Adding Force Vectors

Edouard Des Parois Perrault

Physics

Shawn Weiland

February 10, 2021

Contents

1 Question 2

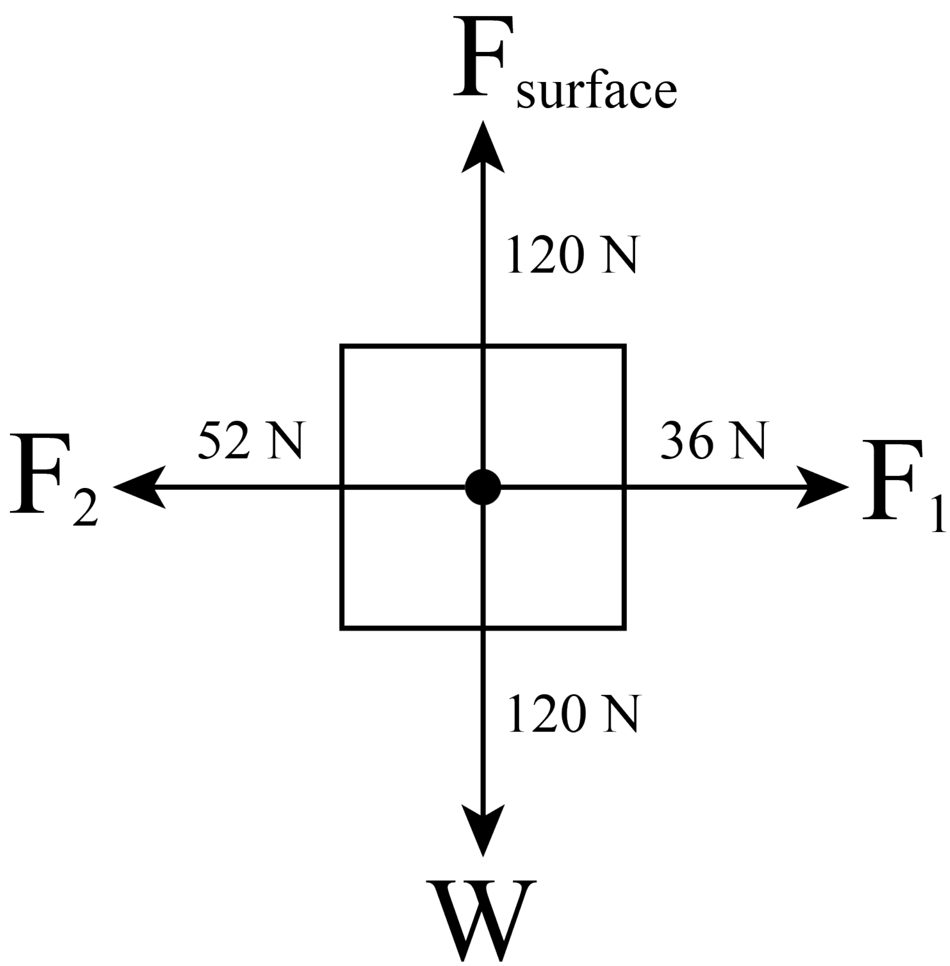

Figure 1: Question 2

According to Figure 1, the net force is $52 - 36 = 16$ N.

2 Question 4

The situation is illustrated in the image.

As shown in Figure 2, there are essentially two vectors. The first is $\vec{\mathbf{A}} = 3000\text{N}[W]$ and the second is $\vec{\mathbf{B}} =$

