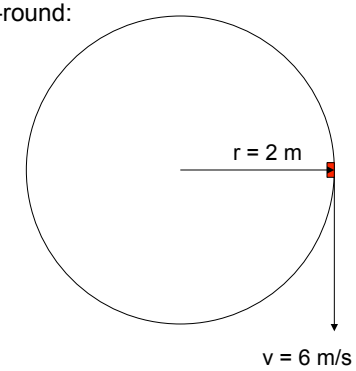
Problem 7.25 A child on a merry-go-round:

a.) What is the 50 kg child's centripetal acceleration?

b.) What is the minimum force of friction at the child's feet?

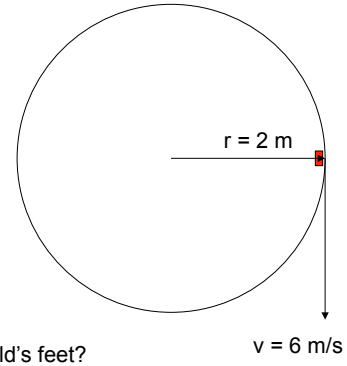


c.) What is the minimum coefficient of static friction?

a.) What is the 50 kg child's centripetal acceleration?

Centripetal acceleration is simply:

$$a_c = \frac{v^2}{R} = \frac{(6\ \text{m/s})^2}{(2\ \text{m})} = 18\ \text{m/s}^2$$



b.) What is the minimum force of friction at the child's feet?

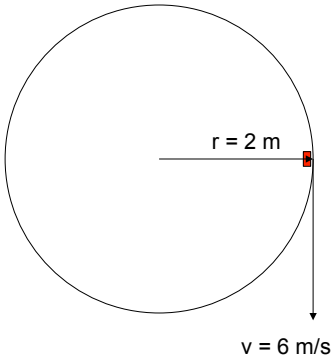
Friction is what generates the centripetal acceleration here. As friction is the only force in the center seeking direction, we can write:

$$\sum F_{c.s.}$$

$$f_s = m\frac{(v)^2}{(R)} = (50\ \text{kg})\frac{(6\ \text{m/s})^2}{(2\ \text{m})} = 900\ \text{nts}$$

c.) What is the minimum coefficient of static friction that will keep the kid from breaking loose?

The coefficient of static friction is associated with the maximum static frictional force a surface can generate. In this case, the static frictional force acts centripetally to force the kid out of straight line motion. If we were to somehow change the surface so the coefficient got bigger, the same amount of centripetal force would be required to motivate the kid out of straight line motion, but the new MAXIMUM static frictional force would more than was needed. In that case, the surface would need to generate a static frictional force that was less than the maximum. If the coefficient of friction was made smaller, we run the risk that the new maximum frictional force would not be big enough to push the kid out of straight line motion, given the size of the radius of the arc required. There is ONE maximum static friction force (hence one coefficient), though, that will be just right to act as the kid's center-seeking motivator. Combining the expression of static friction with the centripetal acceleration in a Newton's Second Law problem gives us that coefficient as:



$$f_s = \mu_s N$$

$$(900\ \text{nts}) = \mu_s\ (\text{m}\quad \text{g})$$

$$(900\ \text{nts}) = \mu_s\left((50\ \text{kg})(9.8\ \text{m/s}^2)\right)$$

$$\Rightarrow\ \mu_s = 1.83$$