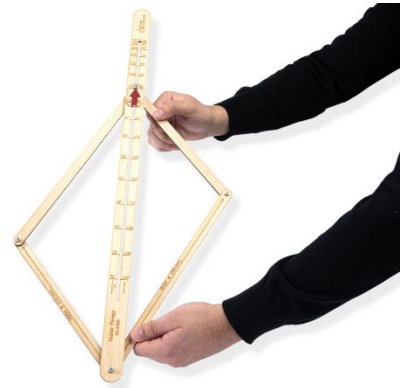


INSTRUCTIONAL GUIDE**Contents****Vector Thingy****Recommended for Activity:**

- [Meter Stick 6/pk \(P1-7072\)](#)

**Introduction****For the Physics, Math or Physical Science Teacher...**

The World of Physics and Math can be described with the Language of Numbers. Whether it's the Distance an object travels, the Forces applied to one or more objects or the combined Velocities of a boat sailing across a flowing river. It is crucial in Physics and Math not only to know the Magnitude (Scalar) of what you are measuring but, in many instances, the Magnitude AND Direction (Vector) of the quantity you are measuring. In those cases, students are required to calculate the Resultants of Vector quantities such as velocity, acceleration, force and momentum, which all have both a magnitude (size) and a direction.

It is a difficult concept for Physics and Math students to visualize Vector Addition, especially when the two Vector quantities may be at various angles in relation to each other. Too many misconceptions about the Resultants from adding two Vectors are commonly made by high school Physics students as the angle between two Vectors is increased or decreased. For example, if a student is presented with the concept of increasing the angles between two Vector quantities and asked to determine if the Resultant also increases or decreases, more often than not, the answers are unclear to them.

The "Vector Thingy" allows students to actually manipulate and observe in "real-time" how the Resultants *change* as the angles are varied. With the Vector angles clearly printed on the device, along with the Supplementary angles that students will need to calculate non-right-angled Vectors and their Resultants, the "Vector Thingy" can be used for general Vector concepts and as well as actual Vector problems! You can use the "Vector Thingy" with any of your Vector labs, Vector homework and activities or for Vector review before a quiz or test. It is an additional tool in your teaching kit; a supplement to any Vector teacher-created activity. When the student manipulates the "Vector Thingy", the Resultant (shown clearly by the RED arrow) changes visually as the angles between the two fixed Vectors (A & B) increase or decrease. In addition, the Vectors (A & B) are clearly marked with fixed magnitudes (Vector A @ 300 mm and Vector B @ 220 mm) and can be used for "real-time" calculations.

This device has been designed for General High School Physics and Math students dealing with two-vector systems and not intended for higher-level AP or College Vector problems where three or more Vectors may be added. Its conceptual level was designed based on the New York State Regents-Level Physics and Math courses and basic AP Physics Vector problems dealing with non-right angle two Vector systems.

Arbor Scientific has included a sample activity that will augment and feature the use of the “Vector Thingy” although we encourage every teacher to incorporate the usage of this device into their own homework, activities and labs to enhance their students’ understanding of Vector concepts.

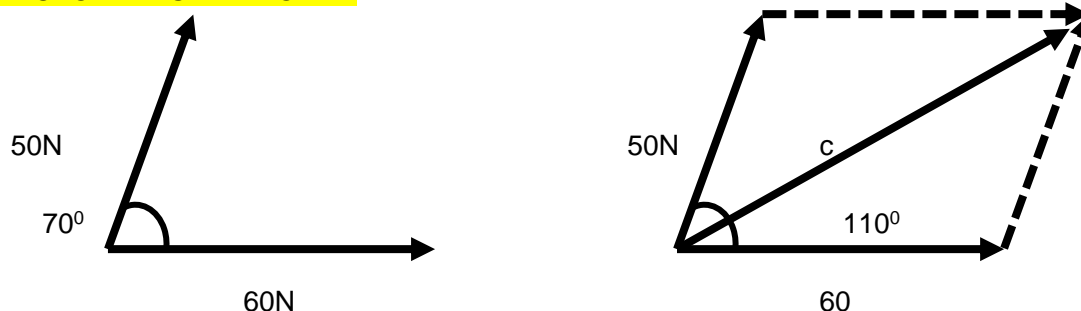
Activities

VECTOR PRACTICE ANSWERS

Using your knowledge of Vectors, complete the following Vector problems. You may use your calculator, Pythagorean Theorem, Law of Cosines and the “Vector Thingy” to help you solve the questions.