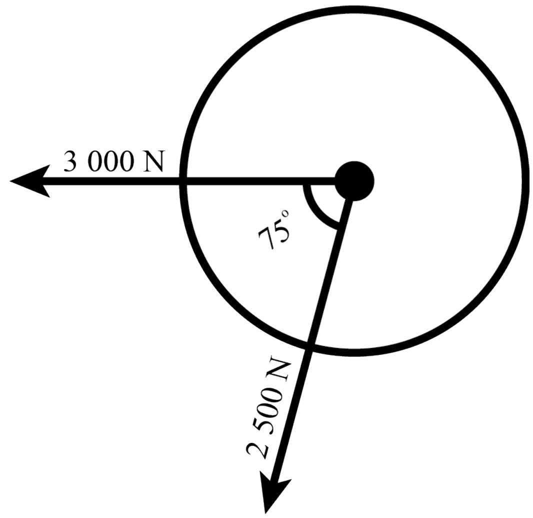

Figure 2: Tractor and Rocks Free Body Diagram

$2500\text{N}[W75°S]$. We are looking for the vector produced when $\vec{\mathbf{A}} + \vec{\mathbf{B}}$. Since $\vec{\mathbf{A}}$ is in one direction, we only need to concern ourselves with $\vec{\mathbf{B}}$. We can decompose $\vec{\mathbf{B}}$ into a triangle with sides x and y and solve for these sides using trigonometry, as shown in Figure 3.

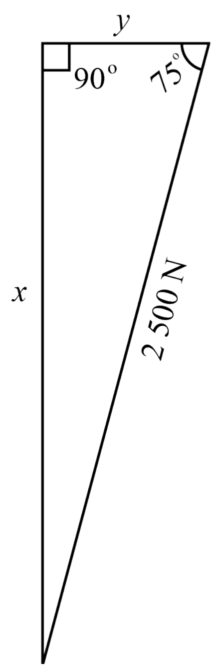

Figure 3: Trigonometry

$$\begin{aligned} \sin(75) &= \frac{x}{2500} && (1) \\ &= 2414.81 && (2) \\ & && (3) \end{aligned}$$

$$\begin{aligned} \cos 75 &= \frac{y}{2500} && (4) \\ &= 647.05 && (5) \end{aligned}$$

Now, we combine the decomposed $\vec{\mathbf{B}}$ with $\vec{\mathbf{A}}$. The horizontal component is $3000 + 647.05 = 3647.05$N and the vertical is 2414.81N. Now, we can solve for the hypoteneuse, Γ, and the angle θ, as shown in Figure 4.

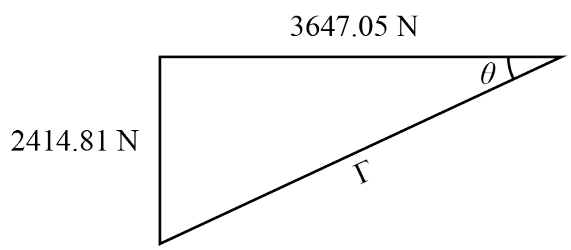

Figure 4: Solving for the hypoteneuse and the missing angle

$$\begin{aligned} \Gamma &= \sqrt{3647.05^2 + 2414.81^2} && (6) \\ &= 4374.05 && (7) \end{aligned}$$

$$\begin{aligned} \tan\theta &= \frac{2414.81}{3647.05} && (8) \\ \theta &= \tan^{-1}\left(\frac{2414.81}{3647.05}\right) && (9) \\ &\approx 33.5^\circ && (10) \end{aligned}$$

Therefore, the missing vector is $\vec{\mathbf{V}} = 4373.99$ N$[W33.4^\circ S]$

3 Question 7

Figure 5 can essentially be reduced to three vectors, $\vec{\mathbf{A}}$, $\vec{\mathbf{B}}$, and $\vec{\mathbf{C}}$, as shown in 6

Note that the sign convention has been ignore for simplicity. We can decompose $\vec{\mathbf{A}}$ into a horizontal and vertical component using trigonometry. $\vec{\mathbf{C}}$ does not need to be decomposed, as it is only in one direction.

$$\begin{aligned} \sin 60 &= \frac{x}{10} && (11) \\ x &= 10\sin 60 && (12) \\ x &= 5\sqrt{3} && (13) \end{aligned}$$

The vertical component is $5\sqrt{3}$.

$$\begin{aligned} \cos 60 &= \frac{y}{10} && (14) \\ y &= 5 && (15) \end{aligned}$$

