no class next Sun. Oct. 11

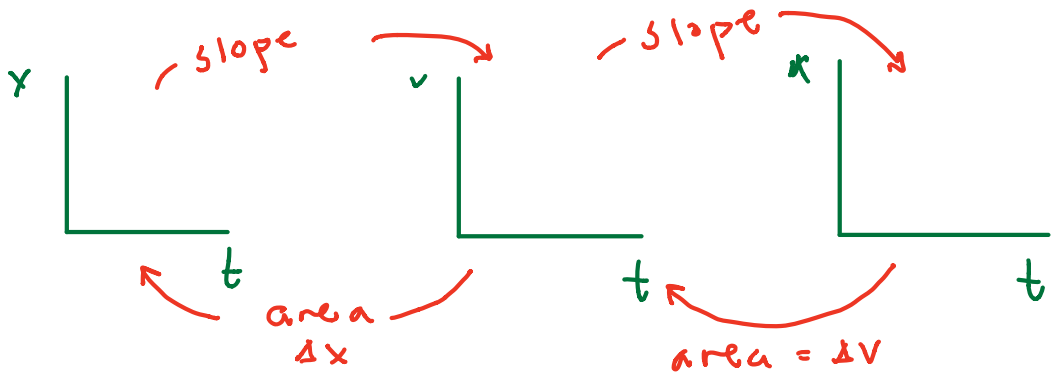
Kinematics

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

$$v = v_0 + a \Delta t$$

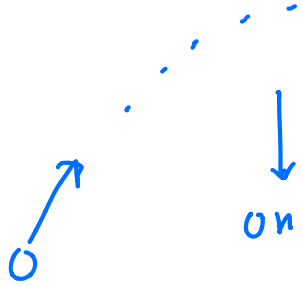
$$v^2 = v_0^2 + 2 a \Delta x$$

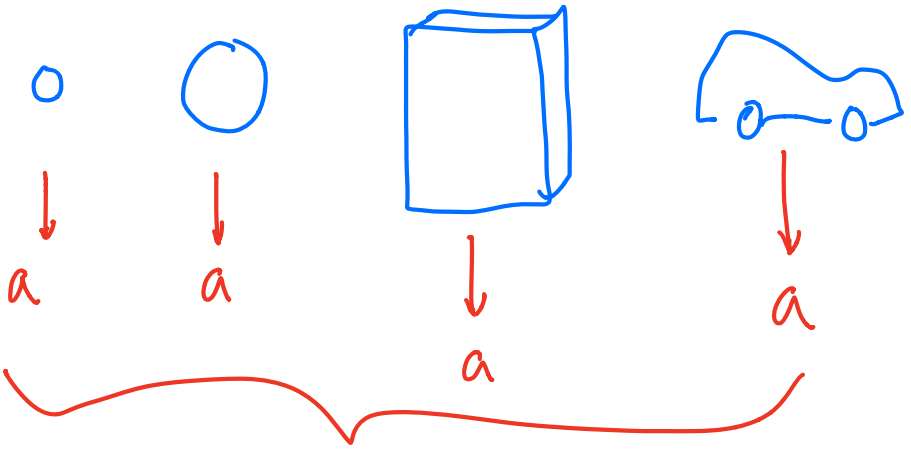
$$\bar{v} = \frac{v_0 + v}{2} = \frac{\Delta x}{\Delta t}$$



Free Fall

motion under the influence of ONLY gravity





the same acceleration

near Earth's surface

$a = 9.8\ m/s^2$ DOWN

g = the acceleration due to gravity (magnitude)

$g_{Earth} = 9.8\ m/s^2$

$g_{moon} = 1.6\ m/s^2$

an object is dropped. How far does it fall in 3s?

