Calculating Acceleration

Guided Practice (direction changes)

A baseball is thrown 15 m/s [E] and 5.6 s later it is moving 21 m/s [W]. Calculate the average acceleration of the baseball.

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

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

$v_0 = 15\ m/s\ [E]$

$v_f = -21\ m/s\ [E]$

$t = 5.6\ s$

$a = ?$

Check for a formula using only the known and wanted quantities

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

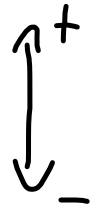
Substitute values and solve for the unknown

$$a = \frac{-21 - 15}{5.6} = \frac{-36}{5.6} = \boxed{-6.4\ m/s^2}$$

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

Extra Practice: Objects Thrown on Earth

A ball is thrown upwards (on Earth). It takes 5.7 seconds for the ball to reach a velocity of 3.4 m/s [up]. a) Calculate the initial velocity and b) the height above the ground.



a) $v_0 = ?$ $\quad a = -9.81\ m/s^2$

$t = 5.7\ s$

$v_f = 3.4\ m/s$ $\quad a = \dfrac{v_f - v_0}{t}$

$\times 5.7$

$-9.81 = \dfrac{3.4 - v_0}{5.7} \times 5.7$

-3.4

$-55.9 = 3.4 - v_0 \quad -3.4$

$-59.3 = -v_0$

$59.3\ m/s = v_0$

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 and time when it is 15 m above the ground.

$d_0 = 75\,m$ $v_f = ?$

$d_f = 15\,m$ $t = ?$

$v_0 = 30\,m/s$ $a = -9.81\,m/s^2$

+ ↑

− ↓

Solve for time

$$d_f = d_0 + v_0 t + \frac{1}{2}at^2$$

$$15 = 75 + 30t - 4.9t^2$$

* rearranging to have positive t^2

$$4.9t^2 - 30t + 15 - 75 = 0$$

$$\frac{4.9t^2}{4.9} - \frac{30t}{4.9} - \frac{60}{4.9} = \frac{0}{4.9}$$

$$t^2 - 6.12t - 12.2 = 0$$

$$t = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$

$$t = \frac{-(-6.12) \pm \sqrt{(-6.12)^2 - 4(1)(-12.2)}}{2(1)}$$

$$t = \frac{6.12 \pm \sqrt{86.25}}{2}$$

$t = 7.7\,s$ and ~~$-1.6\,s$~~ cannot have neg. time

$v_f = ?$

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

$$-9.81 = \frac{v_f - 30}{7.7} \quad (\times 7.7)$$

$$(-9.81)(7.7) = v_f - 30$$

$$-75.5 = v_f - 30 \quad (+30)$$

$$-45.5\,m/s = v_f$$

or

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

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

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

$$v_f^2 = 900 + 1177.2$$

$$v_f^2 = 2077.2$$

$$v_f = \pm\sqrt{2077.2}$$

$$v_f = -45.6\,m/s$$

↑ downward motion

Attachments

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