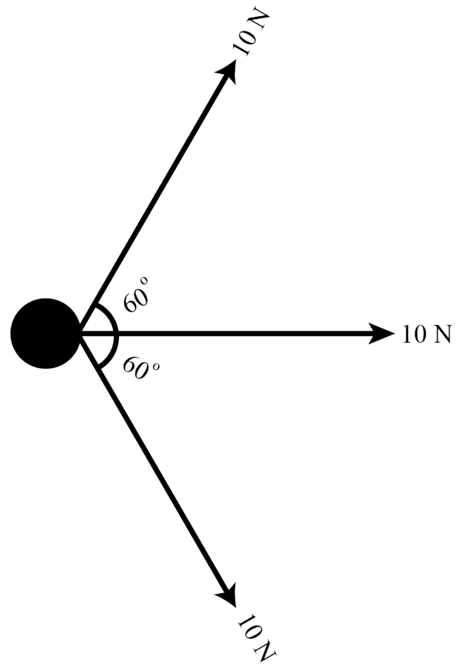

Figure 5: Question 6

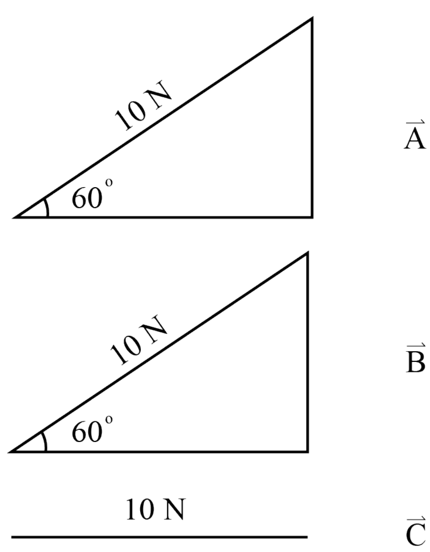

Figure 6: Decomposed question 7

The horizontal part of the component is five. Now, we don't need to calculate $\vec{\mathbf{B}}$ as it's components are the opposite of $\vec{\mathbf{A}}$. Thus, the vertical components cancel each other out as $5\sqrt{3}-5\sqrt{3}=0$. The net force is therefore equal to sum of the vertical vectors.

$$\begin{aligned} F_{\text{net}} &= 5+5+10 && (16)\\ &= 20 && (17)\\ & && (18) \end{aligned}$$

Therefore, the final vector is $\vec{\mathbf{V}} = 20\text{N}[E]$.

4 Question 8

This question essentially describes two vectors, as shown in Figure 7.

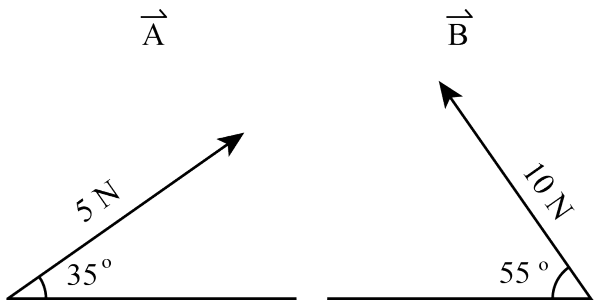

Figure 7: Question 8

We will be solving for $\vec{\mathbf{V}} = \vec{\mathbf{A}} + \vec{\mathbf{B}}$.

First, we decompose the vectors. I will decompose them into α, β, γ, and δ.

$$\begin{aligned} \sin 35 &= \frac{\alpha}{5} && (19)\\ x &= 2.87 && (20) \end{aligned}$$

$$\begin{aligned} \cos 35 &= \frac{\beta}{5} && (21)\\ &= 4.10 && (22) \end{aligned}$$

$$\begin{aligned} \sin 55 &= \frac{\gamma}{10} && (23)\\ \gamma &= 8.19 && (24) \end{aligned}$$

$$\begin{aligned} \cos 55 &= \frac{\delta}{10} && (25)\\ &= 5.74 && (26) \end{aligned}$$

Now, we must add the magnitudes while respecting the sign convention. The convention I have chosen is Cartesian; right and up are positive. The vertical portion of the vector is $2.87 + 8.19 = 11.06$. The horizontal is $5.74 - 4.10 = 1.64$.

We can now calculate the hypotenuse and the angle.

$$\begin{aligned} \text{hyp} &= \sqrt{11.06^2 + 1.64^2} && (27) \\ &= 11.18 && (28) \end{aligned}$$

$$\begin{aligned} \tan\theta &= \frac{11.06}{1.64} && (29) \\ \theta &= \tan^{-1}\left(\frac{11.06}{1.64}\right) && (30) \\ &= 81.57 && (31) \end{aligned}$$

Therefore, the $\vec{\mathbf{A}} = 11.18\text{N}[L82°U]$