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- I. Model Problems.
- II. Vector Basics
- III. Addition Of Vectors
- IV. Find Resultant Magnitude
- V. Find Angle associated with Resultant
- VI. Answer Key

Vectors

Web Resources

Vectors : www.mathwarehouse.com/vectors

Resultant Vectors : www.mathwarehouse.com/vectors/resultant-vector.php

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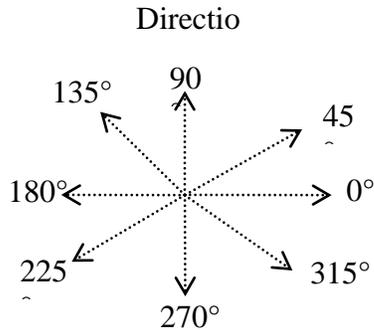
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Vectors

Vectors represent magnitude and direction. Vectors can be named like a ray, \overrightarrow{AB} , or in bold with one letter in bold, \mathbf{u} (or \vec{u} in handwritten text).

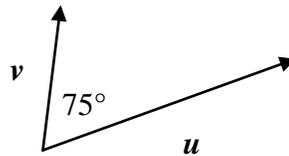
The magnitude of vector is the size of a vector often representing force or velocity. The direction of a vector is an angle measurement where 0° is to the right on the horizontal.



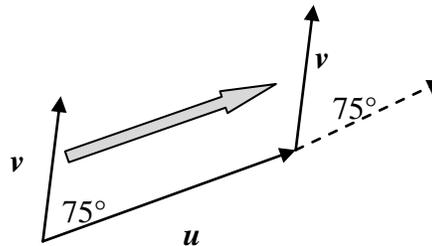
I. Model Problems

In the following problem you will learn to show vector addition using the tail-to-tip method.

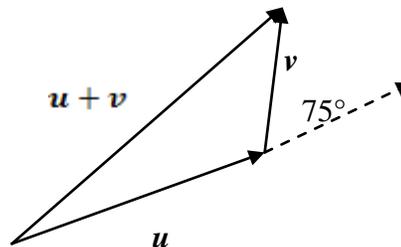
Find $\mathbf{u} + \mathbf{v}$.



Translate \mathbf{v} . Slide \mathbf{v} along \mathbf{u} so that the tail of \mathbf{v} is at the tip of \mathbf{u} .



Draw the resultant vector, $\mathbf{u} + \mathbf{v}$, which starts at the tail of \mathbf{u} and ends at the tip of \mathbf{v} .

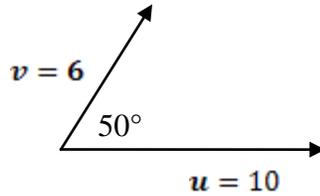


In the following problem you will find the magnitude and direction of a resultant vector.

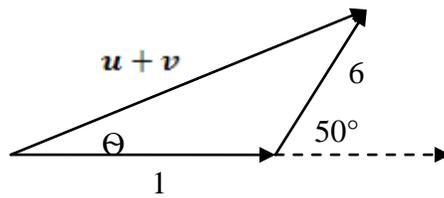
Problem:

A vector u has a magnitude of 10 and a direction of 0° . A vector v has a magnitude of 6 and a direction of 50° . Find the direction and magnitude of $u + v$ to the nearest whole values.

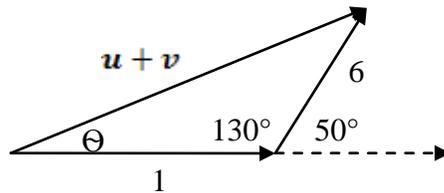
Sketch the vectors.



Translate and draw the resultant.



Find the supplementary angle to find an angle of the triangle.



Use Law of Cosines to find the magnitude, m , of $u + v$.

Law of Cosines
Substitute.
Simplify.

$$(m)^2 = u^2 + v^2 - 2uv \cos 130^\circ$$

$$(m)^2 = (10)^2 + (6)^2 - 2(10)(6) \cos 130^\circ$$

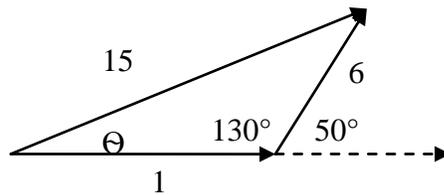
$$(m)^2 = 100 + 36 - 120 \cos 130^\circ$$

$$\sqrt{(m)^2} = \sqrt{100 + 36 - 120 \cos 130^\circ}$$

$$m \approx 15$$

Round .

Label with new information.



