1

1-03-44

Linear motion: $v(0) = 0$, $a = 30\ m/s^2$ Constant

$x(0) = 0$

Find x(t) at t = 5 s

$a = \frac{dv}{dt} \rightarrow dv = a\,dt$

integrate

$$\int_{v_0}^{v(t)} dv' = \int_0^t a(t')\,dt'$$

a Constant

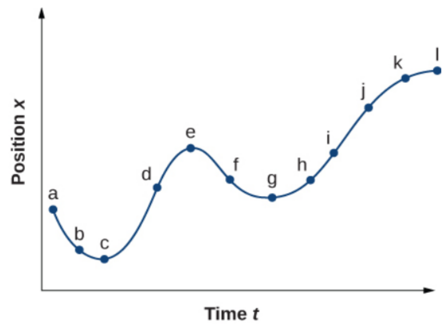
$$\underbrace{v(t) - v(0)}_{=0} = \int_0^t a\,dt' \rightarrow v(t) = at$$

$$\underbrace{x(t) - x(0)}_{=0} = \int_0^t v(t')\,dt' = a\int_0^t t'\,dt' = a\frac{t^2}{2}$$

$$\rightarrow x(t) = \frac{1}{2}at^2 \quad \rightarrow x(5) = \frac{30}{2}\frac{m}{s^2}\,25\ s^2 = 375\ m$$

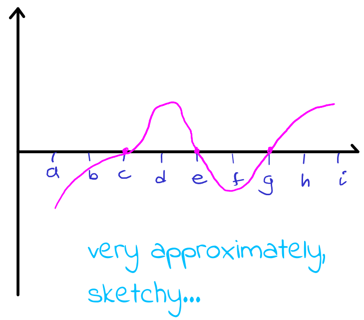
2

1-03-46



a) Sketch the corresponding v(t) graph

$$v(t) = \frac{dx(t)}{dt}$$



very approximately, sketchy...

b) Max values for v(t) occur at

t_a, t_d, t_i, t_j

c) when is v(t) = 0?

t_c, t_e, t_g, t_l

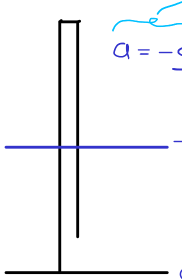
d) v(t) < 0 for t_b, t_f, t_a

3

1-03-74

constant acceleration

$a = -g$



Tree

$h = 7.0$ m

0

$v_0 = v(0) = 15.0\ m/s$

$x(0) = 0$

want to find Δt, the time interval during which the ball is above the tree branch

$$x(t) = v_0 t - \frac{1}{2}gt^2$$

parabola in t

During the trip of the ball we will hvave twice

$$h = v_0 t - \frac{1}{2}gt^2$$

$$\rightarrow \frac{g}{2}t^2 - v_0 t + h = 0$$

or

$$\boxed{t^2 - \frac{2v_0}{g}t + \frac{2h}{g} = 0}$$

which has two solutions

4

The roots are

$$t = \frac{2v_0}{2g} \pm \frac{1}{2}\sqrt{\left(\frac{2v_0}{g}\right)^2 - 4\frac{2h}{g}}$$

$$= \frac{v_0}{g} \pm \sqrt{\left(\frac{v_0}{g}\right)^2 - \frac{2h}{g}}$$

$$\rightarrow \Delta t = 2\sqrt{\left(\frac{v_0}{g}\right)^2 - \frac{2h}{g}}$$

$$= 2\sqrt{\left(\frac{15}{9.81}\right)^2 s^2 - \frac{2\cdot 7}{9.81}s^2} \approx 1.91\ s$$

1-04-44

Max throw range of a boy is 50 m, assume always the same initial speed and find the max height

$$R = \frac{v_0^2 \sin(2\theta_0)}{g}$$

max R is for $\theta_0 = 45$ as then $\sin(2\theta_0)$ takes a max value

$$\rightarrow v_0^2 = gR$$

Throw straight up

$$h = v_0 t - \frac{1}{2} g t^2 = \sqrt{gR}\, t - \frac{g}{2} t^2$$

Max height when $\frac{dh}{dt} = 0 \rightarrow \sqrt{gR} - g t_m = 0$

$$\rightarrow t_m = \frac{\sqrt{gR}}{g} = \sqrt{\frac{R}{g}}$$

$$h_m = h(t_m) = \sqrt{gR}\sqrt{\frac{R}{g}} - \frac{g}{2}\frac{R}{g}$$

$$= R - \frac{R}{2} = \frac{R}{2} = 25\ m$$

Think, no airresistance, the motion is symmetric in x. The angle is 45 degrees is the answer R/2 then not realistic?