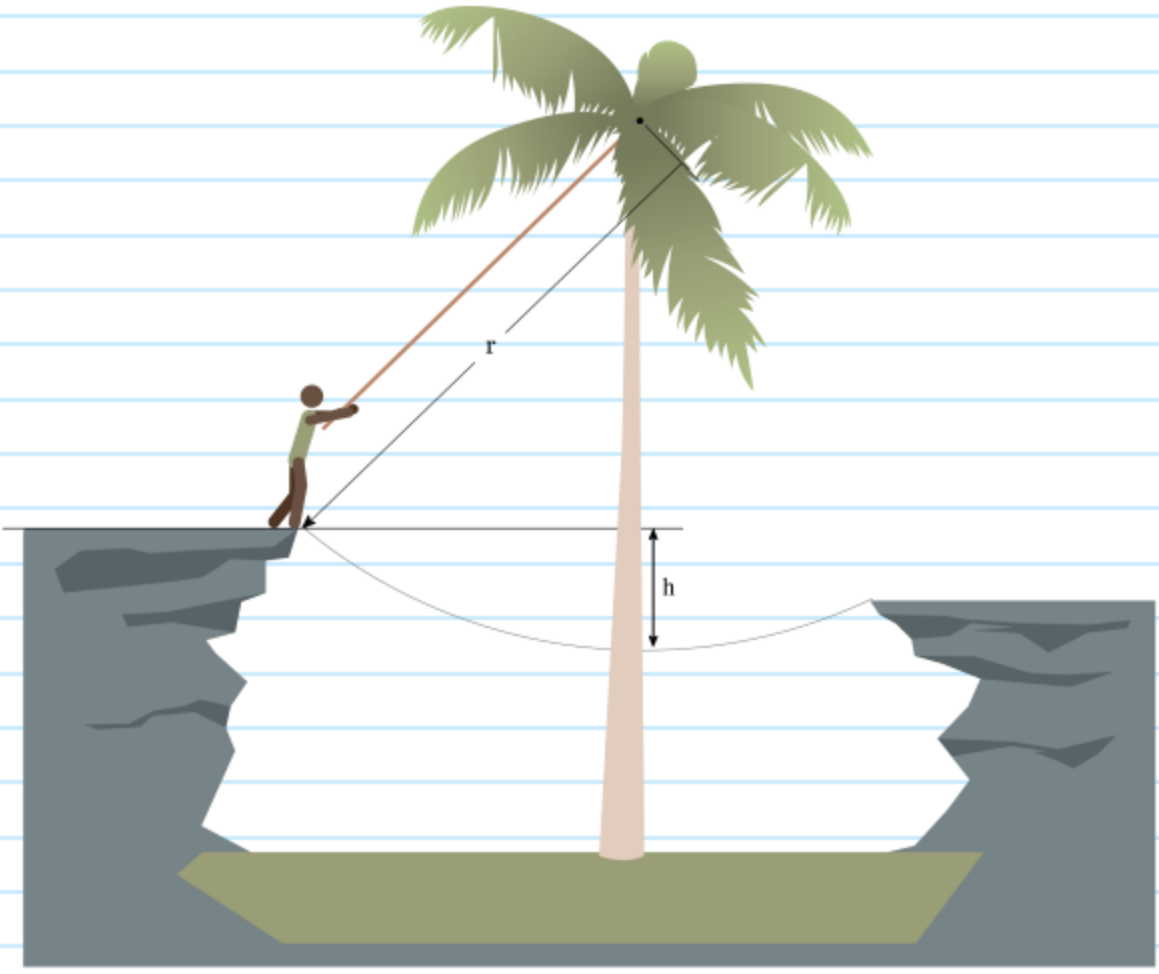
21-P-WE-GD-017



You need to quickly cross a dangerous ravine. Lucky for you, there is a large palm tree rising up from the ravine. You toss a rope to the top of the tree and swing across, starting from rest.

Your mass is m kg, and the radius of your motion is r m. At the bottom of your swing, if the tension in the rope is T N, how fast are you going and how far below your starting position are you?