- The Magnitude of the Resultant between two vectors increases as the angle between the two vectors... (Hint... use your “Vector Thingy”!)
 - increases
 - decreases**
- The Resultant between two Forces acting concurrently on the same point is at a maximum when the angle between the two Forces is... (Hint.. use your “Vector Thingy”!)
 - 0 degrees**
 - 45 degrees
 - 90 degrees
 - 180 degrees
- Two vectors act concurrently on a point with an angle of 125 degrees between them. As the angle decreases to 40 degrees, the Resultant becomes... (Hint.. use your “Vector Thingy”!)
 - larger**
 - smaller
 - unchanged
- Two Vectors of 50N and 60N act concurrently on a point with an angle of 70 degrees between them. Using the Parallelogram Method of Vector Addition and the Law of Cosines ($c^2 = a^2 + b^2 - 2ab\cos C$), Find...
 - ...the Supplementary angle (in degrees) for Angle C.
(Hint.. your “Vector Thingy” will help!)
110°
 - ...the Resultant

VECTOR DIAGRAM FOR #4

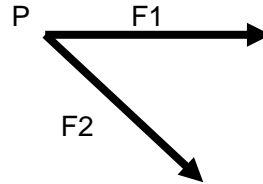




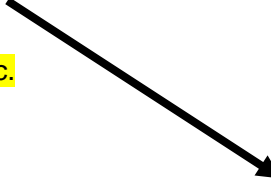
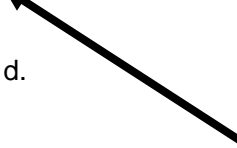
USE... $c^2 = a^2 + b^2 - 2ab \cos C$

$c^2 = 50^2 + 60^2 - 2(50)(60)\cos 110^\circ$

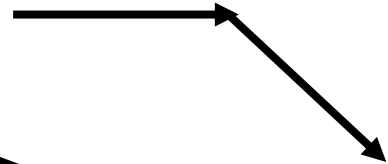
$c^2 = 90.3N$



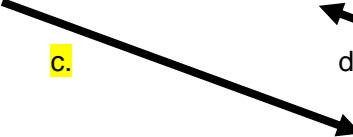
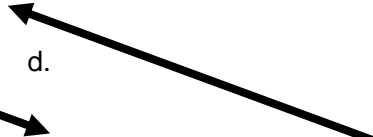
5. Which Vector best represents the Resultant of Forces F1 and F2 acting on Point P?
(Hint.. use your "Vector Thingy"!)



- a.  b.  c.  d. 

6. Which Vector best represents the Resultant of Forces F1 and F2 acting on Point P?
(Hint.. use your "Vector Thingy"!)



- a.  b.  c.  d. 

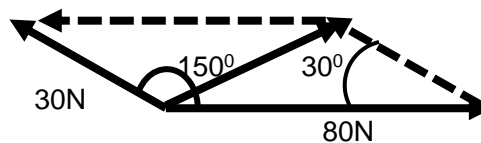
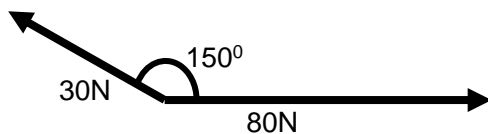
7. Two Vectors of 30N and 80N act concurrently on a point with an angle of 150 degrees between them. Using the Parallelogram Method of Vector Addition and the Law of Cosines ($c^2 = a^2 + b^2 - 2ab\cos C$), Find...

- a. ...the Supplementary angle (in degrees) for Angle C.
(Hint.. your "Vector Thingy" will help!)

30°

- b. ...the Resultant

VECTOR DIAGRAM FOR #7



USE... $c^2 = a^2 + b^2 - 2ab \cos C$

$c^2 = 30^2 + 80^2 - 2(50)(60)\cos 30^\circ$

$c^2 = 56N$

8. The resultant of a 12N force and a 7N force is 5N. The angle between the two forces is...

(Hint.. your "Vector Thingy" will help!)

- a. 0 degrees b. 45 degrees c. 90 degrees **d. 180 degrees**

9. Two concurrent Forces of 30N each act to produce a Resultant whose Magnitude is 60N. The Angle between these two forces MUST be...

(Hint.. use your "Vector Thingy"!)

