13.2

10:

$$\tan^{-1}\left(\frac{18}{15}\right) = 50.2^\circ$$

16:

$$\begin{aligned} F' &= -(F_1 + F_2) \\ &= -11\hat{\imath} + 4\hat{\jmath} \end{aligned}$$

22:

Find vector sum of first two forces:

$$\begin{aligned} \vec{u} &= (70\cos(80^\circ) + 100\cos(30^\circ))\hat{\imath} + (-70\cos(80^\circ) + 100\cos(30^\circ))\hat{\jmath} + 0\hat{k} \\ &= 98.8\hat{\imath} - 18.9\hat{\jmath} + 0\hat{k} \end{aligned}$$

Magnitude of $\vec{u}$:

$$\begin{aligned} \|\vec{u}\| &= \sqrt{(70\cos(80^\circ) + 100\cos(30^\circ))^2 + (-70\cos(80^\circ) + 100\cos(30^\circ))^2} \\ &= 100.55 \end{aligned}$$

Magnitude of $\hat{k}$ component:

$$\begin{aligned} a &= \sqrt{(3000)^2 - ((70\cos(80^\circ) + 100\cos(30^\circ))^2 + (-70\cos(80^\circ) + 100\cos(30^\circ))^2)} \\ &= 2998.3 \\ \vec{v} &= -98.8\hat{\imath} + 18.9\hat{\jmath} + 2998.3\hat{k} \end{aligned}$$

24:

$$\begin{aligned} \vec{f} &= \frac{2}{3}\vec{w} + \frac{1}{3}\vec{v} \\ &= (79, 79.3, 89, 68.3, 89.3) \end{aligned}$$

13.3

4:

$$(2\hat{\imath} + 5\hat{k}) \cdot 10\hat{\jmath} = 0$$

6:

$$\begin{aligned} \vec{u} \cdot \vec{w} &= \|\vec{u}\|\|\vec{w}\|\cos(120^\circ) \\ &= -100 \end{aligned}$$

12:

$$\vec{a} \cdot (\vec{c} + \vec{y}) = -2$$

14:

$$(\vec{a} \cdot \vec{y})(\vec{c} \cdot \vec{z}) = 238$$

22:

$$5x + 4y - z = 3$$

24:

$$5x + y - 2z = 3$$

32:

$$\begin{aligned}\theta &= \cos^{-1}\left(\frac{\vec{u}\cdot\vec{v}}{\|\vec{u}\|\|\vec{v}\|}\right)\\ &= 57.9^\circ\end{aligned}$$

44: (a) $\vec{u} = \hat{i} + 2\hat{j} - \hat{k}$

(b)

$$\begin{aligned}\theta &= \cos^{-1}\left(\frac{\vec{u}\cdot\vec{v}}{\|\vec{u}\|\|\vec{v}\|}\right)\\ &= 136.8^\circ\end{aligned}$$

(c) The angle between $\vec{v}$ and the plane is thus 46.8°

54: There are two vectors such that $\vec{a}\cdot\vec{b} = 4$, with $\cos(\theta) = 0.5 \Rightarrow \Theta = 60^\circ$ and $\theta = 300^\circ$

60:

$$\begin{aligned}W &= \vec{F}\cdot\overrightarrow{PQ}\\ &= -6\text{ J}\\ &= 4.43\text{ ft-lb}\end{aligned}$$

13.4

2:

$$\vec{v}\times\vec{w} = -\hat{i}$$

4:

$$\vec{v}\cdot\vec{w} = -2\hat{i} + 2\hat{j}$$

10:

$$\begin{aligned}\left((\hat{i}+\hat{j})\times\hat{i}\right)\times\hat{j} &= (\hat{i}\times\hat{i} + \hat{i}\times\hat{j})\times\hat{j}\\ &= \hat{k}\times\hat{j}\\ &= -\hat{i}\end{aligned}$$

12:

