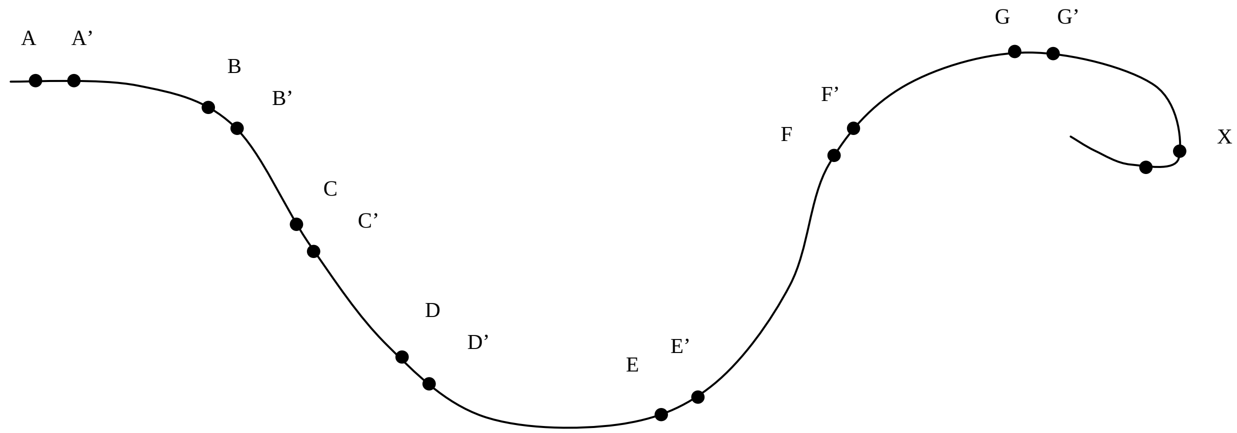
Velocity and Acceleration

Physics 111 Name: ______________________

A. Velocity: $\vec{v} = \Delta\vec{x} / \Delta t = (\vec{x}_f - \vec{x}_i) / \Delta t$.

An object is moving at a ***constant speed*** of 10.0 cm/second along the curved path below. Each of the pairs of dots represents the object at two closely-spaced times. For example, the object is initially at Point A, then at Point A' an ***instant*** later.



[4 pts] On each pair of dots (but ***not*** X and X'), draw an arrow straight from one dot to the next (i.e. from A to A', then B to B', etc). Each ***short*** arrow is the displacement $\Delta\vec{x}$ from one point to the next.

[4 pts] Extend each arrow above until each arrow is exactly 2.0cm long. Each of these ***long*** arrows represents the velocity of the object ***at each starting point***.

The velocity of an object is given by $\vec{v} = \Delta\vec{x} / \Delta t$. Note that this points along the displacement $\Delta\vec{x}$.
The acceleration of an object is given by $\vec{a} = \Delta\vec{v} / \Delta t = (\vec{v}_f - \vec{v}_i) / \Delta t$.

[2 pts] Does the velocity at B have the same magnitude as the velocity at A? yes no (circle one)

[2 pts] Does the velocity at B point in the same direction as the velocity at A? yes no (circle one)

[2 pts] Did the velocity change from A to B? yes no (circle one)

[2 pts] Did the object accelerate between points A and B? yes no (circle one)

Two students have the following disagreement:

Student #1: "I put another point at X' about a centimeter away from X. That should be OK to get the velocity vector at X."

Student #2: "No way norker. Look at point X'. You're going to get the direction wrong if you pick a point that far away from X."

[5 pts] With which student do you agree? State your answer and explain your reasoning below.

Have this answer checked before proceeding.

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Each vector you drew around the curved path starts at one point, and has its direction determined by where the object is just an ***instant*** *later. These vectors lie along the path, parallel to the path at each location. There is one word that describes such vectors: "tangent."*

All velocity vectors are tangents to the path of the object.

B. Linear velocity and acceleration—do this part in your lab table groups

Have two people with croquet mallets at opposite ends of the bowling ball track. The first person will speed the ball up from rest while the second slows it down to a stop.

