Group problem #1 score on webCT

H.w & grp problem solutions on
class web page

Physics Action CENTER
Th 5-7 p.m Room 103

Read 2.8

FROM LAST LECTURE

CAN a person accelerate at $6.7\ m/s^2$ for $2.5\ s$?

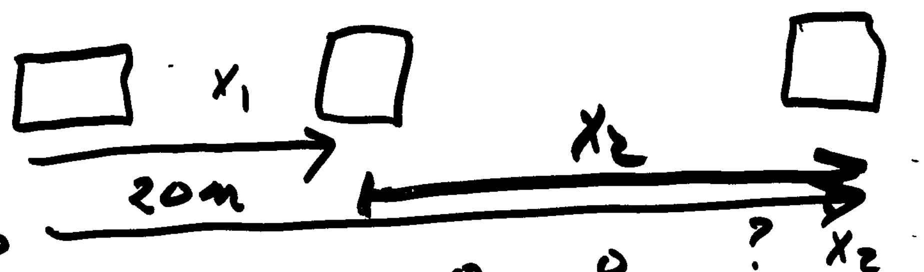
$$V = V_0 + at$$

$$= 0 + (6.7\ m/s^2)(2.5\ s) = 16.8\ m/s$$

WORLD RECORD FOR 100 m DASH IS ~10 S

$$V = \frac{100\ m}{10\ s} = 10\ m/s$$

so Football player running faster at end zone than fastest person in the world ex] A car starts from rest and accelerates at a constant rate in a straight line. In the 1st second it covers 20m. How much additional distance will it cover in the 2nd second?



$v_0 = 0$

x_1

t_1

$x_0 = 0$

$$X = \cancel{X_0}^{\,0} + \cancel{V_0}^{\,0}\, t + \frac{1}{2} a t^2$$

$$X_1 = \frac{1}{2} a t_1^2 \qquad t_1 = 1s$$

$$X_2 = \frac{1}{2} a t_2^2 \qquad t_2 = 2s$$

$$\frac{X_1}{X_2} = \frac{\cancel{\tfrac{1}{2}}\,\cancel{a}\, t_1^2}{\cancel{\tfrac{1}{2}}\,\cancel{a}\, t_2^2} = \frac{1s}{4s}$$

$$X_2 = 4X_1 \qquad X_2 = 4 \cdot 20m = \underline{80m}$$

additional => $80m - 20m = \underline{\underline{60m}}$

Note

many ways to solve this problem
could solve for acceleration
using

$$X = X_0 + V_0 t + \tfrac{1}{2}at^2$$

$X = 20m$
$t = 1s$
$X_0 = 0$
$V_0 = 0$

then put acceleration
into (2nd second)