Use Law of Sines to find the direction, θ , of $u + v$.

Law of Sines

$$\frac{\sin A}{a} = \frac{\sin B}{b}$$

Substitute.

$$\frac{\sin 130^\circ}{15} = \frac{\sin \theta}{6}$$

Isolate $\sin B$.

$$\sin \theta = \left(\frac{\sin 130^\circ}{15} \right) (6)$$

Find the inverse.

$$\sin \theta = \frac{6}{5} (\sin 130^\circ)$$

Round to the nearest whole degree.

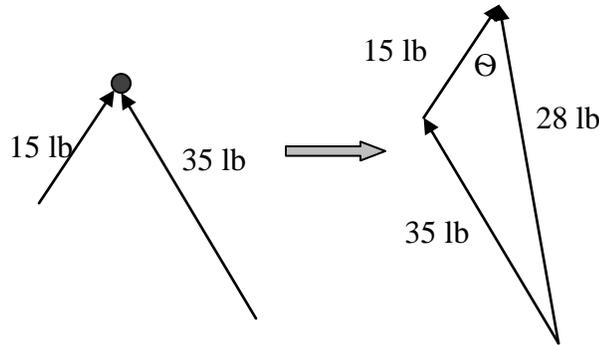
$$m\angle\theta \approx 18^\circ$$

$u + v$ has a magnitude of 15 and a direction of 18° .

In the following problems you will find information about the resultant vector of two forces applied to an object

Problem: Two forces with magnitudes of 15 pounds and 35 pounds are applied to an object. The magnitude of the resultant is 28 pounds. Find the measurement of the angle between the resultant vector and the vector of the 15 pound force to the nearest whole degree.

Sketch the problem. Remember this is a sketch. The actual angles may look very different.



Law of Cosines

Substitute.

Simplify.

Isolate cos A.

Find the inverse.

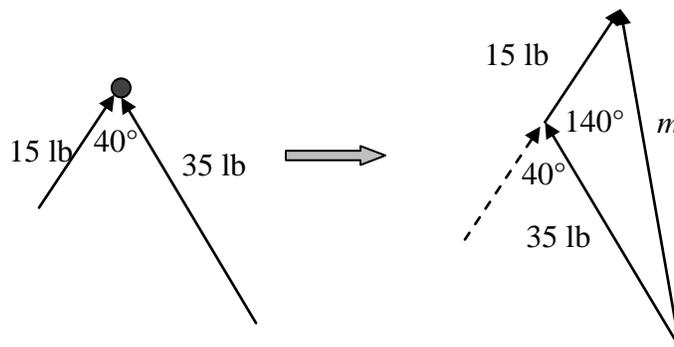
Round to the nearest degree.

$$\begin{aligned}
 a^2 &= b^2 + c^2 - 2bc \cos \theta \\
 (35)^2 &= (15)^2 + (28)^2 - 2(15)(28) \cos \theta \\
 1225 &= 225 + 784 - 840 \cos \theta \\
 1225 &= 1009 - 840 \cos \theta \\
 216 &= -840 \cos \theta \\
 -\frac{216}{840} &= \cos \theta \\
 m\angle \theta &\approx 105^\circ
 \end{aligned}$$

Problem:

Two forces with magnitudes of 15 pounds and 35 pounds and an angle of 40° between them are applied to an object. Find the magnitude of the resultant vector.

Sketch the problem. Remember this is a sketch. The actual angles may look very different.



Law of Cosines

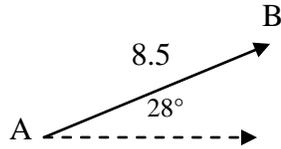
Substitute.

Simplify.

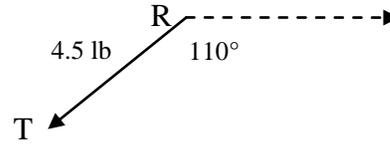
$$\begin{aligned}
 a^2 &= b^2 + c^2 - 2bc \cos \theta \\
 m^2 &= (15)^2 + (35)^2 - 2(15)(35) \cos 140^\circ \\
 m^2 &= 225 + 1225 - 1050 \cos 140^\circ \\
 \sqrt{m^2} &= \sqrt{225 + 1225 - 1050 \cos 140^\circ} \\
 m &\approx 47 \text{ lb}
 \end{aligned}$$

II. Vector Basics

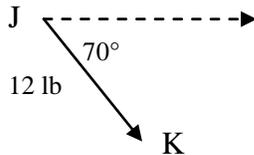
1. What is the magnitude and direction of \overrightarrow{AB} ?



