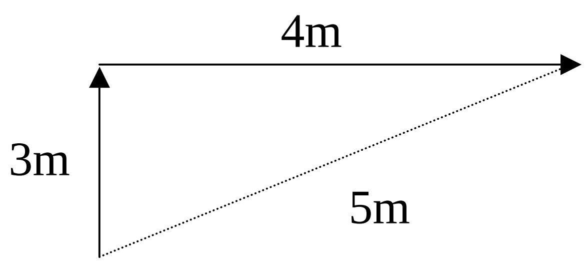
Name: ____________________ | Unit II
Mr. Willis | Motion (Velocity/Acceleration)
Conceptual Physics: __________ | Need extra help?
Date: _____________ | Check out *http://www.bayhicoach.com*

II

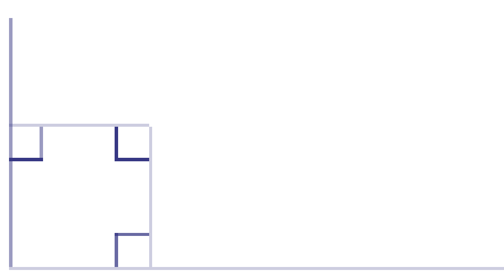
Video: Victory with Vectors

We are familiar with both scalars and vectors. Scalars are numbers. Your age is a scalar as is the temperature in the room, the speed of your car, or the distance between your math and science classes. Vectors are also numbers, but unlike scalars, vectors include direction. The speed of your car AND its direction is a vector called velocity. The distance between your math and science class AND the direction is a vector called displacement. Most of the mathematics we learn in the early grades is the mathematics of scalars where 3 + 4 must equal 7. When adding vectors, 3 + 4 may equal 5, but it may also equal 1, 2, 3, 4, 5, 6, or 7, or any number in between. Vector arithmetic is as important as scalar arithmetic and is not much more difficult.

If a person walks 3 meters north and then walks 4 meters east, the distance traveled is 7 meters (that's scalar math: 3 + 4 = 7). If we wanted to know how far that person was displaced (i.e., how far is that person from the starting point), we have a different problem. A quick scale diagram can show that the person is 5 meters from the origin. Alternatively, the Pythagorean theorem ($a^2 + b^2 = c^2$) can be used to compute the displacement as 5 meters ($3^2 + 4^2 = 5^2$).

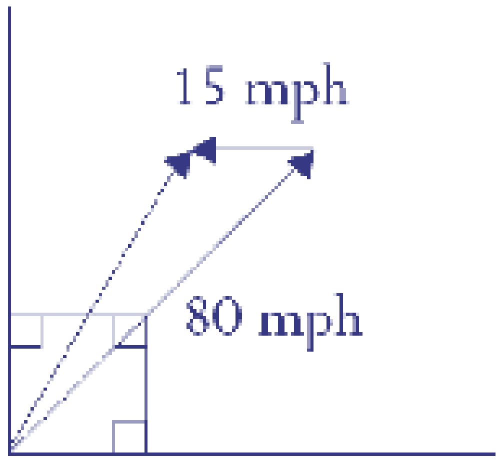


Since these vectors are in two dimensions, there is an alternative way of adding them using i, j notation. The 4 meter vector is in the x-direction and would be represented as 4i. The 3 meter vector is in the y-direction and would be represented as 3j. The sum of these would be 4i + 3j. A batter after slamming a home run rounds the bases. Assuming that home plate is at the origin and first base is along the x-axis (90 feet away), we can describe the motion as four vectors: a run to first base (90i + 0j), a turn and a run to second base in the y-direction only (0i + 90j), moving to third base or along the negative x-direction (-90i + 0j), and back to home along the negative y-direction (0i -90j).



Adding these up, we get (0i + 0j) – the player returns home.

The addition of velocity vectors is extremely valuable in determining how far a baseball may go in the wind or which direction to head an airplane. If a baseball were hit at 80 miles per hour toward center field and the wind blew it at 15 miles per hour toward the third baseline, where would the ball travel? Once again we can add the i, j notation.



The 80 mph vector has components of 56.6i + 56.6j. We can check this with the Pythagorean theorem ($56.6^2 + 56.6^2 = 80^2$). Adding to this the wind vector of -15i + 0j, we get the sum of 41.6i + 56.6j. We can see that this is still a fair ball. A foul ball would have given us a sum in the negative x-direction.

Simulate the motion of a fly ball with different winds. You will need a partner to provide the simulated wind. Draw a baseball diamond and the field on a piece of paper. Drag your pen across the paper to show the path of a ball traveling to center field. Repeat this motion as your partner pulls the paper toward the right simulating a wind. What happens to the path of the baseball? Repeat the simulation with a faster wind by having your partner pull the paper faster. Repeat the simulation again with a slower fly ball. How do the speed of the ball and the speed of the wind affect the path?

1. The coordinates of home plate are 0,0 and the coordinates of 1st base are 90,0. The home run fence can be assumed to be 350 feet from home plate. Provide possible coordinates for right field, the foul pole in left field, and the position of the shortstop.

2. A baseball is hit at 90 mph (135 feet per second) along the first baseline and is ruled foul by 20 feet. The ball traveled a distance of 200 feet. Describe a wind that may have helped keep this ball in fair territory.

3. A plane is traveling due north at 500 miles per hour. The wind is heading toward the east at 30 mph. The plane travels for 3 hours. How far off course will the plane be if it does not take the wind direction into account?

4. A car requires new tires. Is this due to the distance it has traveled or its displacement? Please explain your answer.