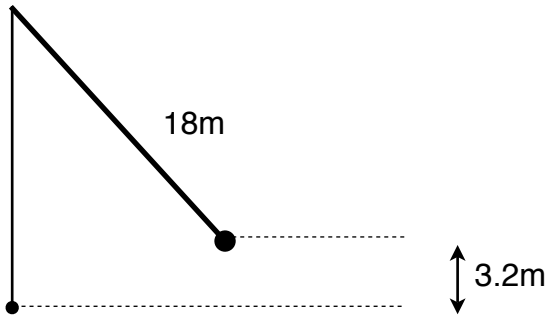
Tarzan

Tarzan, who weighs 688N, swings from a cliff at the end of a convenient vine that is 18m long. From the top of the cliff to the bottom of the swing he descends by 3.2m.

(a) What is his speed at the bottom of the swing? Neglect air resistance.

(b) The vine will break if the force on the vine exceeds 950N. Does it break at the bottom of the swing?

Solution:



(a) Total mechanical energy is conserved, so

$$ME_1 = U_1 + K_1 = ME_2 = U_2 + K_2$$

Take the bottom of the swing as h=0; then we have

$$U_1 = mgh$$
$$K_1 = 0 \text{ J}$$

and

$$U_2 = 0 \text{ J}$$
$$K_2 = \tfrac{1}{2}mv^2$$

where v is his speed at the bottom of the swing.

Hence, from conservation of mechanical energy,

$$ME_1 = mgh = ME_2 = \tfrac{1}{2}mv^2$$

so

$$v^2 = 2gh = 2 \times 9.8 \times 3.2 = 62.7$$
$$v = 7.9 \text{ ms}^{-1}$$

(b) At the bottom of the swing, he is moving in circular motion. Hence there must be a net force pointing towards the centre of the circle providing the centripetal force.

Hence we must have

$$T - W = mv^2/r$$

so

$$T = W + mv^2/r$$
$$= 688 + 70.2 \times 62.7/18$$
$$= 688 + 244.5$$
$$= 932 \text{ N}$$

This is less than the breaking strength of the vine, so the vine does not break and Tarzan is safe.