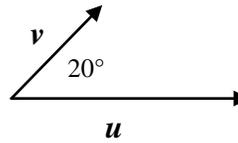
2. What is the magnitude and direction of \overrightarrow{RT} ?



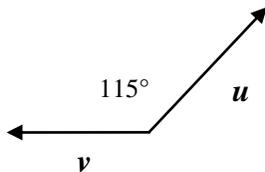
3. What is the magnitude and direction of \overrightarrow{JK} ?



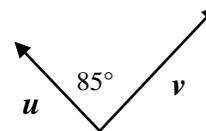
4. Sketch the resultant vector $\mathbf{u} + \mathbf{v}$.



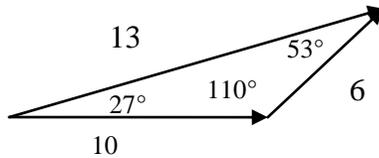
5. Sketch the resultant vector $\mathbf{u} + \mathbf{v}$.



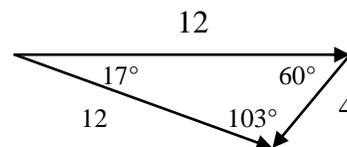
6. Sketch the resultant vector $\mathbf{u} + \mathbf{v}$.



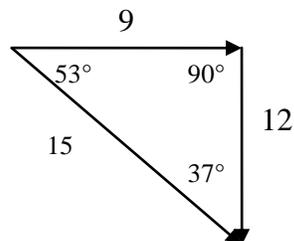
7. What is the magnitude and direction of the resultant in the sketch below?



8. What is the magnitude and direction of the resultant in the sketch below?

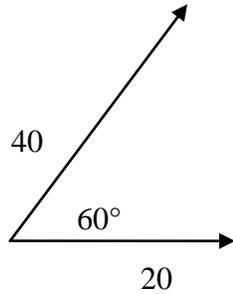


9. What is the magnitude and direction of the resultant in the sketch below?

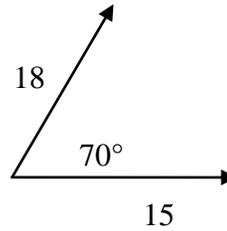


III. Addition of Vectors

10. Vector u has a magnitude of 20 and a direction of 0° . Vector v has a magnitude of 40 and a direction of 60° . Find the magnitude and direction of the resultant to the nearest whole number.



11. Vector u has a magnitude of 15 and a direction of 0° . Vector v has a magnitude of 18 and a direction of 70° . Find the magnitude and direction of the resultant to the nearest whole number.

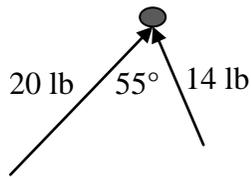


12. Vector u has a magnitude of 24 and a direction of 0° . Vector v has a magnitude of 40 and a direction of 115° . Find the magnitude and direction of the resultant to the nearest whole number.

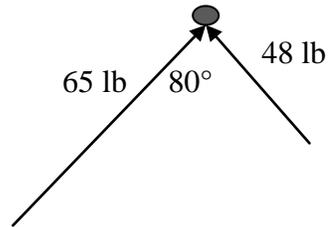
(continued on next page)

IV. Find the magnitude of the resultant vector when two forces are applied to an object.

13. Two forces with magnitudes of 20 pounds and 14 pounds and an angle of 55° between them are applied to an object. Find the magnitude of the resultant vector to the nearest whole number.



14. Two forces with magnitudes of 48 pounds and 65 pounds and an angle of 80° between them are applied to an object. Find the magnitude of the resultant vector to the nearest whole number.



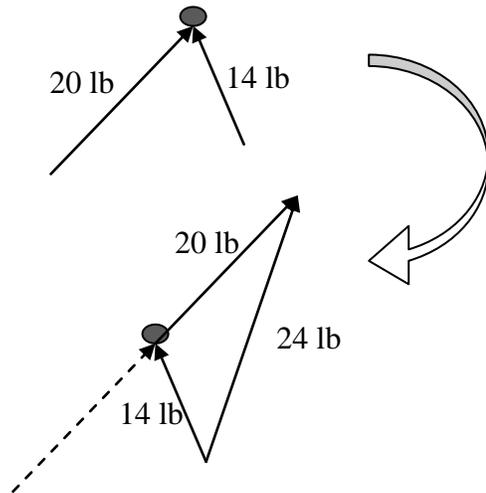
15. Two forces with magnitudes of 70 pounds and 40 pounds and an angle of 130° between them are applied to an object. Find the magnitude of the resultant vector to the nearest whole number.

