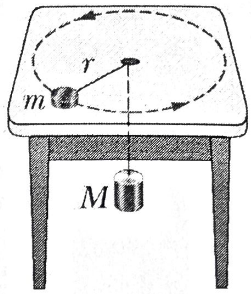
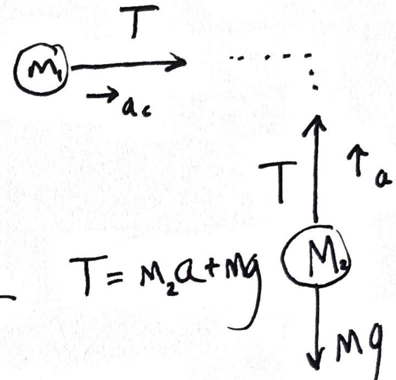
5. A mass of m (= $2\ kg$) on a frictionless table is attached to a hanging mass M (= $3\ kg$) by a cord through a hole in the table – the radius of the string is 1.0 m. Find the speed at with which m must move for M to:



a) remain stationary ($a = 0\ m/s^2$)
b) accelerate upwards at $1.0\ m/s^2$
c) accelerate downwards at $1.0\ m/s^2$
[Ans: a) 3.83 m/s b) 4.02 m/s c) 3.63 m/s]

use the general equation and replace a with the values ∅, 1, -1



$T = \frac{M_1 v^2}{r}$

$T = M_2 a + Mg$

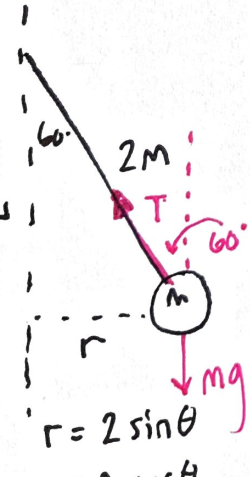
sub.

$\frac{M_1 v^2}{r} = M_2 a + Mg$

$\boxed{v = \cancel{\sqrt{\frac{r(a M_2 + M_2 g)}{M_1}}}}$ general

$\boxed{v = \sqrt{\frac{r(M_2 a + M_2 g)}{M_1}}}$

6. An Australian bushman hunts kangaroos with the following weapon, a heavy rock tied to one end of a light vine of length 2 m. He holds the other end above his head, at a point 2 m above the ground level, and swings the rock in a horizontal circle. The cunning kangaroo has observed that the vine always breaks when the angle theta (measured between the vine and the vertical) reaches 60°. At what minimum distance from the hunter can the kangaroo stand with no danger of a direct hit? (SIN '72)
[Ans: 3.0 m]



$r = 2\sin\theta$
$L = 2\cos\theta$

vertical
$\Sigma F = \emptyset$
$T\cos\theta = Mg$
$T = \frac{Mg}{\cos\theta}$

radial
$\Sigma F = Ma_c$
$T\sin\theta = \frac{Mv^2}{r}$

$\cancel{M} g \tan\theta = \frac{\cancel{M} v^2}{r}$ r

horizontal launch speed $\boxed{v = \sqrt{g(2\sin\theta)\tan\theta}}$

$V = $ 5.422 m/s ✓

projectile motion: ↓+

$V_{2y}^2 = \cancel{V_{1y}^2} + 2a\Delta d_y$

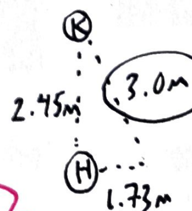
$V_{2y} = \sqrt{2a\Delta d_y}$

$V_{2y} = 4.43\ m/s$

$\Delta t = \frac{V_{2y}}{a} = 0.452\ s$

$\Delta d_x = 2.45\ m$

$L = 2\cos\theta$
$L = 1$
$\Delta d_y = 2 - 1 = 1\ m$



This is the tough part