13.1 Accelerating Objects

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$$\frac{m/s}{s}$$

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A batter changes the velocity of a baseball by 55 m/s during 0.003 seconds the bat is in contact with the ball.

$\Delta \vec{v} = 55\ m/s$

$\Delta t = 0.003 s$

$\vec{a} = ?$

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{55 m/s}{0.003 s} = 18\,333\ m/s^2$$

13.1 Accelerating Objects

Acceleration can be calculated using the equation:

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$

A car maker advertises that its car can go from zero to 100 km/h in 3.2 seconds. This a description of acceleration.

13.1 Acceleration as a Vector

Since acceleration is a **vector** quantity, uniform motion means that both the **magnitude** and **direction** of the velocity are constant (acceleration is zero).

If either the magnitude (speed) or the direction change, the object is accelerating.

E.g. Objects moving at constant speed in a circle (merry-go-round, planets) are constantly accelerating

13.1

Acceleration can be positive, negative, or zero

Positive acceleration – increasing velocity, same direction as the moving object

Zero acceleration - uniform motion (velocity stays constant).

Negative acceleration - decreasing velocity, opposite direction of moving object

There is no deceleration!!!

13.1

A car is initially traveling at a velocity of 52 km/h [W]. During a time interval of 15 s, it increases its velocity to 76 km/h [W]. What is the average acceleration of the car?

$\vec{v}_i = 52\,km/h\,[W] = 14.4\,m/s\,[W]$

$\vec{v}_F = 76\,km/h\,[W] = 21.1\,m/s\,[W]$

$\Delta t = 15\,s$

$\vec{a} = ?$

$$\vec{a} = \frac{\vec{v}_F - \vec{v}_i}{\Delta t} = \frac{21.1\,m/s - 14.4\,m/s}{15\,s} = 0.45\,m/s^2\,[W]$$

13.1

~~A cheetah is waiting in the bushes for its prey. At just the right moment, it suddenly begins racing across the field. Within moments, it has~~ reached its maximum velocity of 26 m/s [N]. If its acceleration was 3.1 m/s² [N], how long did the cheetah take to reach its maximum velocity?

$\vec{v}_F = 26 m/s [N]$

$\vec{v}_i = 0 m/s$

$\vec{a} = 3.1 m/s^2$

$\Delta t =$

$\Delta t = \frac{\Delta \vec{v}}{\vec{a}}$

$= \frac{\vec{v}_F - \vec{v}_i}{\vec{a}}$

$= \frac{26 m/s [N]}{3.1 m/s^2 [N]}$

$= 8.4 s$

13.1

A bicycle is moving east along a straight sidewalk. During the 1.7 s interval, the bicycle accelerates at 1.2 m/s² [E]. After the time interval, the bicycle's velocity is 4.3 m/s [E]. What was the bicycle's velocity at the beginning of that time interval?

E (+)

$\Delta t = 1.7 s$

$\vec{a} = 1.2 m/s^2$

$\vec{v}_F = 4.3 m/s [E]$

$\vec{v}_i = ?$

$\vec{v}_i = \vec{v}_F - \vec{a} \Delta t$

$= 4.3 m/s - (1.2 m/s^2)(1.7 s)$

$= 2.3 m/s [E]$