Tuesday, August 30, 2022 3:44 PM

Dynamics - branch of mechanics that focuses on the motion of bodies under the action of forces

- statics (bodies at rest)
- ★ dynamics (bodies in motion) } rigid bodies
- strength of materials (deformable bodies)
- fluids

Particles - an object of negligible dimension

rigid body - do not deform but they have dimensions

Newton's 2nd Law of MOTION $\bar{F} = m\bar{a}$

	SI	English
time	s	s
mass	kg	slug
length	m	ft
force	N	lb ★
gravity	$9.81\ m/s^2$	$32.2\ ft/s^2$

memorize

★ if given kg multiply by gravity to get force

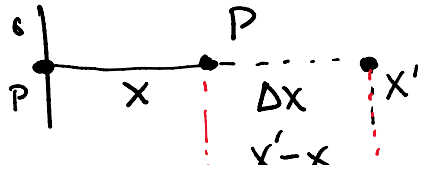
if given lb you need to divide by gravity to get mass

$F = ma$

$[N] = [kg]\left[\frac{m}{s^2}\right]$

Rectilinear Motion (Motion in 1D)

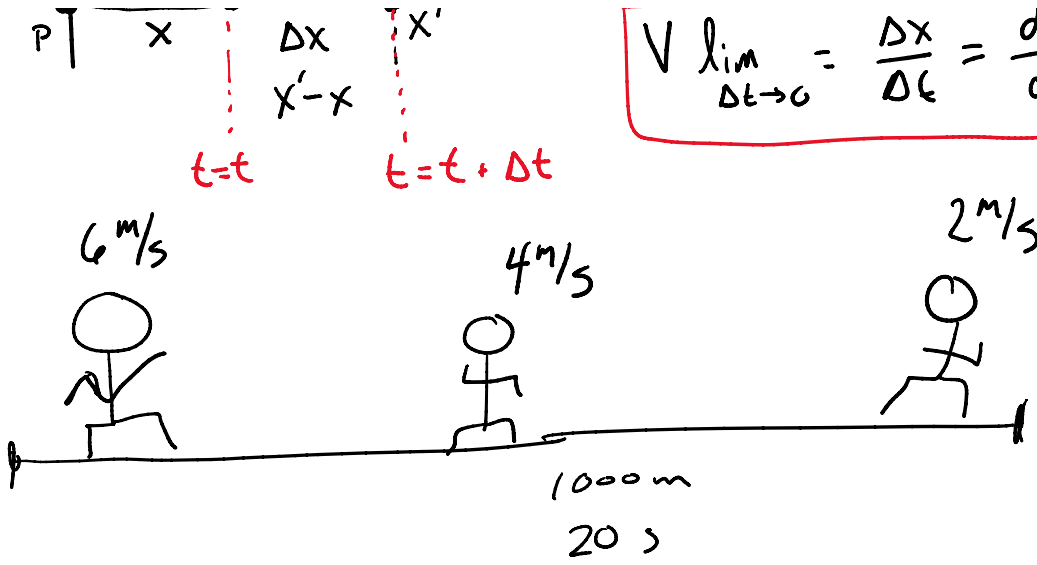
Velocity



$V_{AVG} = \frac{\Delta x}{\Delta t}$

Instantaneous Velocity

$V \lim_{\Delta t \to 0} = \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$



$$V \lim_{\Delta t \to 0} = \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

$$V_{AVG} = \frac{1000m}{20s} = 5\,m/s$$

Acceleration

$$a_{AVG} = \frac{\Delta v}{\Delta t}$$

Instantaneous Acceleration

$$a \lim_{\Delta t \to 0} = \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$$

All valid

$$a = \frac{d^2x}{dt^2} \qquad a = v\frac{dv}{dx}$$

If acceleration is constant

① $V_f = V_0 + at$

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

③ $V_f^2 = V_0^2 + 2a(x_f - x_0)$

Kinematic equations of motion only valid when a is constant

Memorize

Dynamics

Sunday, May 8, 2022 11:39 AM

Example 1

The motion of a particle is given by the equation $x = t^3-9t^2+24t-8$ in

A) Determine when v = 0

B) The Position and total distance traveled when a = 0

$$V = \frac{dx}{dt} = \frac{d(t^3-9t^2+24t-8)}{dt} = \overbrace{3t^2-18t+24}^{V}$$

