Acceleration & Displacement

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 average acceleration.

$v_o = 20\ m/s$

$v_f = 32\ m/s$

$t = 3.5\ s$

$a = ?$

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

$a = \frac{32 - 20}{3.5} = \frac{12}{3.5} = \boxed{3.4\ m/s^2}$

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

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

W,- E,+

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

$v_o = 20\ m/s$ $d_f = ?$

$v_f = 32\ m/s$ $d_o = 0\ m$ * Always the case if not given.

$t = 3.5\ s$

$a = 3.4\ m/s^2$

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.

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

Substitute values and solve for the unknown

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

$(0.5)(3.4)(3.5)^2$

$(1.7)(12.25)$

20.8

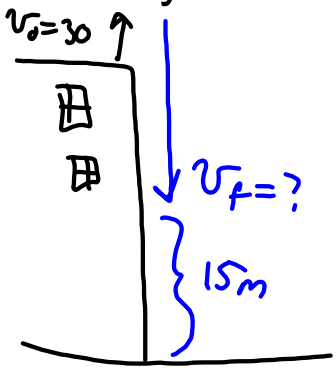
$= 70 + 20.8$

$\boxed{d_f = 90.8\ m}$

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

Extra Practice: Objects Thrown on Earth

A person stands near the edge of a 75 m high building and throws a quarter upwards with an initial velocity of 30 m/s. Calculate the velocity when it is 15 m above the ground.



$v_0 = 30 m/s \quad d_0 = 75 m$

$a = -9.81 m/s^2 \quad d_f = 15 m$

$v_f = ?$

$$v_f^2 = v_0^2 + 2a(d_f - d_0)$$

$$= (30)^2 + 2(-9.81)(15 - 75)$$

$$v_f^2 = 900 - 19.62(-60)$$

$$v_f^2 = 900 + 1177$$

$$v_f^2 = 2077$$

$$v_f = \pm\sqrt{2077}$$

$$v_f = -45.6 m/s$$

↑ because object traveling down.

Attachments

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