↳ $v_0 = 0$ m/s

$v_0 = 0$ m/s

$v =$

$a = 9.8$ m/s^2

$\Delta t = 3$ s

$\Delta x = ?$

$\Delta x = v_0 \Delta t + \frac{1}{2} a \Delta t^2$ ($v_0 \Delta t \to 0$)

$= \frac{1}{2}(9.8 \text{ m/s}^2)(3\text{s})^2$

$= 44.1$ m (45 m if $a = 10$)

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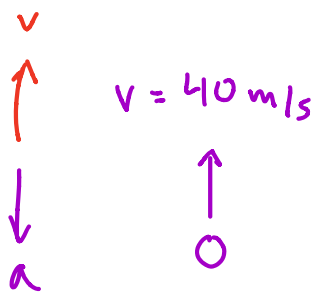
use $g = 10$ m/s^2

How high does it reach?



$v_0 = +40$ m/s

$v = 0$ at top

$a = -10$ m/s^2

$\Delta t =$

$\Delta x = ?$

$v^2 = v_0^2 + 2a\Delta x$

$0 = (40 \text{ m/s})^2 + 2(-10 \frac{\text{m}}{\text{s}^2})(\Delta x)$

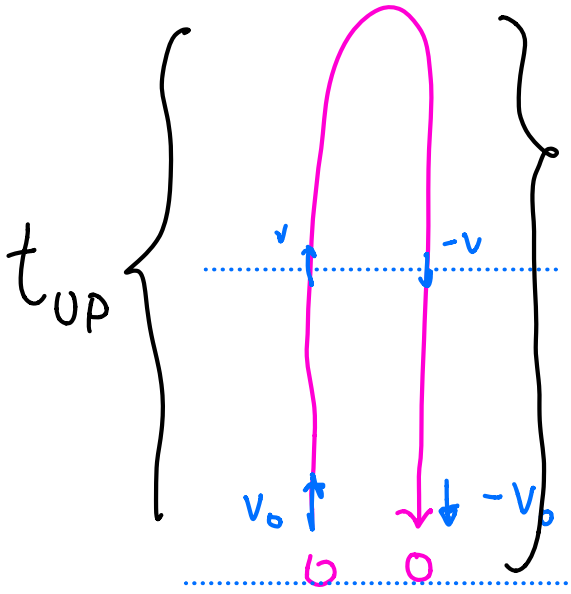
$\frac{-1600 \text{ m}^2/\text{s}^2}{-20 \text{ m/s}^2} = 80$ m

How long to reach highest point? $v = v_0 + a\Delta t$

$0 = 40 \text{ m/s} + (-10 \text{ m/s}^2)\Delta t$

$\Delta t = 4$ s

SYMMETRY in free fall



at points @ same height speeds will be the same

← returns at same speed thrown up at

$$t_{up} = t_{down}$$

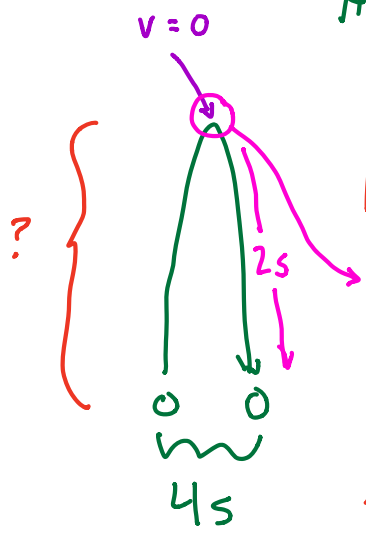
$a = g$ (downward) the ENTIRE path

at highest point: $v = 0$

$a = g$ (down)

An object thrown up returns to its original height 4s later.

How high did it go?



