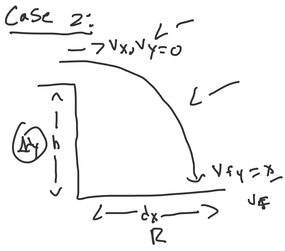
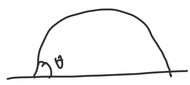
projectile motion P2

Wednesday, October 16, 2024 4:03 PM

Case 2:



Case 1:



Case Based Rules:

→ vertical position $= -\frac{1}{2}gt^2 + h$

$0 - h = -\frac{1}{2}gt^2 + h - h$

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

$h = \frac{1}{2}gt^2$

$\Delta d_y = -\frac{1}{2}at^2 + h$

$d_y = (v_i)\Delta t + \frac{1}{2}at^2$

$d_y = 0\Delta t + \frac{1}{2}at^2$

$d_y = \frac{1}{2}at^2$ → $\Delta t = \sqrt{\frac{2\Delta d_y}{a}}$ $\Delta t = 2$

$\Delta d_y = \frac{1}{2}(-9.81)(2)$

→ $\Delta d_x = v_x \Delta t$ → $d = vt$ ← because v_x is constant $\frac{\Delta d_x}{\Delta t} = v_{ix}$ $\Delta t = \frac{\Delta d_x}{v_{ix}}$

→ $\theta = \tan^{-1}(v_y / v_x)$ ⊂— $v_{fy}, v_{fx} \rightarrow v_{ix}$

→ $v_f = \sqrt{v_x^2 + v_y^2}$

→ under constant acceleration:

$v_{fy} = -a\Delta t$ → $v_{fy} = v_{iy} + a\Delta t$

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

$v_{fy} = v_{iy} - a\Delta t$ → $0 - a\Delta t$

$= 9.81$

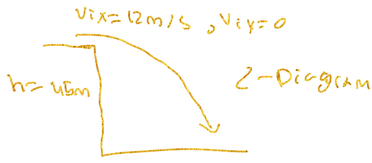
$v_{fy} = -a\Delta t$

Example:

A ball is rolled off a cliff that is 45m high with initial horizontal velocity of 12m/s

a) Calculate time of flight

b) Calculate final velocity



(1) Givens/unknowns:

Givens: $v_{ix} = 12\ m/s$, $v_{iy} = 0\ m/s$, $h = 45m$

Unknowns: $\Delta t = ?$, $v_f = ?$

(2) Calculate time of flight:

$\Delta t = \sqrt{\frac{2\Delta d_y}{a}} = \sqrt{\frac{2(45)}{9.81}} = 3.03\ s$ ✓

(3) Calculate v_{fy}

v_{fx}, v_{fy}

$v_{fy} = -a\Delta t$

$= -9.81(3.03)$

$= -29.7\ m/s$

(4) Calculate v_f:

$v_{fx} = v_{ix} = 12\ m/s$

$v_{fy} = -29.7\ m/s$

$v_{ix} = v_{fx}$

v_{ix} → constant

a → not seen in the horizontal

$v_f = \sqrt{v_{fx}^2 + v_{fy}^2}$

$v_f = \sqrt{12^2 + (-29.7)^2}$

$= 32.05\ m/s$

$(29.7)^2 = x$

$(29.7)^2 = x$

(5) angle for v_f:

$\theta = \tan^{-1}(v_{fy} / v_{fx})$

$= \tan^{-1}(29.7/12)$

$= 68°$

$v_f = 32.05\ m/s\ [68°]$

Soh Cah Toa

tan θ