1 DIMENSIONAL MOTION

- Position, Distance and Displacement

- Speed vs Velocity & Average vs Instantaneous

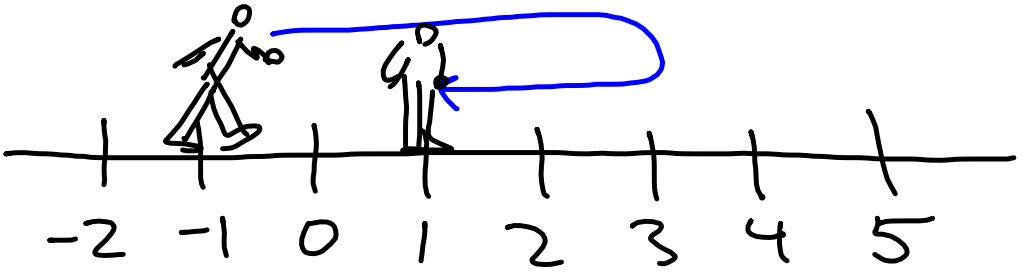
- xva - graphs & calculus

- The equations of kinematics

- Free Fall

- Example probs

- Position, Distance and Displacement



distance = $4_m + 2_m$

always (+)

$\boxed{6m}$

displacement

$\Delta X = X - X_0$

$X = 1$

$X_0 = -1$

$\Delta X = 1 - (-1)$

$= 2m$

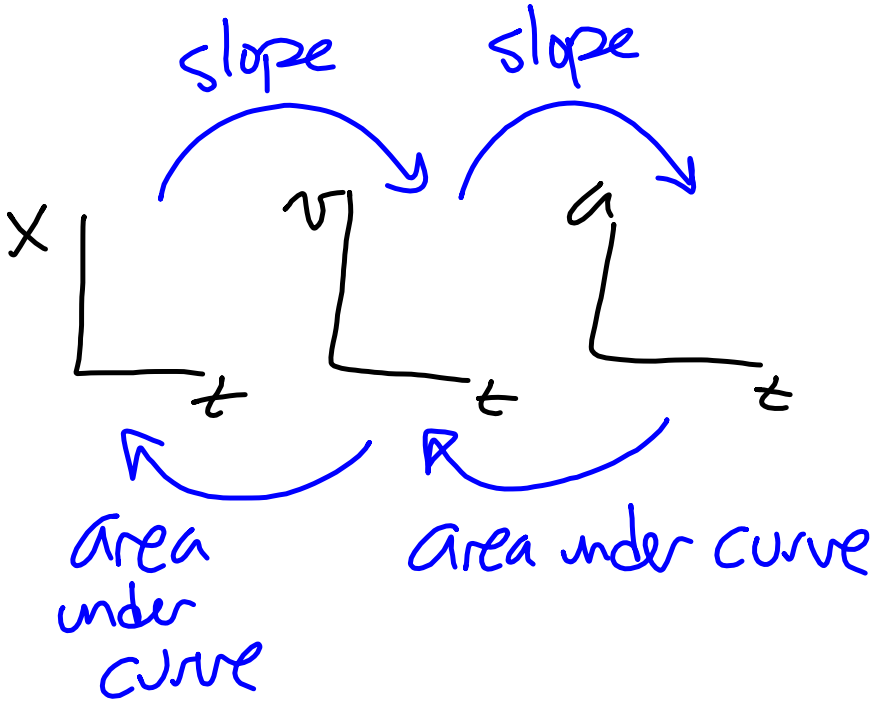
- **Speed vs Velocity**

$$\text{speed} = \frac{d}{t}$$

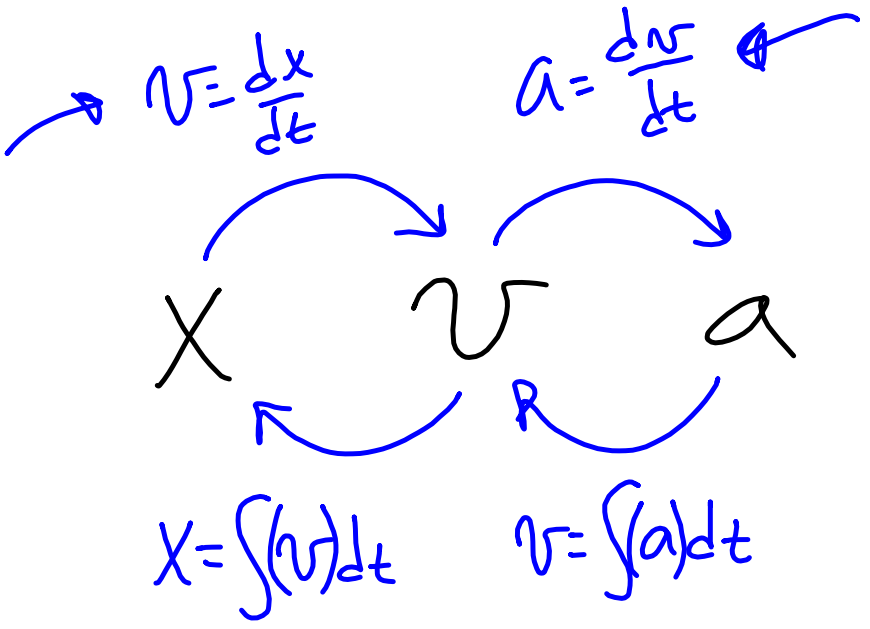
$$v_{avg} = \frac{\Delta x}{\Delta t} = \bar{v}$$

$$a_{avg} = \frac{\Delta v}{\Delta t} = \bar{a}$$

xva relations: graphically



xva relations: calculus



The equations of kinematics

Only use if acceleration is constant!

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

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

$$x = x_0 + \tfrac{1}{2}(v + v_0)t$$

$$\Delta x = \tfrac{1}{2}(v + v_0)t$$

$$v = v_0 + at$$

$$\Delta v = at$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

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

