Vector Practice Questions from College Physics

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[46] We define $\uparrow$ and $\rightarrow$ as positive, with angles going anticlockwise from East as positive.

$$\begin{aligned}
\vec{S} &= \vec{S_1} + \vec{S_2} \\
\vec{S_1} &= 85\cos(22^\circ)\,\hat{\mathbf{i}} + 85\sin(22^\circ)\,\hat{\mathbf{j}} \\
\vec{S_2} &= 115\cos(-48^\circ)\,\hat{\mathbf{i}} + 155\sin(-48^\circ)\,\hat{\mathbf{j}} \\
\implies \vec{S} &= (85\cos(22^\circ) + 115\cos(-48^\circ))\,\hat{\mathbf{i}} + (85\sin(22^\circ) + 115\cos(-48^\circ))\,\hat{\mathbf{j}} \\
\vec{S} &= 155.76\,\hat{\mathbf{i}} - 53.62\,\hat{\mathbf{j}} \\
\implies |\vec{S}| &= \sqrt{(-53.62)^2 + (155.76)^2} = 164.73 \text{ mi} = 165 \text{ mi} \\
\text{Angle} &= \tan^{-1}\left(\frac{-53.62}{155.76}\right) = -18.995^\circ = -19^\circ \implies 19^\circ \text{ South of East}
\end{aligned}$$

[47] Since you are in static equilibrium $F_{net} = \sum F = 0$.
y-direction:

$$\begin{aligned}
|\vec{F_l}|\cos(45^\circ) + |\vec{F_r}|\cos(45^\circ) &= 620 \\
\because |\vec{F_l}| &= |\vec{F_r}| \\
\therefore 2 \times |\vec{F_l}|(\cos(45^\circ)) = 2\left(\frac{1}{\sqrt{2}}\right)|\vec{F_l}| &= 620 \\
|\vec{F_l}| = \frac{620}{\sqrt{2}} &= 438\text{N}
\end{aligned}$$

[61] We define ↑ and → as positive, with angles going anticlockwise from East as positive.

$$\begin{aligned}
\vec{S_1} + \vec{S_2} + \vec{S_3} + \vec{S_4} &= 0 \\
\vec{S_4} &= -(\vec{S_1} + \vec{S_2} + \vec{S_3}) \\
\because \vec{S_1} &= -180\,\hat{\mathbf{i}} \\
\vec{S_2} &= 210\cos(-45^\circ)\,\hat{\mathbf{i}} + 210\sin(-45^\circ)\,\hat{\mathbf{j}} \\
\vec{S_3} &= 280\cos(90^\circ - 30^\circ)\,\hat{\mathbf{i}} + 280\sin(90^\circ - 30^\circ)\,\hat{\mathbf{j}} \\
&= 280\cos(60^\circ)\,\hat{\mathbf{i}} + 280\sin(60^\circ)\,\hat{\mathbf{j}} \\
\text{or} &= 280\sin(30^\circ)\,\hat{\mathbf{i}} + 280\cos(30^\circ)\,\hat{\mathbf{j}} \\
\therefore \vec{S_4} &= -[(-180 + 210\cos(-45^\circ) + 280\cos(60^\circ))\,\hat{\mathbf{i}} + (210\sin(-45^\circ) + 280\sin(60^\circ))\,\hat{\mathbf{j}}\,] \\
&= -\left[\left(\frac{210}{\sqrt{2}} - 40\right)\,\hat{\mathbf{i}} + \left(-\frac{210}{\sqrt{2}} + \frac{260\sqrt{3}}{2}\right)\,\hat{\mathbf{j}}\right] \\
&= \left(40 - \frac{210}{\sqrt{2}}\right)\,\hat{\mathbf{i}} + \left(\frac{210}{\sqrt{2}} - \frac{260\sqrt{3}}{2}\right)\,\hat{\mathbf{j}}
\end{aligned}$$

$$\begin{aligned}
\implies |\vec{S_4}| &= 132.85 = 133\text{m} \\
\text{Angle} &= 35.2^\circ \text{ North of East}
\end{aligned}$$

[62] Same concept as Q61. We define ↑ and → as positive, with angles going anticlockwise from East as positive.

$$\begin{aligned}
\vec{S_3} &= -\vec{S_2} + (5.80 - 2.00)\,\hat{\mathbf{i}} \\
&= -3.50[\cos(-45.0^\circ)\,\hat{\mathbf{i}} + \sin(-45.0^\circ)\,\hat{\mathbf{j}}\,] + 3.80\,\hat{\mathbf{i}} \\
&= \left(3.80 - \frac{3.50}{\sqrt{2}}\right)\,\hat{\mathbf{i}} + \frac{3.50}{\sqrt{2}}\,\hat{\mathbf{j}}
\end{aligned}$$

$$\begin{aligned}
\implies |\vec{S_3}| &= 2.81\text{m} \\
\text{Angle} &= 61.8^\circ \text{ North of East}
\end{aligned}$$

[63] Same concept as Q47: Since you are in static equilibrium $F_{net} = \sum F = 0$.
x-direction:

$$\begin{aligned}
|\vec{A}|\cos(32^\circ) + |\vec{B}|\cos(32^\circ) &= 5.60 \\
\because |\vec{A}| &= |\vec{B}| \\
\therefore 2 \times |\vec{A}|(\cos(32^\circ)) &= 5.60 \\
|\vec{A}| = \frac{5.60}{2\cos(32^\circ)} &= 3.30\text{N}
\end{aligned}$$

[64] Same concept as Q61: We define ↑ and → as positive, with angles going clockwise from North as positive. (The sin and cos used in this question would be a bit different/they are opposite because of the way the angles used are defined.)

$$
\begin{aligned}
\vec{S_1} + \vec{S_2} + \vec{S_3} + \vec{S_4} &= 0 \\
\vec{S_4} &= -(\vec{S_1} + \vec{S_2} + \vec{S_3}) \\
\because \vec{S_1} &= 147\sin(85^\circ)\,\hat{\mathbf{i}} + 147\cos(85^\circ)\,\hat{\mathbf{j}} \\
\vec{S_2} &= 106\sin(167^\circ)\,\hat{\mathbf{i}} + 106\cos(167^\circ)\,\hat{\mathbf{j}} \\
\vec{S_3} &= 166\sin(235^\circ)\,\hat{\mathbf{i}} + 166\cos(235^\circ)\,\hat{\mathbf{j}} \\
\therefore \vec{S_4} &= -[(147\sin(85^\circ) + 106\sin(167^\circ) + 166\sin(235^\circ))\,\hat{\mathbf{i}} \\
&\quad + (147\cos(85^\circ) + 106\cos(167^\circ) + 166\cos(235^\circ))\,\hat{\mathbf{j}}\,] \\
\implies |\vec{S_4}| &= 188.83 = 189\text{m} \\
\text{Angle} &= -79.5^\circ \text{ East of North} = 79.5^\circ \text{ West of North}
\end{aligned}
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