Finding $\vec{a}\times\vec{b}$

$$\begin{aligned}\vec{a}\times\vec{b} &= \begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 3 & 1 & -1\\ 1 & -4 & 2\end{vmatrix}\\ &= -2\hat{i} - 7\hat{j} - 13\hat{k}\end{aligned}$$

Checking $\vec{a}\cdot(\vec{a}\times\vec{b})$:

$$
\begin{aligned}
\vec{a}\cdot(\vec{a}\times\vec{b}) &= (-2)(3)+(-7)(1)+(-1)(-13) \\
&= 0
\end{aligned}
$$

Checking that $\vec{b}\cdot(\vec{a}\times\vec{b})$:

$$
\begin{aligned}
\vec{b}\cdot(\vec{a}\times\vec{b}) &= (-2)(1)+(-4)(-7)+(2)(-13) \\
&= 0
\end{aligned}
$$

14:

$$(-\hat{i}+\hat{j})\times(-\hat{j}+\hat{k}) = \hat{i}+\hat{j}+\hat{k}$$

Therefore, the plane is:

$$x+y+z=1$$

34 (a):

$$(4\hat{i}-\hat{j}+4\hat{k})\times(-2\hat{i}-3\hat{j}+\hat{k}) = 11\hat{i}-12\hat{j}-14\hat{k}$$

Therefore, the plane is:

$$11x-12y-14z=-45$$

36: $\vec{v}\times\vec{w}$ is parallel to the z axis, as both of its constituent vectors must lie on the xy-plane, so their cross product must be perpendicular to both.

38:

$$
\begin{aligned}
\|\vec{v}\times\vec{w}\| &= \sqrt{38} \\
\tan\theta &= \frac{\|\vec{v}\times\vec{w}\|}{\vec{v}\cdot\vec{w}} \\
&= \frac{\sqrt{38}}{3}
\end{aligned}
$$

40: Since $\vec{v}\times(\hat{i}+\hat{j}+\hat{k})=0$, $\vec{v}$ is parallel to $(\hat{i}+\hat{j}+\hat{k})$, so $\vec{v}=2\hat{i}+2\hat{j}+2\hat{k}$.

14.1

2:

$$
\begin{aligned}
f_x(3,2) &= \lim_{h\to 0}\frac{\frac{(3+h)^2}{3}-3}{h} \\
&= \frac{(3+h)^2-9}{3h} \\
&= \frac{h^2+6h}{3h} && = 2 \\
f_y(3,2) &= \lim_{k\to 0}\frac{\frac{9}{3+h}-3}{h} && = \frac{3h}{(3+h)h} \\
&= 1
\end{aligned}
$$

4: (a) Change in price as a function of age.
(b) Negative, due to depreciation of the car.

(c) Change in price as a function of original cost.

(d) Positive, because a more originally expensive car will have a higher price at any given age.

10: (a) $f(A) = 10$

(b) Positive

(c) Zero

14: (a) $f(A) = 40$

(b) Negative

(c) Positive

16:
- $f_x > 0$
- $f_y > 0$

20: (a) Positive

(b) Negative

(c) Positive

(d) Negative

22:

$$f_x(3,5) \approx -\frac{2}{3}$$

36: (a)

$$\frac{\partial T}{\partial x}\Big|_{15,20} \approx -\frac{1}{2} \text{ °C per meter}$$
$$\frac{\partial T}{\partial x}\Big|_{15,20} \approx \frac{1}{2} \text{ °C per minute}$$

The wall heats up at $\frac{1}{2}$ a degree Celsius per minute, and cools by $\frac{1}{2}$ degree Celsius per meter away from the heat source.

(b)

$$\frac{\partial T}{\partial x}\Big|_{5,12} \approx 1 \text{ °C per meter}$$
$$\frac{\partial T}{\partial x}\Big|_{5,12} \approx \frac{1}{6} \text{ °C per minute}$$

The wall heats up at $\frac{1}{6}$ of a degree Celsius per minute, and cools by 1 degree Celsius per meter away from the heat source.