathbf{k}$.

12.2, Problem # 22. $-2\mathbf{u}+3\mathbf{v}=-2\langle -1,0,2\rangle+3\langle 1,1,1\rangle=\langle 5,3,-1\rangle=5\mathbf{i}+3\mathbf{j}-\mathbf{k}>$

12.2, Problem # 34. Any vector whose direction is opposite to that of $\frac{1}{2}\mathbf{i}-\frac{1}{2}\mathbf{j}-\frac{1}{2}\mathbf{k}$ has the form $-a\mathbf{i}+a\mathbf{j}+a\mathbf{k}$ with $a>0$. The length (magnitude) $\sqrt{a^2+a^2+a^2}=a\sqrt{3}$ should be 3; hence $a=\sqrt{3}$, and our vector is $-\sqrt{3}\mathbf{i}+\sqrt{3}\mathbf{j}+\sqrt{3}\mathbf{k}$.

12.2, Problem # 40. If $\overrightarrow{AB}=-7\mathbf{i}+3\mathbf{j}+8\mathbf{k}$, $A=(-2,3,6)$, and $B=(a,b,c)$, then $-7=a+2,\ 3=b-3,\ 8=i-6$, hence $a=-9,\ b=6,\ c=14$, and $B=(-9,6,14)$.

12.3, Problem # 4. If $\mathbf{v}=2\mathbf{i}+10\mathbf{j}-11\mathbf{k},\ \mathbf{u}=2\mathbf{i}+2\mathbf{j}+\mathbf{k}$, then

(a) $\mathbf{v}\cdot\mathbf{u}=2\cdot 2+10\cdot 2-11\cdot 1=13$, $|\mathbf{v}|=\sqrt{2^2+10^2+11^2}=15$, $|\mathbf{u}|=\sqrt{2^2+2^2+1^2}=3$, (b) $\cos\theta=\frac{13}{15\cdot 3}=\frac{13}{45}$, (c) the scalar component of $\mathbf{u}$ in the direction of $\mathbf{v}$ is $|\mathbf{u}|\cdot\cos\theta=3\cdot\frac{13}{45}=\frac{13}{15}$, (d) $\operatorname{proj}_{\mathbf{v}}\mathbf{u}=\frac{\mathbf{v}\cdot\mathbf{u}}{|\mathbf{v}|^2}\mathbf{v}=\frac{13}{225}\mathbf{v}=\frac{26}{225}\mathbf{i}+\frac{130}{225}\mathbf{j}-\frac{143}{225}\mathbf{k}$

12.3, Problem # 10.

$$\cos\theta=\frac{\mathbf{u}\cdot\mathbf{v}}{|\mathbf{u}|\cdot|\mathbf{v}|}=\frac{2\cdot 3-2\cdot 0+1\cdot 4}{3\cdot 5}=\frac{10}{15}=\frac{2}{3};$$

$$\theta\approx 0.84\ rad.$$