[4 points] Draw velocity ***and*** acceleration vectors above the ball while it is speeding up ***and*** while it is slowing.

speeding up slowing down

C. Velocity and acceleration in circular motion: $\vec{a} = \Delta\vec{v} / \Delta t = (\vec{v}_f - \vec{v}_i) / \Delta t$.

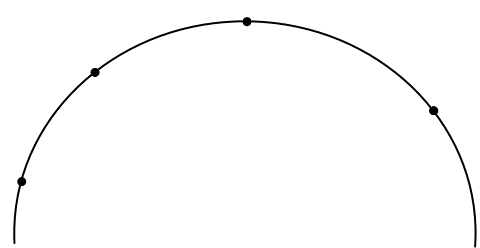
In this part of the lab one or two lab table groups will work together.

In this part of the lab you must keep the bowling ball in the circular path on the floor. One person will launch the ball into the circular path. The rest of the group will be spread around the circle. These people must hit the ball with the mallets so that the ball travels in the circular path between the lines. The ball must travel at a constant speed.

The mallets provide the acceleration for the bowling ball.

[8 pts] On each of the 4 points on the circle below, draw two vectors—one showing the direction of the velocity and one showing the direction of acceleration of the bowling ball. ***<u>Label</u>*** each vector ($\vec{v}$ or $\vec{a}$).

[4 pts] Describe the direction of the acceleration vectors in a phrase.



[4 pts] What is the angle between the velocity and the acceleration?

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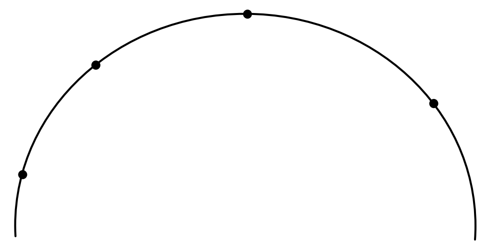
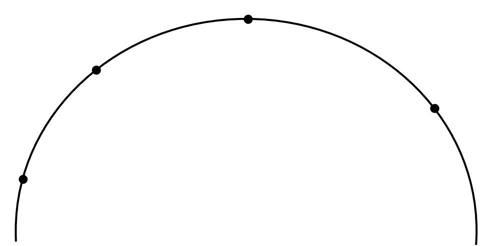
[8 pts] Choose a different person to launch the ball. The other group members must ***increase*** its speed while still following the circular path. On each of the four points below draw an arrow for the velocity and an arrow for the acceleration. ***Label*** each vector (either $\vec{v}$ or $\vec{a}$). Remember to make your velocity vectors the appropriate lengths.

[5 pts] Describe how the angle between this $\vec{v}$ and $\vec{a}$ compare to the angle on the previous page.



[8 pts] Choose a different person to launch the ball. The other group members must ***decrease*** its speed while still following the circular path. On each of the four points below draw an arrow for the velocity and an arrow for the acceleration. ***Label*** each vector (either $\vec{v}$ or $\vec{a}$). Remember to make your velocity vectors the appropriate lengths.

[5 pts] Describe how the angle between this $\vec{v}$ and $\vec{a}$ compare to the angle on the previous page.



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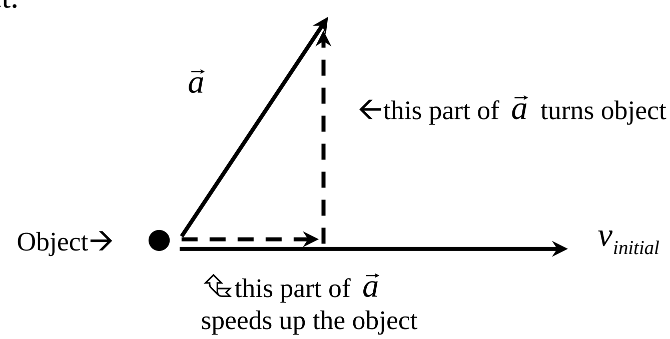
D. Application: $\vec{a} = \Delta\vec{v} / \Delta t$.

