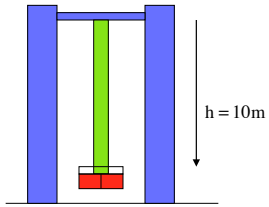
Problem 8.53

A giant swing consists of a 365 kg, 10 meter long arm with two “massless” seats at its end.

a.) relative to the chair at its lowest point, where’s the center of mass of the arm?

b.) What’s the potential energy when at the forty-five degree mark?



c.) what’s the potential energy at the bottom of the arc?

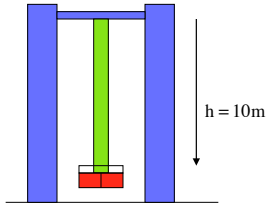
Problem 8.53

A giant swing consists of a 365 kg, 10 meter long arm with two “massless” seats at its end.

a.) c. of m.

The center of mass will be halfway down as the chairs are massless.

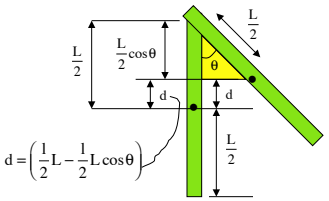
$$y_{cm} = 5 \text{ m}$$



b.) gravitational potential energy at 45° when chair at lowest point is y=0

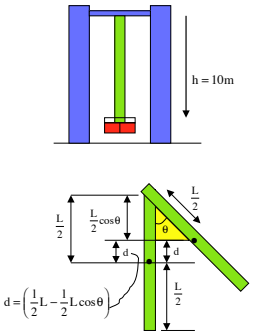
$$\begin{aligned} U_1 &= mg\left(\frac{1}{2}L + d\right) \\ &= mg\left(\frac{1}{2}L + \left(\frac{1}{2}L - \frac{1}{2}L\cos\theta\right)\right) \\ &= mgL\left(1 - \frac{1}{2}\cos\theta\right) \end{aligned}$$

side view



c.) at the bottom of the arc, U is just "$mg\left(\frac{L}{2}\right)$."

c.) What's the speed of the chair at the bottom of the arc?



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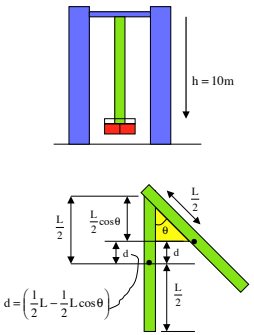

$$\sum KE_1 + \sum U_1 + \sum W_{ext} = \sum KE_2 + \sum U_2$$

$$0 + mgL\left(1 - \frac{1}{2}\cos\theta\right) + 0 = \left(\frac{1}{2}I_{axis}\omega^2\right) + mg\left(\frac{L}{2}\right)$$

$$\Rightarrow \cancel{mgL}\left(1 - \frac{1}{2}\cos\theta\right) = \left(\frac{1}{2}\left(\frac{1}{3}\cancel{m}L^{\cancel{2}}\right)\left(\frac{v_{chair}}{\cancel{L}}\right)^2\right) + \cancel{mg}\left(\frac{\cancel{L}}{2}\right)$$

$$\Rightarrow v_{chair} = \sqrt{6g\left(1 - \frac{1}{2}\cos\theta\right) - 3g}$$

$$\Rightarrow v = \sqrt{6\left(9.8 \text{ m/s}^2\right)(10 \text{ m})\left(1 - \frac{1}{2}\cos 45°\right) - 3\left(9.8 \text{ m/s}^2\right)(10 \text{ m})}$$

$$\Rightarrow v = 9.28 \text{ m/s}$$