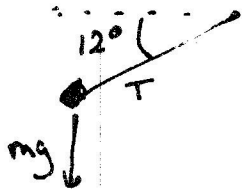4a – 12 pts) You make it down safely into the cave and see bats hanging from the ceiling. One of the Fog brothers says he sees the lead vampire bat on the floor of the cave. He pulls out his sling with a length of 0.8 meters and starts twirling a ball (mass = 400 grams) around his head. The sling makes an angle of 12 degrees from the horizontal. What is the velocity of the rock?

$$L = 0.8 \, m \qquad r = L \cos \theta$$

$$x: \quad F_c = \frac{mv^2}{r} = T_x = T \cos \theta$$

$$y: \quad F_y = 0 = T \sin \theta - mg$$

$$mg = T \sin \theta$$

$$\text{dividing } \frac{y}{x}: \quad \tan \theta = \frac{mg}{mv^2/r} = \frac{gr}{v^2}$$

$$v = \sqrt{\frac{gr}{\tan \theta}} = \sqrt{\frac{gL\cos\theta}{\tan \theta}} = 6 \, m/s$$

4b – 13 pts) The Fog brother's aim is good and the ball travels at a 35 degree angle from the ground towards the vampire bat. How much time does it take for the rock to hit its intended target?

Projectile Motion:
$$x = \frac{v_0^2 \sin 2\theta}{g} \qquad x = v_0 \cos \theta_0 \, t$$

Combining:

$$v_0 \cos \theta_0 t = \frac{v_0^2 \sin 2\theta}{g}$$

$$t = \frac{v_0 \sin 2\theta}{g \cos \theta}$$

$$= \frac{6 \, m/s \cdot \sin 70°}{g \cos 35°} = 0.7 \, s$$