Vectors

In this laboratory, we try to develop an understanding of vectors, both physically and mathematically. Vectors are used to represent some of the quantities that we care about in physics, such as velocity, acceleration, force, and momentum. This laboratory exercise focuses on force vectors.

Make sure that you have the following pieces of equipment.

- force table (short round table with degree markings from 0° to 360°)
- small ring with four strings attached
- weights and weight holders
- pulleys that clamp onto the force table

1 Resolve a vector into components

1.1 Experimentally

We wish to apply a force of 3.5 N at 35° to the ring at the center of the force table. Figure out how many grams you need to hang from a string (including the weight hanger) to produce a force of 3.5 N. Include units (grams, abbreviated g, in this case) in the table below and in all subsequent places in which they are appropriate.

Mass required to produce a force of 3.5 N	

Apply the 3.5 N force at 35° on the force table. Our goal in this section is to break the force of 3.5 N at 35° into components along 0° and 90°. In

other words, we wish to know what *two* forces, one at 0° and one at 90°, are equivalent to 3.5 N at 35°.

We may achieve this goal as follows. Apply a second 3.5 N force in the direction exactly opposite to 35°, so that the ring is balanced in the center of the force table. Now replace the original 3.5 N force at 35° with one force at 0° and one force at 90°. Adjust the masses on these two component forces until the ring is again balanced in the center of the force table.

Record the components of the 3.5 N force at 35° in the table below (you will need to compute the force in Newtons produced by the number of grams of mass hanging).

0° component of force, F_x	
90° component of force, F_y	

1.2 Graphically

With a ruler, protractor, and graph paper, draw a vector to represent the force of 3.5 N at 35°. In order to do this, you must choose a scale for how many centimeters of graph paper will represent how many Newtons of force. Record that scale on the graph paper near your figure. Use a ruler to measure the components of the force, and record them in the table below.

0° component of force, F_x	
90° component of force, F_y	

1.3 Analytically

Use trigonometry to calculate the components of the force of 3.5 N at 35°. Show your work in the space below, and record your results in the table.

0° component of force, F_x	
90° component of force, F_y	

2 Add two vectors

Our goal in this section is to add the following two vectors.

- 3.5 N at 0°
- 2.5 N at 90°

The sum of the two force vectors is the single force vector that is equivalent to both forces acting at the same place at the same time.

2.1 Experimentally

Think of a way to use the force table to add two vectors, and describe your method below.

Record your result below. (Don't forget to include the direction of the net force.)

Net force	

2.2 Graphically

With a ruler, protractor, and graph paper, add the two vectors graphically. Record the net force below.

Net force	

2.3 Analytically

Use trigonometry to find the net force. Show your work in the space below, and record your result in the table.

Net force	

3 Add two vectors again

Our goal in this section is to add the following two vectors.

- 3.5 N at 30°
- 2.5 N at 75°

3.1 Experimentally

Briefly describe your method for using the force table to add the two vectors.

Record your result below.

Net force	

3.2 Graphically

With a ruler, protractor, and graph paper, add the two vectors graphically. Record the net force below.

Net force	

3.3 Analytically

Use trigonometry to find the net force. Show your work in the space below, and record your result in the table.

Net force	

4 Add three vectors

Our goal in this section is to add the following three vectors.

- 3.5 N at 25°
- 2.5 N at 110°
- 1.5 N at 220°

4.1 Experimentally

Briefly describe your method for using the force table to add the three vectors.

Record your result below.

Net force	

4.2 Graphically

With a ruler, protractor, and graph paper, add the three vectors graphically. Record the net force below.

Net force	

4.3 Analytically

Use trigonometry to find the net force. Show your work in the space below, and record your result in the table.

Net force	