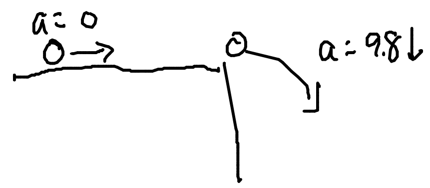
Constant Acceleration Problems in 1D

e.g. free fall $\quad a = 9.8\,m/s^2 \downarrow$

(ignoring air resistance)

e.g. constant (or zero) force



Five variables which are interesting in these problems

$x_f - x_i = \Delta x$ displacement (or Δy or Δz)

Δt time interval

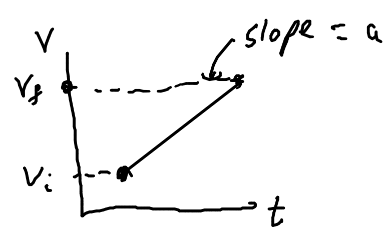
V_{xi} initial velocity

V_{xf} final velocity

a_x acceleration

Average velocity $\quad \bar{V}_{avg} = \frac{\Delta x}{\Delta t} \rightarrow \Delta x = V_{avg}\,\Delta t$

If v is constant, $\quad V_{avg} = V$



$V_{avg} = \frac{1}{2}(V_i + V_f)$ if a is constant

$\boxed{\Delta x = \frac{1}{2}(v_i + v_f)\,\Delta t}$ Kinematic Equation #1

$a = \frac{\Delta V}{\Delta t} = \frac{V_f - V_i}{\Delta t} \longrightarrow \boxed{V_f = V_i + a\,\Delta t}$ #2

Two independent equations & 5 variables

Can solve for 2 variables

Need to be given 3.

KINEMATIC EQUATIONS

Δx
V_{xi}
V_{xf}
a_x
Δt

$\Delta x = \frac{1}{2}(V_{xi} + V_{xf})\Delta t$ (no a_x)

$V_{xf} = V_{xi} + a_x\,\Delta t$ (no Δx)

$\Delta x = V_{xi}\,\Delta t + \frac{1}{2}a_x(\Delta t)^2$ (no V_{xf})

$\Delta x = V_{xf}\,\Delta t - \frac{1}{2}a_x(\Delta t)^2$ (no V_{xi})

$V_{xf}^2 = V_{xi}^2 + 2a_x\,\Delta x$ (no Δt)

e.g. A car speeds up from 2 m/s to 5 m/s in 3s. with constant acceleration.

How far did it go?

Whaddya know, whaddya need?

Δx = NEED

$v_{xi} = 2\,m/s$

$v_{xf} = 5\,m/s$

a_x = DKDC

$\Delta t = 3s$

Pick equation w/o a.

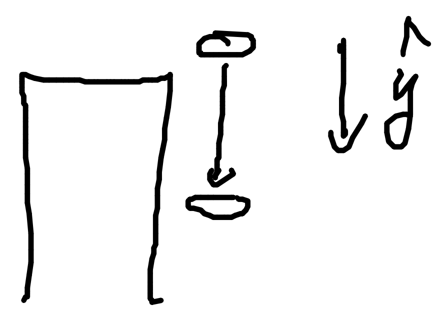
$$\Delta x = \tfrac{1}{2}(v_i + v_f)\Delta t$$

$$\Delta x = \tfrac{1}{2}(2+5)(3)$$

$$= \tfrac{1}{2}(7)(3) = \boxed{10.5\,m}$$

Drop a penny from a building.

How far does it fall in 2s?



Δy = NEED

$v_i = 0$ "drop" = initial velocity 0

v_f = DKDC

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

$\Delta t = 2s$

$$\Delta y = v_i \Delta t + \tfrac{1}{2}a(\Delta t)^2$$

$$\Delta y = 0 + \tfrac{1}{2}(9.8)(2)^2$$

$$= \boxed{19.6\,m}$$