- a. **0 degrees** b. 60 degrees c. 90 degrees. d. 120 degrees e. 180 degrees

10. Using **Vector a (300 mm)** and **Vector b (220 mm)** values on your "Vector Thingy", Find the Resultant for...

10A. Vector a and Vector b @ 90 degrees. ($c^2 = a^2 + b^2$)

USE... $c^2 = a^2 + b^2$
 $c^2 = (220)^2 + (300)^2$
 $c^2 = 48400 + 90000$
 $c^2 = 138400$
 $c = 372.0 \text{ mm}$

10B. Vector a and Vector b @ 40 degrees. ($c^2 = a^2 + b^2 - 2ab\cos C$),

USE... $c^2 = a^2 + b^2 - 2ab \cos C$

$c^2 = 220^2 + 300^2 - 2(220)(300)\cos 140^\circ$

$c = 489.4 \text{ mm}$

10C. Vector a and Vector b @ 140 degrees. ($c^2 = a^2 + b^2 - 2ab\cos C$),

USE... $c^2 = a^2 + b^2 - 2ab \cos C$

$c^2 = 220^2 + 300^2 - 2(220)(300)\cos 40^\circ$

$c = 193.1 \text{ mm}$

11. For Question 10A, after **CALCULATING** the Resultant, **MEASURE** the Resultant (...the RED "sliding" arrow) on the "Vector Thingy" using a metric ruler and compare the results. Using the **CALCULATED** answer and the **MEASURED** answer, find the **Percent Error**.

(Measure from the Concurrent Point (...the silver nut) to the tip of the RED arrow)

Measured Value → 374 mm Calculated Value → 372 mm

$$\text{USE... } \frac{\text{Measured Value} - \text{Calculated Value}}{\text{Calculated Value}} \times 100 = \text{Percent Error}$$

$$\frac{374 \text{ mm} - 372 \text{ mm}}{372 \text{ mm}} \times 100 = 0.53\% \text{ error}$$

12. For Question 10B, after **CALCULATING** the Resultant, **MEASURE** the Resultant (...the RED “sliding” arrow) on the “Vector Thingy” using a metric ruler and compare the results. Using the **CALCULATED** answer and the **MEASURED** answer, find the **Percent Error**.
(Measure from the Concurrent Point (...the silver nut) to the tip of the RED arrow)

$$\text{Measured Value} \rightarrow 489 \text{ mm} \quad \text{Calculated Value} \rightarrow 489.4 \text{ mm}$$

$$\text{USE... } \frac{\text{Measured Value} - \text{Calculated Value}}{\text{Calculated Value}} \times 100 = \text{Percent Error}$$

$$\frac{489 \text{ mm} - 489.4 \text{ mm}}{489.4 \text{ mm}} \times 100 = 0.082\% \text{ error}$$

13. For Question 10C, after **CALCULATING** the Resultant, **MEASURE** the Resultant (...the RED “sliding” arrow) on the “Vector Thingy” using a metric ruler and compare the results. Using the **CALCULATED** answer and the **MEASURED** answer, find the **Percent Error**.
(Measure from the Concurrent Point (...the silver nut) to the tip of the RED arrow)

$$\text{Measured Value} \rightarrow 194 \text{ mm} \quad \text{Calculated Value} \rightarrow 193.1 \text{ mm}$$

$$\text{USE... } \frac{\text{Measured Value} - \text{Calculated Value}}{\text{Calculated Value}} \times 100 = \text{Percent Error}$$

$$\frac{194 \text{ mm} - 193.1 \text{ mm}}{193.1 \text{ mm}} \times 100 = 0.47\% \text{ error}$$

14. The “Vector Thingy” is not manufactured to display a 180-degree angle between Vectors a & b. Given the two Vectors, a & b, what would the Resultant be if the angle between the two Vectors was at 180°?

At 180°, a resultant between two concurrent Vectors will be at its Minimum value.

$$300 \text{ mm} - 220 \text{ mm} = 80 \text{ mm}$$

15. The “Vector Thingy” is ALSO not manufactured to display a Zero-degree angle between Vectors a & b. Given the two Vectors, a & b, what would the Resultant be if the angle between the two Vectors was at 0°?

At 0°, a resultant between two concurrent Vectors will be at its Maximum value.

$$300 \text{ mm} + 220 \text{ mm} = 520 \text{ mm}$$