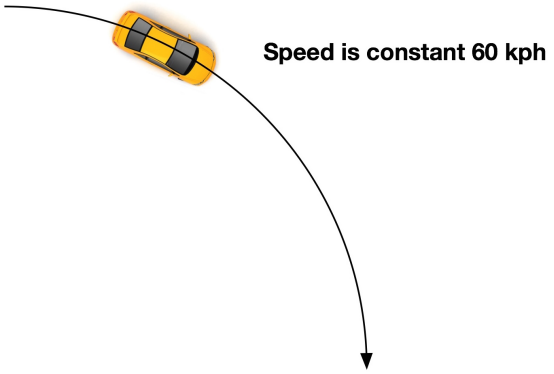
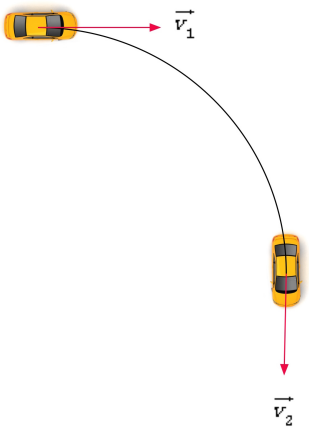
CIRCULAR MOTION

Question: Does a vehicle driving around a curve at a constant speed experience an acceleration?

Consider the following scenario.



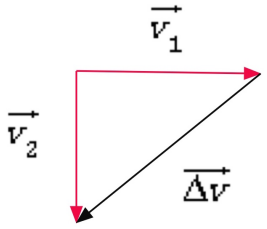
A vehicle is rounding a curve at 60 kph. Its speedometer reads 60 kph during the entire trip. Now let us examine the velocity vector at the top of the curve (12 o'clock position) and at the end of the curve (3 o'clock position.)



The magnitude of both vectors $\vec{v_1}$ and $\vec{v_2}$ is 60 kph.

Acceleration is defined as the change in velocity over time. Since velocity involves a magnitude and a direction, it follows that any change in direction of an object travelling at a constant speed results in a change velocity.

In the above scenario, the vectors $\vec{v_1}$ and $\vec{v_2}$ can be added as follows.



The difference between both velocity vectors is represented by the symbol $\vec{\Delta v}$ where the Greek letter delta (Δ) represents a difference between values. Therefore, if we add vectors $\vec{v_1}$ and $\vec{\Delta v}$, we obtain $\vec{v_2}$.

Given this logic, we can see that there is a change in velocity ($\vec{\Delta v}$) even though the speedometer of the vehicle of the vehicle never changed from 60 kph. Since acceleration is defined as a change in velocity over a corresponding change in time ($\vec{\Delta v} / \vec{\Delta t}$) it follows that the vehicle is accelerating despite the fact that the speed of the vehicle did not change.

If we go one step further, we can observe that the direction of an object is always changing when it is travelling in a circular motion. This leads us to the following conclusion:

ALL circular motion is accelerated motion.