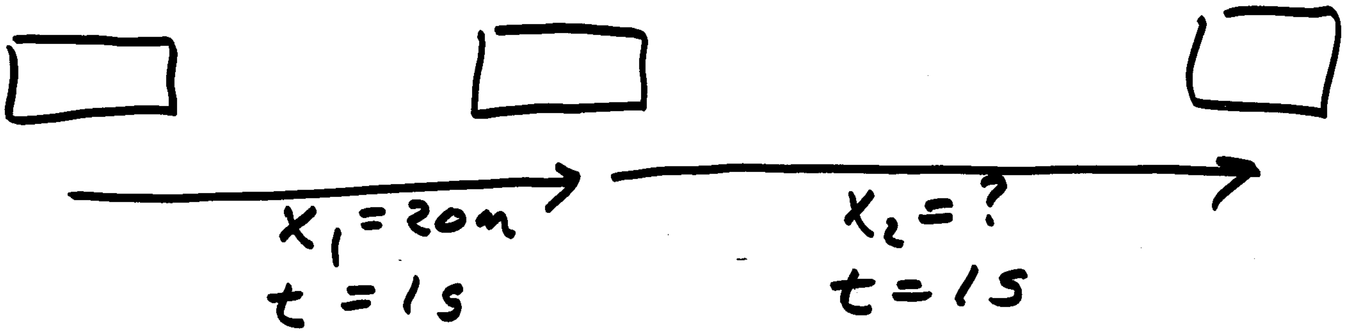
$$X = X_0 + V_0 t + \tfrac{1}{2}at^2$$

$X_0 = 0$
$V_0 = 0$
$t = 2s$

solve for X

At home prove to yourself
that you get same answer

Even more complicated way



solve for acceleration in 1st second

solve for velocity after 1st second

$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

$x_0 = 0$

$v_0 =$

$a =$

solve for x (prove this at home)

much more involved

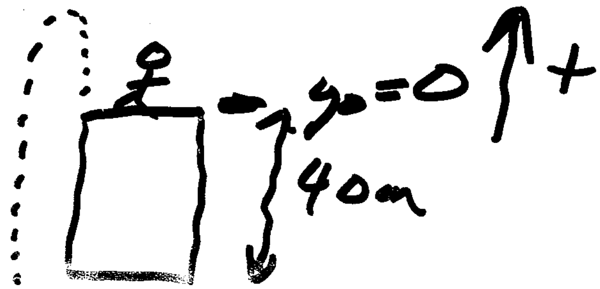
<u>not wrong</u>

ONE OF THE most important cases of constant acceleration is objects near the earth falling

All objects near the surface of the earth fall with a constant acceleration of $\approx 9.8\,m/s^2$

"g"

Equations we have been using for constant acceleration apply to an object in free fall. (ignore AIR RESISTANCE) ex) A boy throws a ball upward with a speed of 10.0 m/s from a building 40.0 m high. How long will it take for the ball to hit the ground?



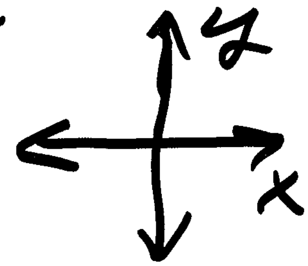
$y = -40\,m$

$t = ?$

$v_0 = 10\,m/s$

$a = -g$

$$x = x_0 + v_0 t + \frac{1}{2}at^2$$



$$y = \cancel{y_0}^{\,0} + v_0 t + \frac{1}{2}at^2$$

$$y = v_0 t + \frac{1}{2}(-g)t^2$$

$$\frac{1}{2}gt^2 - v_0 t + y = 0$$

$$t = \frac{v_0 \pm \sqrt{v_0^2 - 4(\frac{1}{2}g)(y)}}{2 \cdot \frac{1}{2}g}$$

$$= \frac{10.0\,m/s \pm \sqrt{(10.0\,m/s)^2 - 2(9.8\,m/s^2)(-40\,m)}}{9.8\,m/s^2}$$