On the previous pages you have seen that the direction of the acceleration vector can tell you whether an object is speeding up, slowing down, or turning:

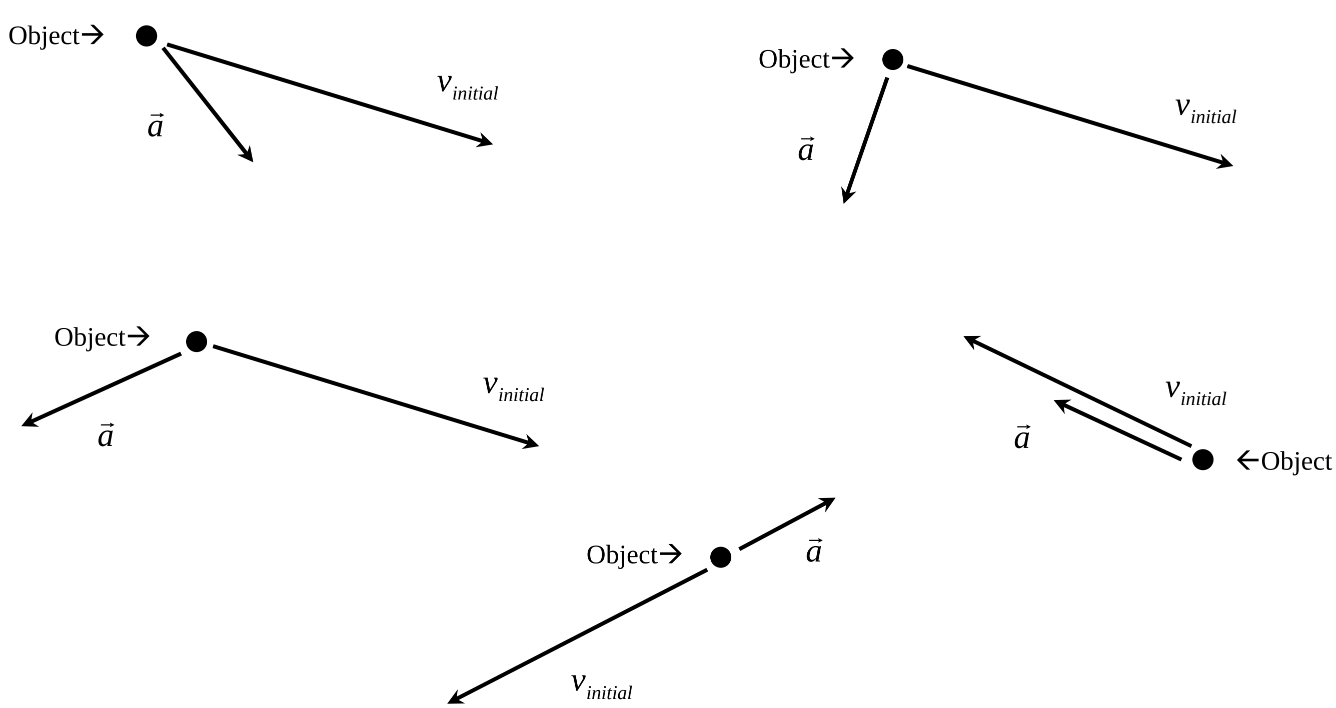
- If part of the acceleration $\vec{a}$ points in the same or opposite direction as the velocity $\vec{v}$, then the object will be speeding up or slowing down.
- If part of $\vec{a}$ is pointed at a 90^0 angle to $\vec{a}$ then this will turn the object.

One example of these two situations is illustrated in the figure below. This acceleration vector has one component along $\vec{v}_{initial}$ and ***speeds the object up.*** But $\vec{a}$ has another component perpendicular to $\vec{v}_{initial}$; this ***turns*** the object.



Notice how comparing these vectors requires them to be tail-to-tail.

[10 pts] Various objects are shown below. The initial velocity vectors $\vec{v}_{initial}$ as well as the acceleration vectors $\vec{a}$ for each object are shown. Use your general rule above to describe the subsequent motion of each object (i.e., whether it is speeding up and turning, only turning, only slowing down, etc.).



Have these answers checked before this in.