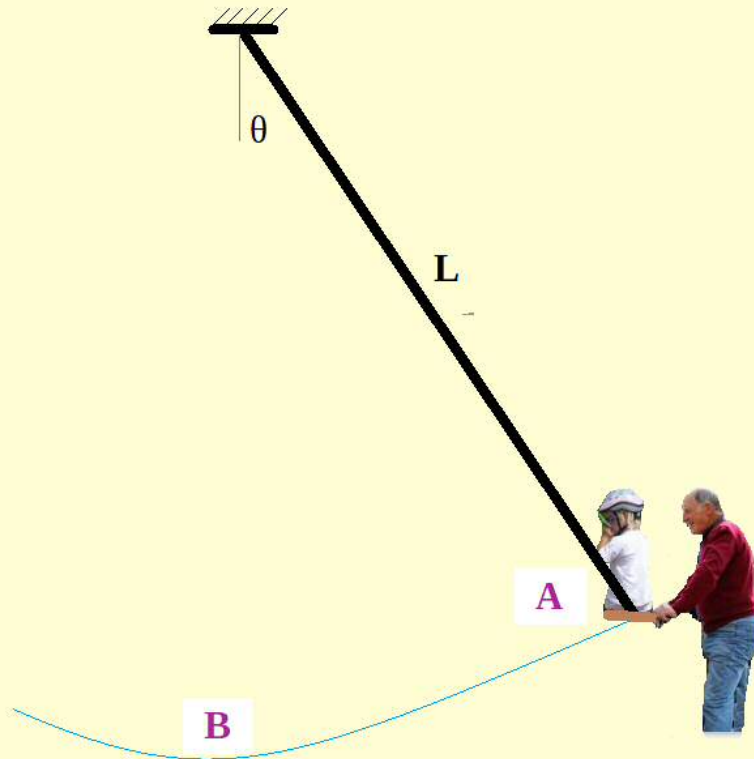


## An Exercise in Dynamics



A man exerts a horizontal force on a swing which has a light rope of length  $L$  that makes an angle  $\theta$  with the vertical. The small child in the swing has a mass  $m$ . The weight of the rope and the seat are negligible. Using the terms  $m$ ,  $L$ ,  $\theta$ , and  $g$  for gravity, find the tension in the rope when the child is passing the lowest point.

### SOLUTION:

Point **A**: released point

Point **B**: lowest point

The height  $h$  fallen from A to B is:  $h = L - L\cos\theta = L(1 - \cos\theta)$

PE at point A = KE at point B

$mgh = \frac{1}{2}mv^2$  [ equation 1]

At point B, the summation of the centrifugal force and weight is equal to the tension

$T = mg + mv^2/L$  [equation 2]

From equation 1:  $2mgh/L = mv^2/L$

Therefore:

$T = mg + 2mgh/L = mg + 2mgL(1 - \cos\theta)/L$

$T = mg + 2mg(1 - \cos\theta) = mg(3 - 2\cos\theta)$

Answer: **Tension =  $mg(3 - 2\cos\theta)$**