$0 = 3t^2-18t+24$

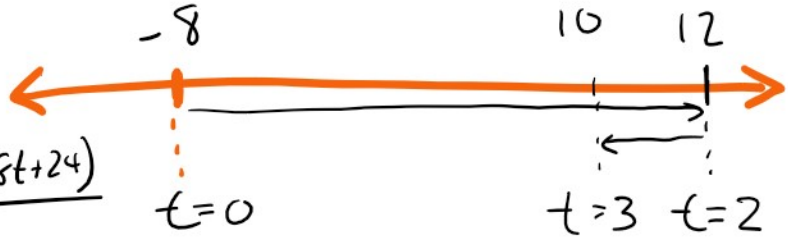
$0 = t^2-6t+8$

$t = 2, 4s$

$$a = \frac{dv}{dt} = 6t-18 \qquad \frac{dv}{dt} = \frac{d(3t^2-18t+24)}{dt}$$

$0 = 6t-18$

$t = 3s$



plug 3s into x equation Position

$x(3) = 3^3-9(3)^2+24(3)-8 = 10$ in

Total Distance

x @ $t = 0$ } plug into x eq $x = -8$ in

$t = 2$ $x = 12$ in

$t = 3$ $x = 10$ in

~~$t = 4$~~ past end

total distance = 20 + 2 = 22 in

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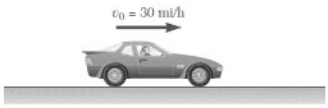
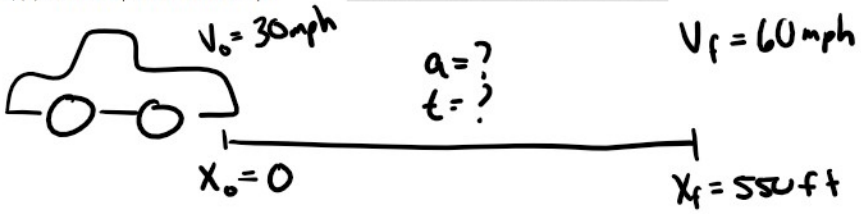
A motorist enters a freeway at 30 mph and accelerates uniformly to 60 mph. From the odometer in the car, the motorist knows that she travelled 550ft while accelerating. Determine (a) the acceleration of the car, (b) the time required to reach 60 mph





$$\left(\frac{30\,mi}{hr}\right)\left(\frac{5280\,ft}{1\,mi}\right)\left(\frac{1\,hr}{3600\,s}\right) = 44\,ft/s \leftarrow V_0$$

$$\frac{60\,mi}{hr} = 88\,ft/s \; V_f$$

a) $V_f^2 = V_0^2 + 2a(X_f - X_0)$

$88^2 = 44^2 + 2a(550 - 0)$

$a = 5.28\,ft/s$

b) $V_f = V_0 + at$

$88 = 44 + 5.28t$

$t = 8.3s$

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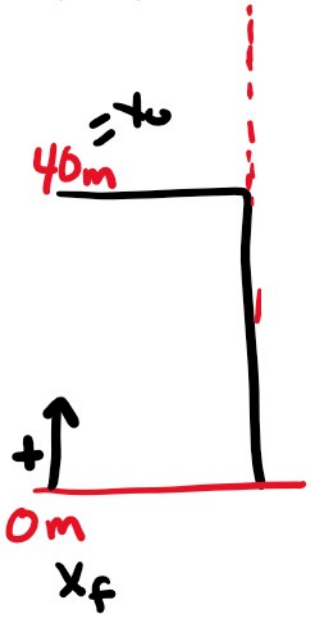
Example 3

A stone is thrown vertically upward from a point on a bridge located 40m above the water. Knowing that it strikes the water 4s after release, determine, a) the speed with which the stone was thrown upward. B) The speed with which the stone strikes the water.

$V_0 = ?$

$V_f = ?$



$\downarrow g$

$t = 4s$

$a = -g = -9.81 \, m/s^2$

a) $x = x_0 + V_0 t + \frac{1}{2} a t^2$

$0 = 40 + V_0(4) + \frac{1}{2}(-9.81)(4)^2$

$V_0 = 9.62 \, m/s$

b) $V_f = V_0 + at$

$= 9.62 + (-9.81)(4)$

$= -29.6 \, m/s$

$= 29.6 \, m/s \downarrow$