

At the end of this worksheet you should be able to

- define a force and discuss the types responsible for most observable interactions
- add vectors graphically
- decompose vectors and recombine components
- discuss Newton's first and third law.

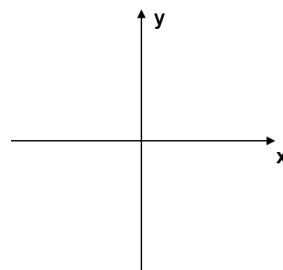
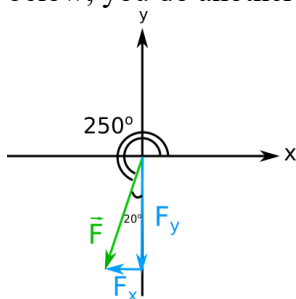
1. What is a force?
2. List the common forces. Which are non-contact? Which are contact?
3. How much force is 250 lbs in newtons? $1 \text{ lb} = 4.45 \text{ Newtons}$ or $1 \text{ Newton} = 0.225 \text{ lb}$.
4. A person has a weight of 1,110 N. What is his mass in kg? $F_g = mg$ where $g = 9.8 \text{ N/kg}$.

Vector Math, Graphical

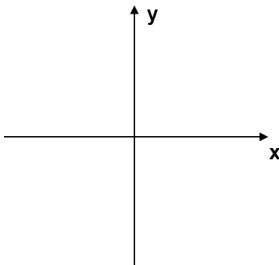
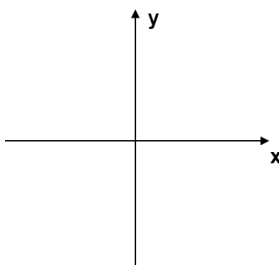
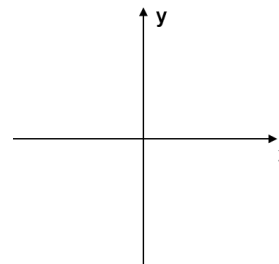
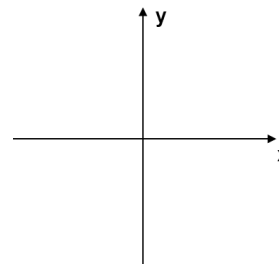
5. Two children are pulling a wagon. Sam pulls with a 5 N force and Ford pulls with a 10 N force.
 - a) What is the net force on the wagon when Sam and Ford pull in the same direction?
 - b) What is the net force on the wagon when Sam and Ford pull in opposite directions?

6. Draw two vectors represented as arrows, with one of them being approximately twice as big as the other and pointed in *different non-parallel directions*.
7. Graphically add these vectors up.
8. Show your results to someone else and look at their results. Draw their vector problem in the space below.

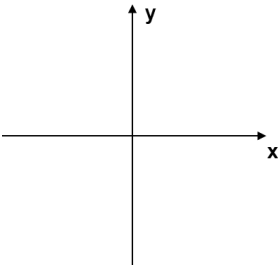
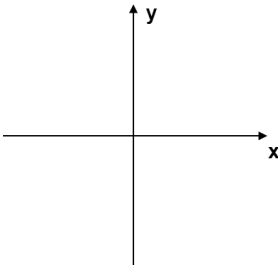
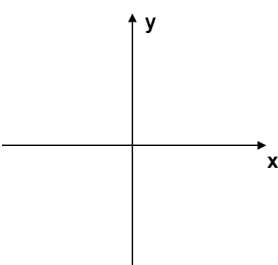
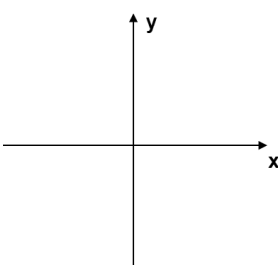
9. Draw out your own vector in any direction on the x - y coordinate plane, and describe its coordinates from both the nearest axis, and from the positive x -axis. I have done an example of this in the space below; you do another one.



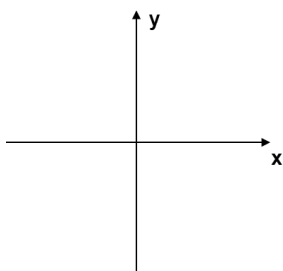
10. Draw a sketch of the following vectors and their components on the coordinate planes.