$v_0 = 0$ m/s (looking from top to bottom)

$v =$

$a = +9.8\ m/s^2$

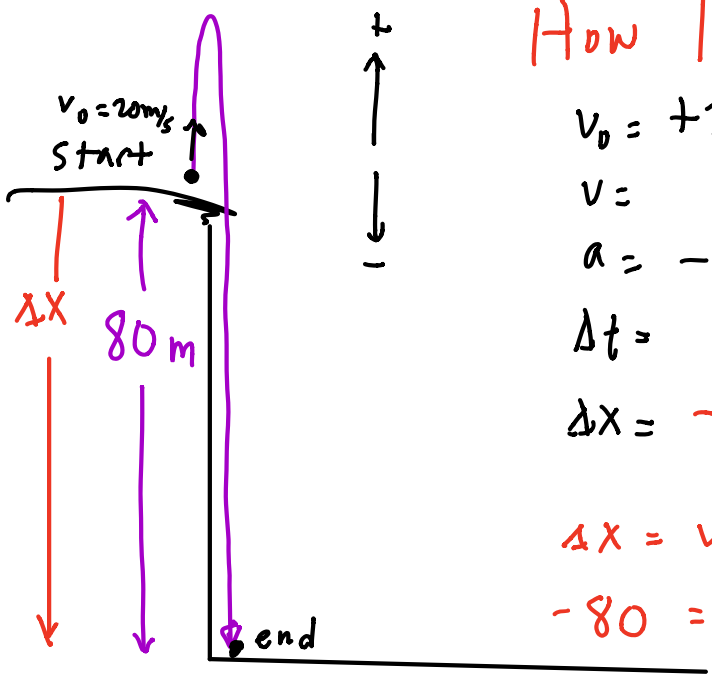
$\Delta t = 2s$

$\Delta x =$

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

$$= 0 + \frac{1}{2}\left(9.8 \frac{m}{s^2}\right)(2s)^2$$

$$= 19.6\ m$$



How long in the air?

$v_0 = +20$ m/s

$v =$

$a = -9.8\ m/s^2$

$\Delta t =$

$\Delta x = -80\ m$

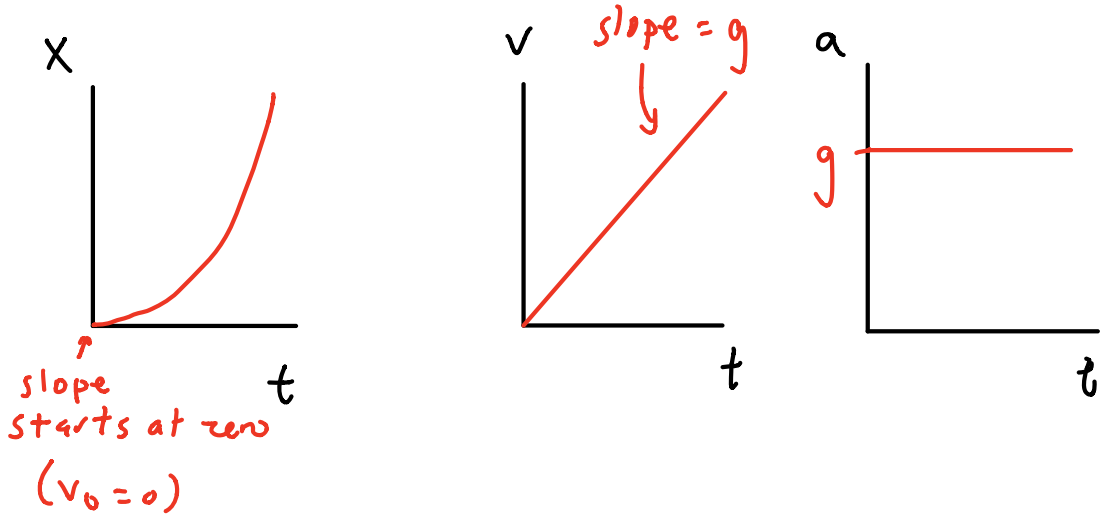
$$\Delta x = v_0 \Delta t + \frac{1}{2} a \Delta t^2$$

$$-80 = 20t - 4.9t^2$$

quadratic

Graphing Free Fall

Dropped ($v_0 = 0$ down is + direction)



Thrown up & returns to same height

(up is +)