PHY141 Notes on demonstrations

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1 Mass on track and pulley

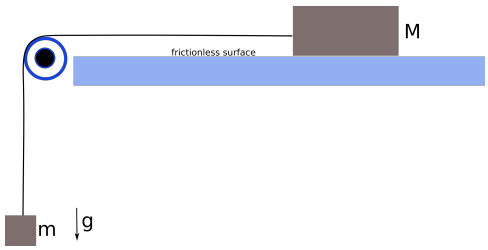

Figure 1: A mass M is on a frictionless surface. A mass m is hanging from a string that goes over a pulley and is connected to M. The mass m falls pulling the mass M along the frictionless surface.

The force on m is $mg - T$ where T is the tension in the string. The tension in the string is $T = Ma$ which the force on M.

$$ma = mg - T = mg - Ma$$

We solve for the acceleration a finding

$$a = g\frac{m}{m+M}$$

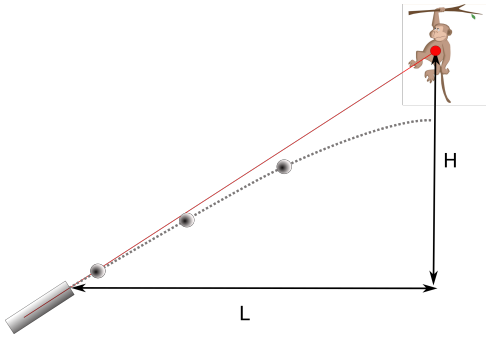

Figure 2: A gun is aimed at the monkey. The gun fires at the same time as the monkey lets go. The bullet hits the monkey.

2 The bullet hits the monkey

The gun is aimed at the monkey. If there were no gravity

$$x_{ball} = v_{0x}t$$
$$z_{ball} = v_{0z}t$$

where v_{0x} and v_{0z} are the initial velocity components of the ball. Because the gun is aimed at the monkey the ball would hit the monkey at the time where

$$t = L/v_{0x}$$

or

$$L = v_{0x}t$$

where L is the horizontal distance between monkey and gun. At the same time

$$v_{0z}t = H$$

the vertical height of the monkey.

Now we turn on gravity. The horizontal position of the ball at time t is the same and at the horizontal location of the monkey. The vertical position of the ball at time t is now

$$z_{ball} = v_{0z}t - gt^2/2 = H - gt^2/2$$

Because the monkey starts at rest, the vertical position of the monkey is

$$z_{monkey} = -gt^2/2 + H$$

Because $v_{0z}t = H$, the two z values are the same. The horizontal value of the ball is unchanged. So both z and x are the same at time t for both ball and monkey. The ball hits the monkey.