<p>A vector is described as 20° north of east.</p> 	<p>A vector is described as 20° south of east.</p> 
<p>A vector is described as 20° east of north.</p> 	<p>A vector is described as 20° west of north.</p> 

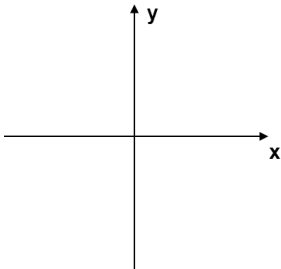
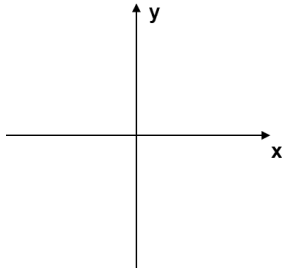
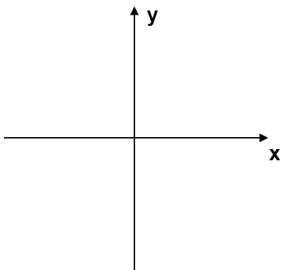
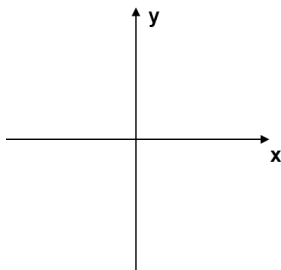
11. Draw the following vectors from the positive x -direction. Express this in three other equivalent ways.

<p>A vector at a 200° angle.</p> 	<p>A vector at a 300° angle.</p> 
<p>A vector at a -30° angle.</p> 	<p>A vector at a -120° angle.</p> 

12. What are the x - and y -components of a 100 N force that is acting on an object at an angle that is 20° north of west?

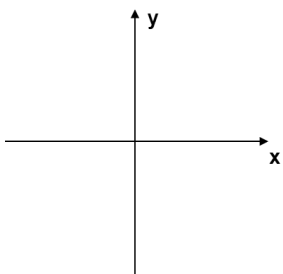


13. Determine the magnitude and direction of the following vectors.

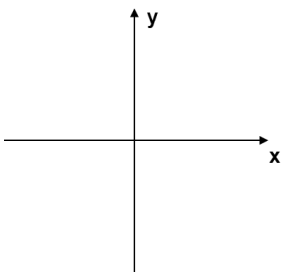
<p>A vector with an x-component of +10 N, and a y-component of +20 N</p> 	<p>A vector with an x-component of -10 N, and a y-component of +20 N</p> 
<p>A vector with an x-component of +10 N, and a y-component of -20 N</p> 	<p>A vector with an x-component of -10 N, and a y-component of -20 N</p> 

Adding Vectors using Components

14. Vector \vec{A} is 10 N 30° north of east and vector \vec{B} is 40 N east. What is the vector sum of $\vec{A} + \vec{B}$?



15. Use the simulation at https://phet.colorado.edu/sims/html/vector-addition/latest/vector-addition_all.html (Tab Explore 2D) to create a vector addition problem, and work through it with our methods to check the results.



Newton's Laws

16. A book is resting on a table. What forces are acting on the book? What forces are acting on the table?
17. You are holding a glass in your hand. What forces are acting on the glass?
18. A book is sliding down a *rough* table that is inclined on one side. What forces are acting on the book?
19. A phone rests on a horizontal table. The phone has a weight (Force of gravity) of 10 N. What must the normal force from the table be? (Rest = 0 N *net force* on the phone)

20. One side of the table that the 10-N phone is resting on is raised so that the surface is at a 10° angle with respect to the horizontal. For this problem, make your coordinate system so that the x -axis is parallel to the surface of the table, and the y -axis is perpendicular to the table.
- With this coordinate system, what are the x - and y - components of the weight of the phone?
 - What would the normal force need to be so that the net force in the y -direction is 0 N?
 - What would the force of friction need to be so that the net force in the x -direction is 0 N?
21. A person pulls a sled with a rope across level ground at constant velocity. The sled has a weight of 1000N, and the person pulls with a force of 500 N at an angle 37° above the horizontal.
- What are the x - and y - components of the tension force?
 - What is the normal force acting on the sled?
 - What is the net force in the x -direction?