$$\Delta x = x - x_0$$

accel of gravity

$-9.8 \frac{m}{s^2} \hat{j}$ (webassign & lab)

$-10 \frac{m}{s^2} \hat{j}$ (everything else)

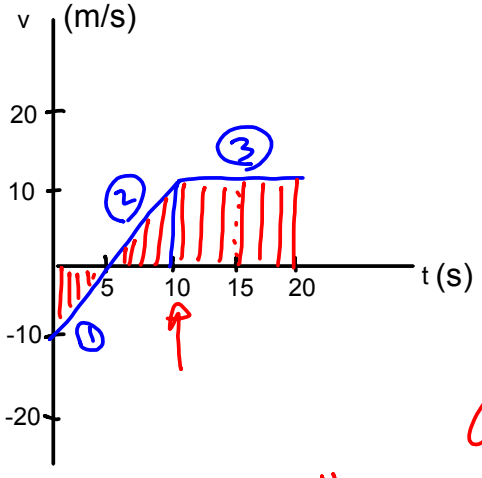
Free Fall

When can you use 9.8 or 10 m/s/s as the accel?

When an object is in Free Fall

- Gravity is the only force acting.
- No Drag.
- No Friction.
- No Tension.
- No Normal.

(etc)



a) Find accel at t = 5 s

b) Find accel t = 15 s

c) Find Δx from t = 0 to t = 20 s

a) $v(5s)$ = slope at 5s.

$a = \frac{\Delta v}{\Delta t} = \frac{10\frac{m}{s} - (-10\frac{m}{s})}{10s - 0s}$

$= \frac{20\frac{m}{s}}{10s}$

$= 2\frac{m}{s^2}$

b) $a(15s) = 0$

c) Δx = area "under" the curve

$t = 0$ to $t = 5s$

$\Delta x_1 = \frac{1}{2}(5s)(-10\frac{m}{s})$

$= -25m$

$\Delta x_2 = \frac{1}{2}(5s)(10\frac{m}{s})$

$= 25m$

$\Delta x_3 = (10s)(10\frac{m}{s})$

$= 100m$

$\Delta x = \Delta x_1 + \Delta x_2 + \Delta x_3$

$= -25m + 25m + 100m$

$= 100m$

A train traveling at 5 m/s undergoes a constant acceleration up to 25 m/s over the course of 10 seconds.

a) What was the train's acceleration?

b) How far did the train travel during the 10 seconds?

