Acceleration: Displacement and Distance

Guided Practice

A car is initially traveling 20 m/s [E]. It then accelerates to 32 m/s [E] in 3.5 seconds.

a) Calculate the acceleration.

$v_0 = 20\ m/s\ [E]$

$v_f = 32\ m/s\ [E]$

$t = 3.5\ s$

$a = ?$

$a = \frac{v_f - v_0}{t}$

$a = \frac{32 - 20}{3.5}$

$= \frac{12}{3.5}$

$a = 3.4\ m/s^2$

b) Calculate the displacement of the car at the end of the acceleration.

Reread question and set up the frame of reference and coordinate system

Frame of reference is relative to the road or a stationary observer outside of the car - this will most often be the case.

Reread question and list known/wanted quantities - include any previously calculate values but only use them if necessary

$v_0 = 20\ m/s\ [E]$ $a = 3.4\ m/s^2$

$v_f = 32\ [E]$ $\vec{d}_0 = 0\ m\ [E]$

$t = 3.5\ s$ $d_f = ?$

Check for a formula using only the known and wanted quantities

Two choices! Which one is more mathematically simple to use?

Think about what we are solving for, then decide.

$$\vec{d}_f = \vec{d}_o + \vec{v}_o t + \frac{1}{2}\vec{a}t^2 \qquad \vec{v}_f{}^2 = \vec{v}_o{}^2 + 2\vec{a}(\vec{d}_f - \vec{d}_o)$$

Substitute values and solve for the unknown

$d_f = 0 + (20)(3.5) + \frac{1}{2}(3.4)(3.5)^2$

$d_f = 70 + 20.8$

$d_f = 90.8\ m$

Check answer conceptually - does its value and direction make sense?

...and now Changing Direction

including how to approach a multi-step problem

The wind changes the velocity of a glider from 25 m/s [E] to 25 m/s [W] in 10 seconds. Calculate the resulting displacement.

Reread question and set up the frame of reference and coordinate system

W,- E,+

Reread question and list known/wanted quantities relative to positive direction

$v_o = 25\ m/s\ [E]$ $d_o = 0\ m\ [E]$

$v_f = -25\ m/s\ [E]$ $d_f = ?$

$t = 10\ s$

Check for a formula using only the known and wanted quantities

error - does not compute

No such formula available :(

Check for a formula that is close, but maybe missing one or two values

Yep → $\vec{d}_f = \vec{d}_o + \vec{v}_o t + \frac{1}{2}\vec{a}t^2$

Check for a formula(s) that solves for a(the) missing value(s) using known quantities

right here $\vec{a} = \frac{\vec{v}_f - \vec{v}_o}{t}$

Substitute values and solve for the unknown

$a = \frac{(-25) - 25}{10} = \frac{-50}{10} = \boxed{-5\ m/s^2}$

Use that value and solve for the unknown in a main (first) equation

$\vec{d}_f = \vec{d}_o + \vec{v}_o t + \frac{1}{2}\vec{a}t^2$

$d_f = 0 + (25)(10) + \frac{1}{2}(-5)(10)^2$

$= 250 + (-2.5)(100)$

$= 250 + (-250)$

$\boxed{d_f = 0\ m}$

Check answer conceptually - does its value and direction make sense?

Attachments

moving-man_all.jar