Finish reading chp 2
(if haven't already)

Nasa feather/hammer on moon on class web site

Check clicker registration
if not registered, send me email with information

4 Kinematic Equations

① $v = v_0 + at$

② $x = x_0 + \frac{1}{2}(v_0 + v)t$

③ $x = x_0 + v_0 t + \frac{1}{2}at^2$

④ $v^2 = v_0^2 + 2a(x - x_0)$

only use if <u>$a = $ constant</u>

Note if $a = 0$

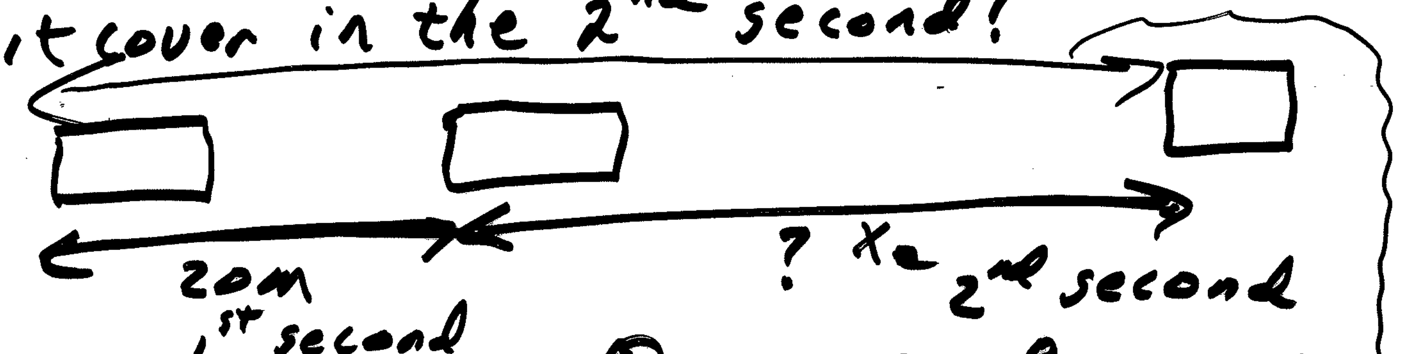
① $v = v_0$

② $x = x_0 + vt$

③ $x = x_0 + vt$

④ $v = v_0$

ex) A car starts from rest and accelerates at a constant rate in a straight line. In the 1st second it covers 20 m. How much additional distance will it cover in the 2nd second?



$v_0 = 0\ m/s$

$X_{1s} = 20m$

$t_1 = 1s$

$X_0 = 0$

(1) $X = \cancel{X_0}^{0} + \cancel{v_0}^{0} t + \frac{1}{2}at^2$

$X_1 = \frac{1}{2}at_1^2 \qquad t_1 = 1s$

$X_2 = \frac{1}{2}at_2^2 \qquad t_2 = 2s$

take ratio: $\frac{X_1}{X_2} = \frac{\cancel{\frac{1}{2}a}t_1^2}{\cancel{\frac{1}{2}a}t_2^2} = \frac{t_1^2}{t_2^2} = \frac{1}{4}$

$X_2 = 4X_1$

$X_1 = 20m$

$X_2 = 80m$

Final answer = 80m − 20m = 60m

Note

many ways to solve this problem
could solve for acceleration
using

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

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

then put acceleration
into (2nd second)