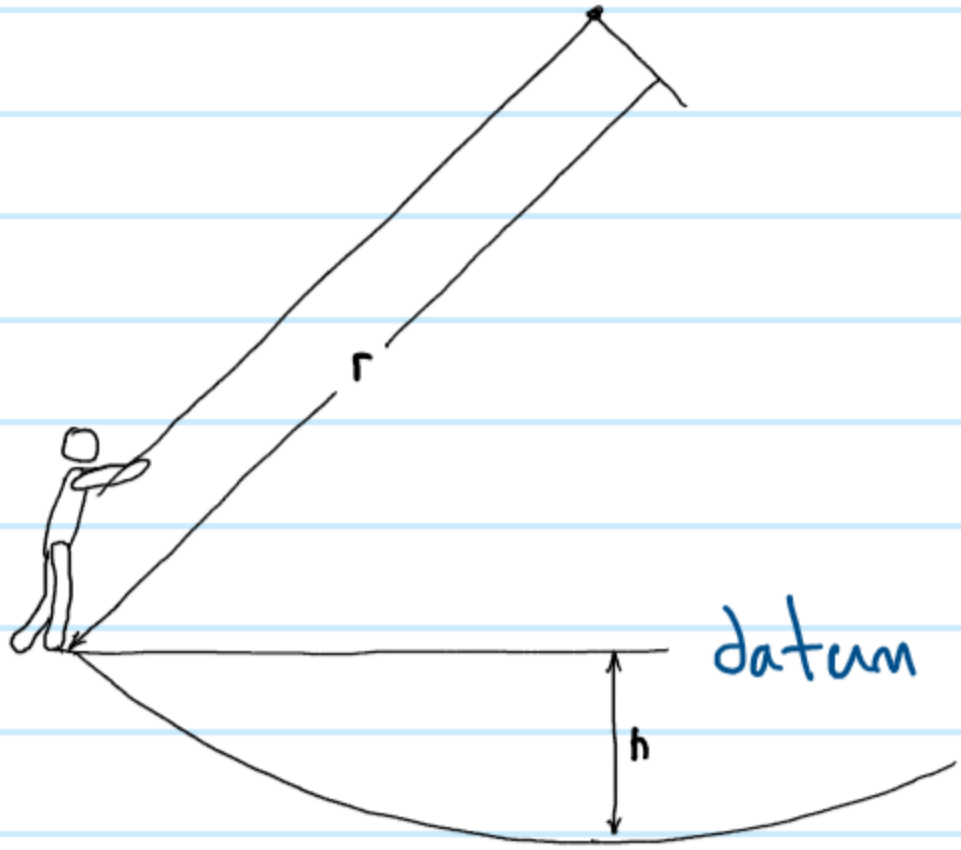
(Assume $g = 9.81\ m/s^2$)

given

m, r, T

find

v_2, h



Conservation of Energy

$$T_1 + V_1 = T_2 + V_2$$

$V_1 \to 0$

$$\tfrac{1}{2} m v_1^2 = \tfrac{1}{2} m v_2^2 - mgh$$

$v_1 \to 0$

$$0 = \tfrac{1}{2} m v_2^2 - mgh$$

v_2 ? h ?

Force Equilibrium

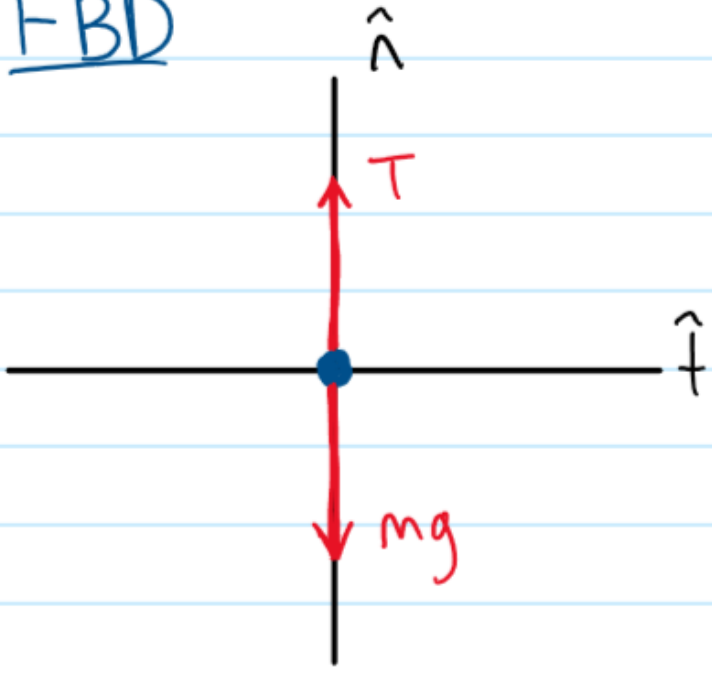
$$\Sigma F_n = ma_n = T - mg$$

$$a_n = \frac{T - mg}{m}$$

$$a_n = \frac{V_2^2}{r} = \frac{T - mg}{m}$$

$$V_2 = \sqrt{\frac{r(T - mg)}{m}}$$

FBD



Conservation of Energy (cont.)

$$0 = \tfrac{1}{2} m V_2^2 - mgh$$

$$0 = \tfrac{1}{2} \cancel{m} \left(\frac{r(T - mg)}{\cancel{m}} \right) - mgh$$

$$0 = \tfrac{1}{2} r(T - mg) - mgh$$

$$h = \frac{\tfrac{1}{2} r(T - mg)}{mg}$$