$$t = -2.01\,s \text{ or } \boxed{4.05\,s}$$

EX A BOY ON A BUILDING OF HEIGHT 50 m THROWS A BALL UPWARD WITH AN INITIAL VELOCITY OF 20 m/s

a) TIME FOR STONE TO REACH MAXIMUM HEIGHT

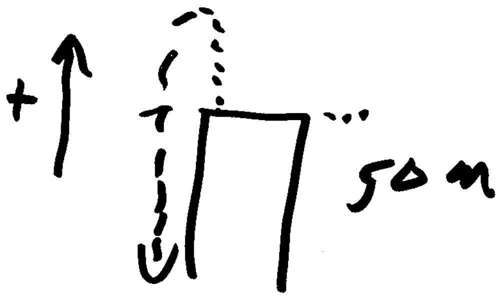
b) MAXIMUM HEIGHT

c) TIME TO REACH LEVEL OF THROWER

d) VELOCITY AT THIS INSTANT

e) VELOCITY AND POSITION OF STONE AFTER 5 s, 10 s

f) VELOCITY WHEN STONE HITS GROUND



$v_0 = 20\,m/s$

$x_0 = 0\,m$

a) max height $v = 0$

$$v = v_0 + at$$

$$0 = v_0 - gt \Rightarrow t = \frac{v_0}{g}$$

$$\frac{20.0\,m/s}{9.8\,m/s^2} = \underline{2.04s}$$

b) $x = x_0 + v_0 t + \frac{1}{2}at^2$

$$0 + (20\,m/s)(2.04s) - \frac{1}{2}g(2.04s)^2$$

$\underline{20.4m}$ from top

c) $x = x_0 + v_0 t - \frac{1}{2}gt^2 \quad x = x_0$

$$0 = v_0 t - \frac{1}{2}gt^2$$

$$t\left[v_0 - \frac{1}{2}gt\right] = 0$$

$t = 0$ or $\underline{v_0 - \frac{1}{2}gt = 0}$

$$20\,m/s - \frac{1}{2}(9.8\,m/s^2)\,t = 0$$

$$\underline{t = 4.08s}$$

d) velocity $V = V_0 - gt$

$$V = (20\,m/s) - (9.8\,m/s^2)(4.08\,s)$$

$$= \underline{-20\,m/s}$$

e) $x = x_0 + V_0 t - \frac{1}{2} g t^2$

$$x = 0 + (20\,m/s)(5\,s) - \frac{1}{2}(9.8\,m/s^2)(5\,s)^2$$

$$= \underline{-22.5\,m}$$

$$V = V_0 - gt$$

$$20\,m/s - (9.8\,m/s^2)(5\,s)$$

$$= \underline{-29.0\,m/s}$$

f) $V^2 = V_0^2 + 2a(x - x_0)$

$$V^2 = (20\,m/s)^2 - 2g(-50\,m)$$

$$\underline{V = -37\,m/s}$$

d) $V = V_0 - g t$

$V = (20 m/s) - (9.8 m/s^2)(4.08 s)$

$\boxed{V = -20 m/s}$ note same magnitude opposite direction

e) $X = \cancel{X_0}^{0} + V_0 t - \frac{1}{2} g t^2$ after 5s

$X = (20 m/s)(5s) - \frac{1}{2}(9.8 m/s^2)(5s)^2$

$\boxed{= -22.5 m}$

$V = V_0 - g t$

$= 20 m/s - (9.8 m/s^2)(5s)$

$\boxed{= -29.0 m/s}$

f) $V^2 = V_0^2 + 2a(X - X_0)$

$V^2 = V_0^2 - 2g(X - X_0)$

$V^2 = (20 m/s)^2 - 2g(-50 m)$

$\boxed{V = -37 m/s}$

If you drop a brick from a building in the absence of air resistance, it accelerates downward at 9.8 m/s^2. If instead you throw it downward, its downward acceleration after release is

A) less than 9.8 m/s^2

B) 9.8 m/s^2

C) more than 9.8 m/s^2

D) impossible to determine with the information given

Interactive Question

Ball **A** is dropped from a window. At the same instant, ball **B** is thrown downward and ball **C** is thrown upward from the same window. Which statement concerning the balls is necessarily true if air resistance is neglected?

A) At one instant, the acceleration of ball **C** is zero.
B) All three balls strike the ground at the same time.
C) All three balls have the same velocity at any instant.
D) All three balls have the same acceleration at any instant.
E) All three balls reach the ground with the same velocity.

Interactive Question

A person standing at the edge of a cliff throws one ball straight up and another ball straight down at the same initial speed. Neglecting air resistance, the ball that hits the ground below the cliff with the greater speed is the one initially thrown

A) upward
B) downward
C) neither, they both hit at the same speed.
D) It is impossible to tell with the information given.

Interactive Question

Two balls are thrown straight up. The first is thrown with twice the initial speed of the second. Ignore air resistance. How much longer will it take for the first ball to return to earth?

A) $\sqrt{2}$ times as long.
B) Twice as long.
C) Three times as long.
D) Four times as long.
E) Eight times as long.