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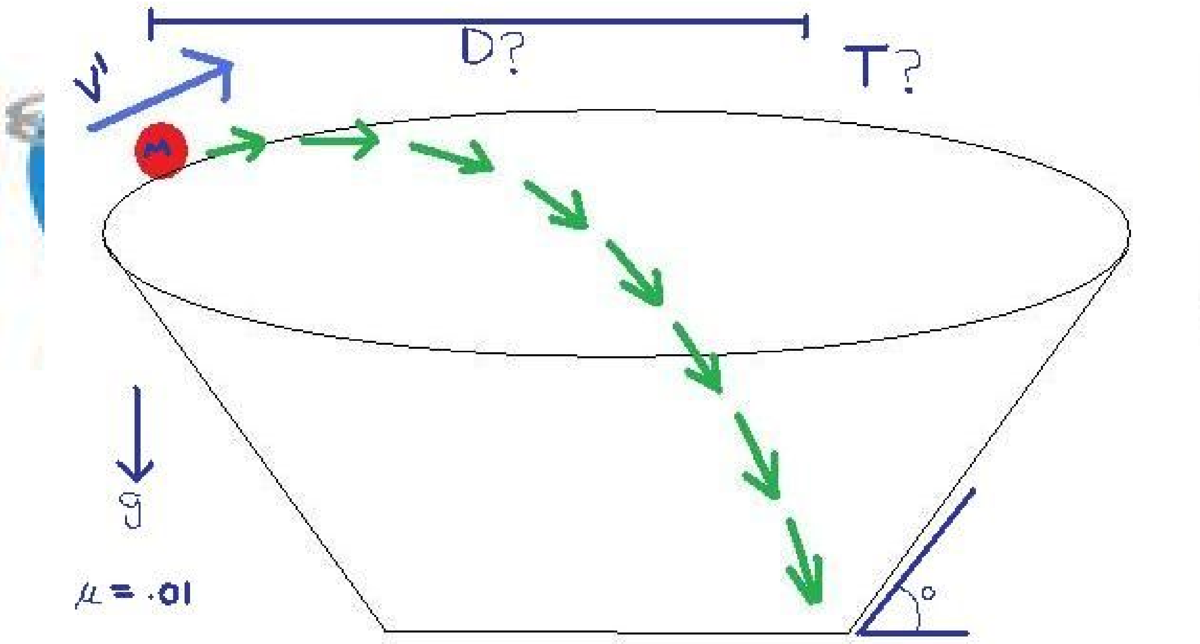
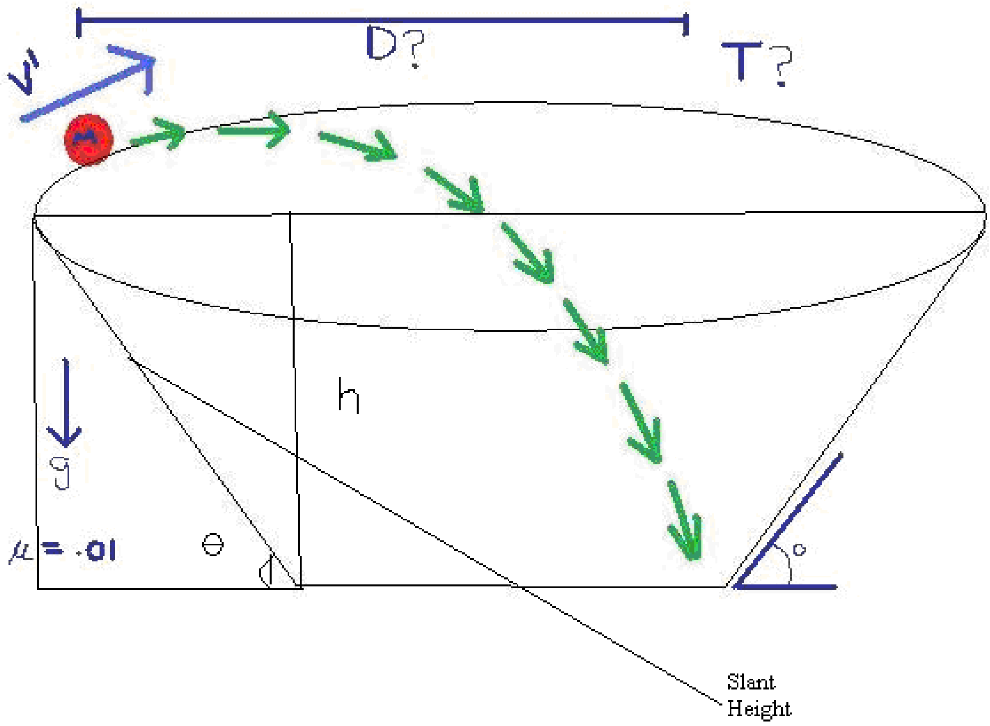
Question: A game that friends and I try to play to guess how long it takes a ball to fall to the bottom of a cone and how many revolutions around the cone it will take. I do not have a lot of physics experience, but I was under the impression that if we knew certain constants such as: the diameter and height of the cone, the mass of the ball, the velocity of the ball as it falls into the cone, the angle of the side of the cone, and the usual constants for gravity and surface friction - that we should be able to know the exact time the ball will fall to the bottom. We should also be able to know the distance the ball travelled going around the cone before hitting the bottom. Sadly, I am not quite able to work out how to guess either the time or distance. What are the formulas to calculate such things? Any suggestions?



