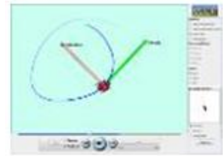
Name: ___________________________

PhET 2D Motion and Vectors Simulations Lab

Introduction:

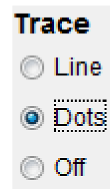
A **vector** quantity is one that has both a **magnitude** and a **direction**. For instance, your car's velocity vector will have a magnitude (24 m/s) and a direction (northeast or 45 degrees). These simulations will illustrate how vectors are made of X and Y components, how two vectors can be added to produce a resulting vector, and how the acceleration vector affects the velocity vector in **two-dimensional** motion.


Ladybug Motion 2D

Part I: Vector Simulation: *Play With Sims → Physics → Motion → LadyBug 2D Motion* Run Now!

1. Click *Manual*. Drag the bug around with your mouse and notice the actions of the two vectors. Spend some time investigating the vectors. Which vector is velocity?________________ and which is acceleration? ________________

2. **Be sure everyone in the lab group does ALL these exercises.**



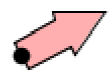
3. Describe the direction of the red vector (in relation to the green vector) when the bug *sped up*.
____

4. What about the red vector when the bug *slowed down*? ____________________________________

5. Click *Circular*. Observe the bug's motion. Where must the acceleration vector be (in relation to the velocity vector) to turn the bug? ____

6. Click *Ellipse*. Observe the bug moving like a car on a racetrack (in an oval). What must a car/runner do in order to turn?
____

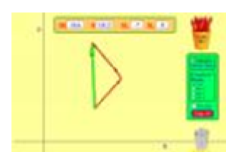
7. Now...use the **Remote Control** area to manually move the bug by controlling its position, velocity, and acceleration. Try to make the letter "C" three times using **position**, then **velocity**, then **acceleration**.



8. Try to trace other letters, such as "O","D","S","J","P". Challenge your labmates! What can you trace using **acceleration**?

Part II: Vector Addition Simulation: *Play With Sims → Math → Vector Addition* Run Now!

Place two vectors  in the work area. Change their direction and magnitude be dragging the heads of the arrows representing each vector. Click Show Sum to view the resultant (sum) of the two vectors. You may click the *Styles* to show the *X* and *Y components*.


Vector Addition

Click on one vector and fill in the boxes: |R| ____ θ ____ R_x ____ R_y ____

Click on another vector and fill in the boxes: |R| ____ θ ____ R_x ____ R_y ____

Click the **resultant** vector and fill in: |R| ____ θ ____ R_x ____ R_y ____

|R| = Magnitude of the vector (M) θ = angle of the vector R_x = X component R_y = Y component

Repeat with two different vectors: Vectors 1 and 2

|R| ____ θ ____ R_x ____ R_y ____

|R| ____ θ ____ R_x ____ R_y ____

The Resultant Vector

|R| ____ θ ____ R_x ____ R_y ____

Part III: Calculating Resultant Vectors: ***GRADED***

Find the mathematical sum of each set of vectors below **(with a calculator).**
After you have calculated, recreate (as closely as possible) the vectors in the simulation to **check your work**.

Vector Components and Vector Addition Review:

- To add vectors, break each vector into its X an Y **components** by calculating $M\cos\theta = X$ and $M\sin\theta = Y$. The components CAN BE NEGATIVE (-x , -y)
- The resultant vector's X and Y components are the sum of the X and Y components of each vector: $X_r = X_1 + X_2$
- The resultant vector's ***magnitude M*** or **|R|** is found using the Pythagorean theorem using X_r and Y_r as the legs of a right triangle, where the hypotenuse is the magnitude.
- The **angle θ** of the resultant vector is found with the **inverse tangent** (**tan^{-1}**) of the X_r and Y_r components.

Fill in all available boxes - exact, graded answers will come from calculations, use the sim to check your work

#1

Vector 1

M	angle, θ	X_1	Y_1
6.0	35		

Vector 2

M	angle, θ	X_2	Y_2
2.5	20.		

Resultant of adding vector 1 and vector 2 components

M_r	θ_r	X_r	Y_r

#2

Vector 1 ***negative angles - be careful***

M	angle, θ	X_1	Y_1
1.8	15.		

Vector 2

M	angle, θ	X_2	Y_2
7.0	-25		

Resultant

M_r	θ_r	X_r	Y_r

#3

Vector 1

M	angle, θ	X_1	Y_1
		3.5	2.5

Vector 2

M	angle, θ	X_2	Y_2
		4.0	6.0

Resultant

M_r	θ_r	X_r	Y_r

#4

Vector 1

M	angle, θ	X_1	Y_1
	70	4.7	

Vector 2

M	angle, θ	X_2	Y_2
	-15		-2.0

Resultant

M_r	θ_r	X_r	Y_r
		12.1	10.8

2D Motion Conclusion Questions:

1. The red vector represented _______________________ and the green represented ________________________.
2. When the acceleration vector was in the same direction as the velocity vector, the object *slowed down / sped up.*
3. When the acceleration vector was in the opposite direction as the velocity vector, the object *slowed down / sped up.*
4. Turning requires the acceleration vector to be directed where? ____
5. Imagine tracing the letter "J". As the ladybug is travelling down, it must turn to make *the hook*. In what direction must the acceleration vector point to move the velocity vector (from down) and trace the hook? ________________________