$v_0 = 5\ \frac{m}{s}$

$v = 25\ \frac{m}{s}$

$\Delta t = 10\ s$

$a = ?$

$\Delta x = ?$

$v = v_0 + at$

$25 = 5 + a(10)$

$20 = a(10)$

$2\ \frac{m}{s^2} = a$

b) $\Delta x = \frac{1}{2}(v + v_0)t$

$\Delta x = \frac{1}{2}(5\ \frac{m}{s} + 25\ \frac{m}{s})(10\ s)$

$= \frac{1}{2}(30\ \frac{m}{s})(10\ s)$

$= (15\ \frac{m}{s})(10\ s)$

$= 150\ m$

$$v = 5 - 6t^2$$

The equation above describes the velocity of an object (v is in m/s and t is in s). The object starts at x= -1 meters

a) Find x(t)

b) Find a(t)

c) Find average velocity between t = 0 and t = 2 s

d) Find velocity at t = 1 s

a) $x = \int (v)\,dt = \int (5 - 6t^2)\,dt$

$= \int (5)\,dt + \int (-6t^2)\,dt$

$= 5t + \frac{-6t^3}{3} + x_0$

$\boxed{x(t) = -1 + 5t - 2t^3}$

b) $a = \frac{dv}{dt} = \frac{d}{dt}(5 - 6t^2) = -12t$

$\boxed{a(t) = -12t}$

c) $\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x(2) - x(0)}{2 - 0} = \frac{-7\text{m} - (-1\text{m})}{2\text{s}} = \frac{-6\text{m}}{2\text{s}}$

$\boxed{= -3\frac{\text{m}}{\text{s}}}$

$x(t) = -1 + 5t - 2t^3$

$x(2) = -1 + 5(2) - 2(2)^3$

$= -1 + 10 - 16$

$= -7\text{m}$

$x(0) = -1 + 5(0) - 2(0)^3$

$= -1$

d) $v = 5 - 6t^2$

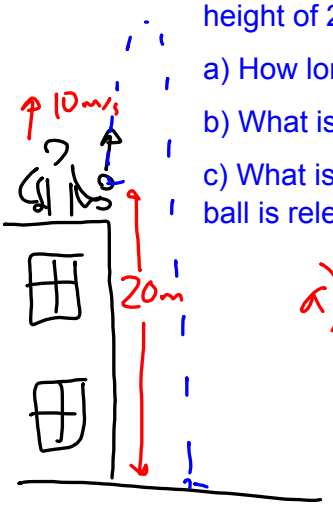
$v(1) = 5 - 6(1)^2 = \boxed{-1\frac{\text{m}}{\text{s}}}$

A ball is thrown upward at 10 m/s from an initial height of 20 m above the ground.

a) How long before it reaches its max height?

b) What is its max height above the ground?

c) What is the total elapsed time from when the ball is released to when it strikes the ground.



a) $v_0 = 10\ \frac{m}{s}$ $\quad v = v_0 + at$

$v = 0\ \frac{m}{s}$ $\quad 0 = 10 + (-10)t$

$a = -10\ \frac{m}{s^2}$ $\quad -10 = -10t$

$t = ?$ $\quad$ $1s = t$

$\Delta y = ?$

b) $v^2 = v_0^2 + 2a\Delta y$

$0 = (10)^2 + 2(-10)\Delta y$

$0 = 100 - 20\Delta y$

$-100 = -20\Delta y$

$5m = \Delta y$ $\longrightarrow$ $y_0 = 20m$ $\therefore$ $y = 25m$

c) $y_0 = 20m$ $\quad y = y_0 + v_0 t + \frac{1}{2}at^2$

$y = 0m$

$v_0 = 10\ \frac{m}{s}$ $\quad 0 = 20 + 10t + \frac{1}{2}(-10)t^2$

$a = -10\ \frac{m}{s^2}$ $\quad 0 = 20 + 10t - 5t^2$

$t = ?$ $\quad 0 = 4 + 2t - t^2$

$t = -1.23\ sec$ or $3.23\ sec$