Since ball is falling from circumference of Cone at poison M (RED BALL) with initial velocity v'. It is given that h is the height of the Cone and θ is the angle between surface and slant height of the cone. Its look like as



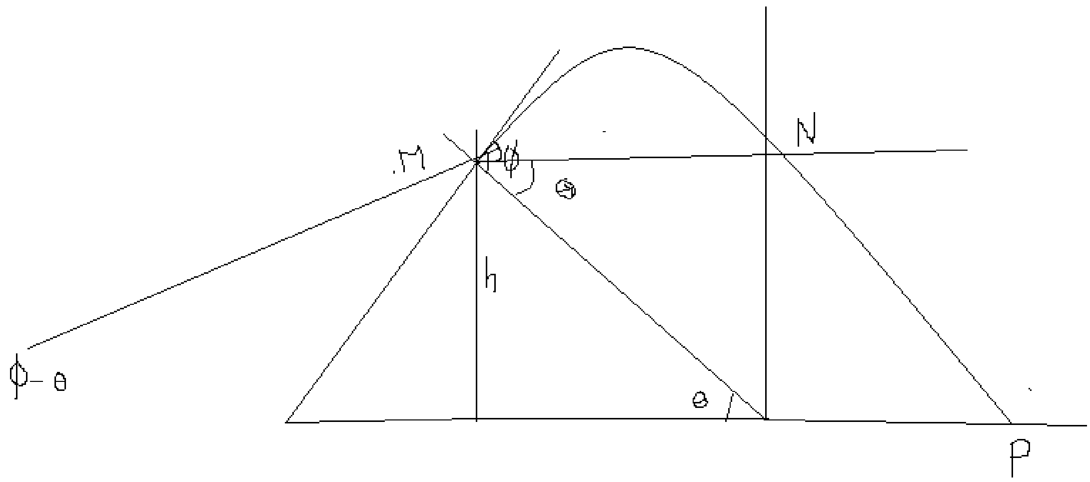
Thus

$$\sin\theta = \frac{\text{Height}}{Hypotensis}$$

$$=> \sin\theta = \frac{h}{slant\ height}$$

$$=> slant\ height = h\,\mathrm{cos}\,ec\,\theta$$

At any point in the path



Thus we throw a ball from point M with initial velocity v. then

$$v' = v'_x i + v'_y j$$

Where v'_x and v'_y are velocities along x and y- direction both.

Thus

$$v' = v'\cos(\phi-\theta) i + v'\sin(\phi-\theta) j$$

Since motion starts at M point which is h height from the base, therefore position of the Ball after t time

$$x = v'\cos(\phi-\theta)t$$

$$y - h = v'\sin(\phi-\theta)t - \frac{1}{2}gt^2$$

Eliminating t from these two equations

$$y - h = x\tan(\phi-\theta) - \frac{g}{2v'^2\cos^2(\phi-\theta)}x^2$$

This is the path of the ball.

Now we will estimate the time travel by ball from M to P via N.

Thus total time travel T = Time travel by ball from M to P = $\frac{2v'_y}{g} = \frac{2v'\sin(\phi-\theta)}{g}$

And using this time, maximum travel by ball

$$R = v'\cos(\phi-\theta)T = \frac{2v'\cos(\phi-\theta).v'\sin(\phi-\theta)}{g}$$

$$= \frac{2v'^2\cos(\phi-\theta).\sin(\phi-\theta)}{g} = \frac{v'^2\sin 2(\phi-\theta)}{g}$$