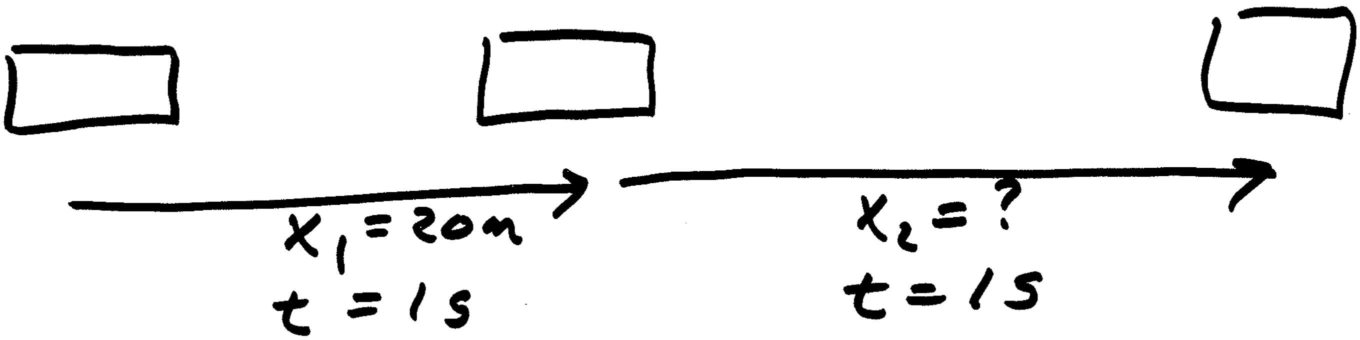
$$X = X_0 + V_0 t + \frac{1}{2} a t^2$$

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

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

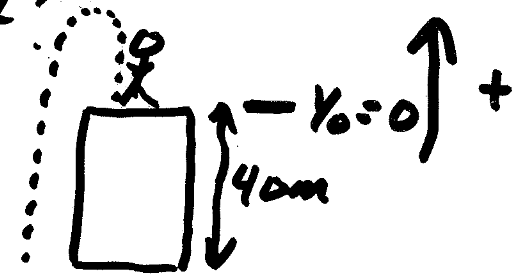
<u>not wrong</u>

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 $\sim 9.8\,m/s^2$

"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 meter high. How long will it take for the ball to hit the ground?



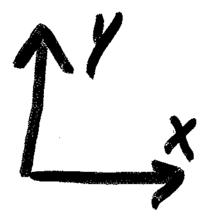
$y = -40\,m$

$t = ?$

$V_0 = 10\,m/s$

$a = -g$

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



$$y = Y_0 + V_0 t + \frac{1}{2} a t^2$$

$$y = 0 + V_0 t + \frac{1}{2}(-g) t^2$$

$$\frac{1}{2} g t^2 - V_0 t + y = 0$$

$$t = \frac{V_0 \pm \sqrt{V_0^2 - 4\left(\frac{1}{2} g\right)(y)}}{2 \cdot \frac{1}{2} g}$$

$$t = \frac{10\,m/s \pm \sqrt{(10\,m/s)^2 - 2(9.8\,m/s^2)(-40\,m)}}{9.8\,m/s^2}$$

$t = -2.01\,s$

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

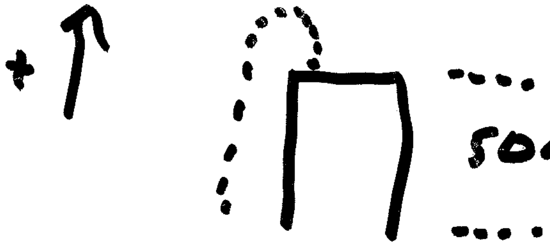
b) MAXIMUM HEIGHT

c) TIME TO REACH LEVEL OF THROWER

d) VELOCITY AT THIS INSTANT

e) VELOCITY AND POSITION OF STONE AFTER 5 s, [redacted]

f) VELOCITY WHEN STONE HITS GROUND



$V_0 = 20\,m/s$
$Y_0 = 0\,m$

a) max height $V = 0$

$$V = V_0 + at$$

$$0 = V_0 + (-g)t \Rightarrow t = \frac{V_0}{g}$$

$$t = \frac{20\,m/s}{9.8\,m/s^2} = \boxed{2.04\,s}$$

b) $\underline{y} = Y_0 + V_0 t + \frac{1}{2}at^2$

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

$\boxed{20.4\,m \text{ from top}}$

c) $Y = Y_0 + V_0 t + \frac{1}{2}at^2$ $\qquad \underset{Y_0}{Y} = Y_0 = 0$

$$0 = 0 + V_0 t + \frac{1}{2}(-g)t^2$$

$$0 = t\left[V_0 - \frac{1}{2}gt\right] \quad t = 0 \text{ or}$$

$$\underline{V_0 - \frac{1}{2}gt = 0}$$

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

$\boxed{t = 4.08\,s}$

d) velocity

$$v = v_0 + at$$

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

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

e) $$y = y_0 + v_0 t - \frac{1}{2} g t^2$$

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

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

$$v = v_0 - g t$$

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

$$= \underline{-29\,m/s}$$

f) $$v^2 = v_0^2 + 2a(y - y_0)$$

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

$$\boxed{v = -37\,m/s}$$