16. Two forces with magnitudes of 77 pounds and 45 pounds and an angle of 43° between them are applied to an object. Find the magnitude of the resultant vector to the nearest whole number.

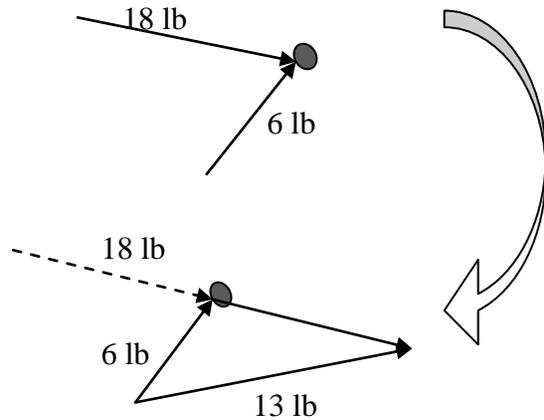
17. Two forces with magnitudes of 62 pounds and 62 pounds and an angle of 145° between them are applied to an object. Find the magnitude of the resultant vector to the nearest whole number.

V. Find the angle measurements between the resultant vector and force vector when two forces are applied to an object.

18. Two forces with magnitudes of 15 pounds and 10 pounds are applied to an object. The magnitude of the resultant is 24 pounds. Find the measurement of the angle between the resultant vector and the vector of the 10 pound force to the nearest whole degree.



19. Two forces with magnitudes of 6 pounds and 18 pounds are applied to an object. The magnitude of the resultant is 13 pounds. Find the measurement of the angle between the resultant vector and the vector of the 18 pound force to the nearest whole degree.



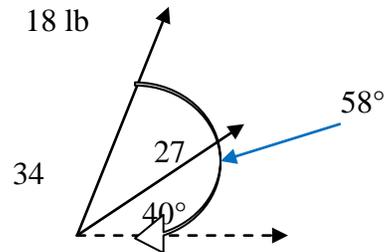
20. Two forces with magnitudes of 45 pounds and 62 pounds are applied to an object. The magnitude of the resultant is 100 pounds. Find the measurement of the angle between the resultant vector and the vector of the 45 pound force to the nearest whole degree.

21. Two forces with magnitudes of 200 pounds and 340 pounds are applied to an object. The magnitude of the resultant is 150 pounds. Find the measurement of the angle between the resultant vector and the vector of the 200 pound force to the nearest whole degree.

22. Two forces with magnitudes of 40 pounds and 42 pounds are applied to an object. The magnitude of the resultant is 31 pounds. Find the measurement of the angle between the resultant vector and the vector of the 42 pound force to the nearest whole degree.

V. Challenge Problems

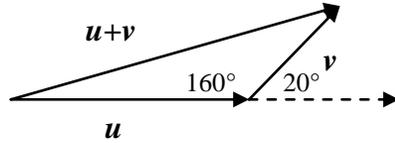
23. Vector u has a magnitude of 53 and a direction of 0° . Vector v has a magnitude of 10 and a direction of 295° . Find the magnitude and direction of the resultant to the nearest whole number.
24. Vector u has a magnitude of 27 and a direction of 40° . Vector v has a magnitude of 34 and a direction of 58° . Find the magnitude and direction of the resultant to the nearest whole number.



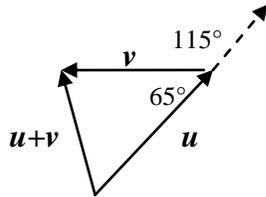
25. Use vectors to answer the following questions.
- If two forces from different directions are applied to an object, can the magnitude of the resultant be larger than the sum of the magnitudes of the forces? Justify your answer.
 - What if the forces were from the same direction? Justify your answer.

VI. Answers

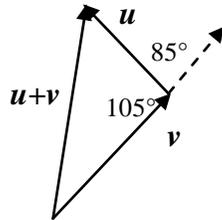
1. 8.5, 28°
2. 4.5 lb, 250°
3. 12 lb, 310°
- 4.



5.



6.



7. 13, 27°
8. 12, 343°
9. 15, 307°
10. 53, 41°
11. 27, 39°
12. 37, 78°
13. 30 lb
14. 87 lb
15. 54 lb
16. 114 lb
17. 37 lb
18. 76°
19. 12°
20. 25°
21. 152°
22. 47°
23. 58, 351°
24. 73, 44°
25. a) No, the sum of two sides is greater than the third therefore the magnitude of the resultant is less than the sum of the two forces. b) The magnitude of the resultant is equal the sum of the two forces.