Name: _____

PhET Vectors Simulations Lab

Introduction:
A vector quantity is one that has both a magnitude and a direction. For instance, a velocity vector will have a magnitude (24 m/s) and a direction (northeast or 45 degrees). These simulations will demonstrate how vectors can be summed to produce a resulting vector, and how the acceleration vector affects the velocity vector.

Part I: Vector Simulation: *Motion* → *Motion in 2D* `Run Now!`

1. Click *Stop*. Drag the object 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 this exercise.

3. Click on *Linear Acc 1*. Observe the motion. A larger blue vector causes what motion?
   _____

4. Click *Simple Harmonic*. Observe the motion. A larger blue vector causes what motion?
   _____

5. Click *Circular*. Observe the motion. What orientation must the vectors (to each other) have to turn the object?
   _____

6. Click Stop. Attempt to move the object like a car or runner on a racetrack (in an oval). What must the car/runner do in order to turn? _____

7. Move the object like a car moving forward, then coming to a quick stop. Describe the acceleration vector._____

Part II: Vector Addition Simulation: *Math Tools* → *Vector Addition* `Run Now!`

Place two vectors ![fries icon] 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.

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: Vectors 1 and 2   *The Resultant Vector*

$|R|$ ☐ θ ☐ R_x ☐ R_y ☐ $|R|$ ☐ θ ☐ R_x ☐ R_y ☐

$|R|$ ☐ θ ☐ R_x ☐ R_y ☐

Part III: Calculating Resultant Vectors: *review of vector addition follows*   ***GRADED***

- Find the mathematical sum of each set of vectors below (with a calculator).
- Recreate (as closely as possible) the vectors in the simulation to check your work.
- 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 ($\nearrow$ = -x, -y)
- The resultant vector's X and Y components are the sum of the X and Y's of each vectors: $X_r = X_1 + X_2$
- 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-<u>Graded answers will come from calculations</u>, use sim to check 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

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

#2

Vector 1

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

#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

Conclusion Questions:

1. The blue vector represented _____ and the green represented _____.

2. When the acceleration vector was in the <u>same</u> direction as the velocity vector, the object *slowed down / sped up.*

3. When the acceleration vector was in the <u>opposite</u> direction as the velocity vector, the object *slowed / sped up.*

4. Turning requires the acceleration vector to be ___p _____ (geometry term) to the velocity vector.

5. When a car comes to a stop, the car's brakes create an __a _____ that is in the *same direction / opposite direction* as the velocity vector.