1. (20%) A 30lb projectile is fired horizontally with an initial velocity of 750 ft/s from the top of a hill, which is 500 ft above the surrounding area as shown in Fig. 1.
(a) (10%) Determine the range R of the projectile (horizontal distance traveled).
(b) (10%) Determine the elapsed time before it strikes the ground.
(Neglect air resistance)

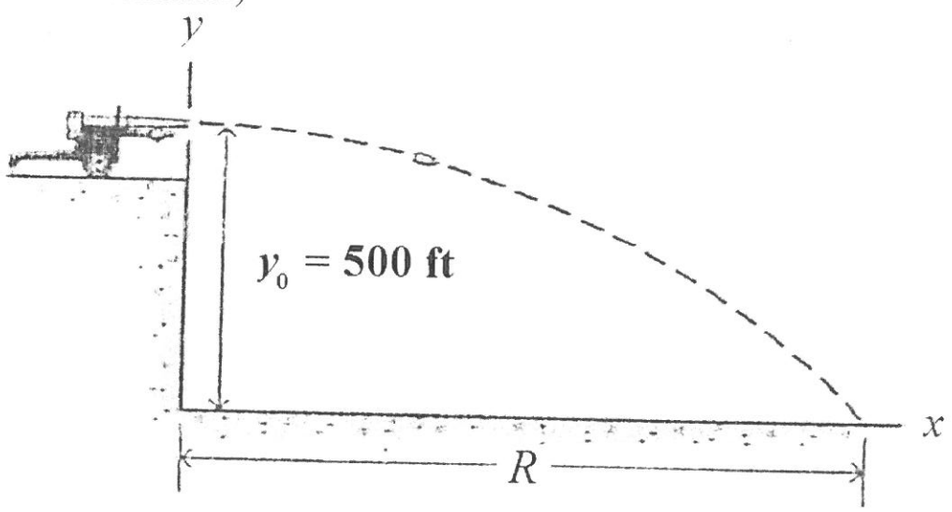

Figure 1

2. (10%) A 0.5-kg bead slides along a circular wire as shown in Figure 2. The diameter of the wire ring is 800 mm, and friction between the bead and the wire may be neglected. If the bead is released from rest when $\theta = 30^\circ$, determine the force exerted on the bead by the wire when $\theta = 180^\circ$ (the bead is at the bottom of the ring).

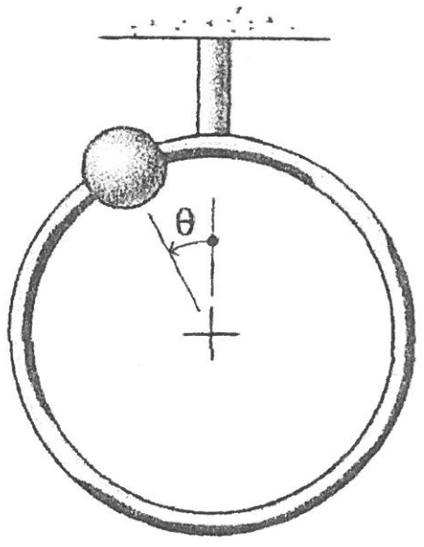

Figure 2

3. (20%) Two masses slide on a horizontal frictionless rod as shown in Figure 3. Slider *A* has a mass of 2 kg and is sliding to the right at 3 m/s, whereas slider *B* has a mass of 0.75 kg and is sliding to the left at 1 m/s. If the coefficient of restitution for the sliders is 0.6, determine
   (a) (10%) The velocity of each mass after they collide.
   (b) (10%) The percentage decrease in energy due to the collision.

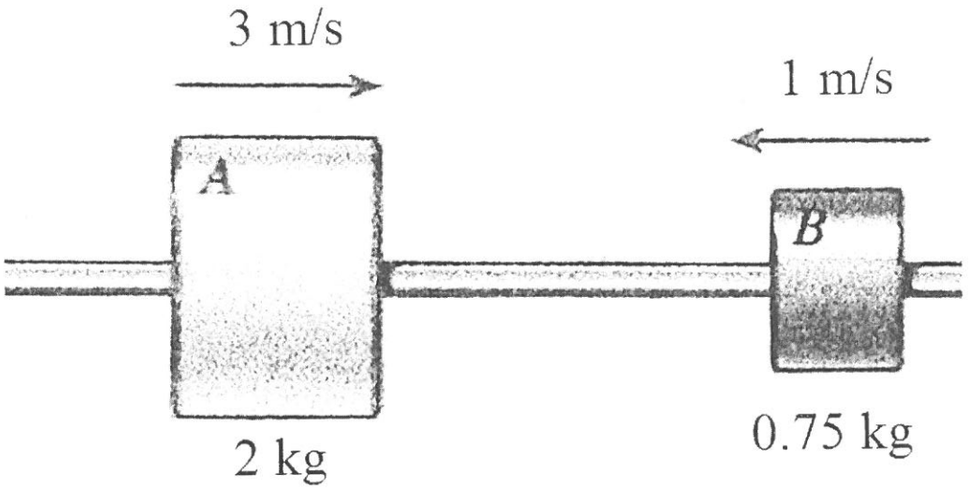

Figure 3

4. (30%) A bike ran over a trouble stone, as shown in Figure 4. Now you are trying to measure whether its rear wheel is still healthy. Suppose you have the following basic tools of measurement in hand: a tape of ruler, a weighting scale, and a stopwatch.
   (a) (10%) How to measure the position of mass center G?
   (b) (20%) How to measure the inertia of moment I_G with respect to the mass center G? You may consider the method of pendulum vibration.

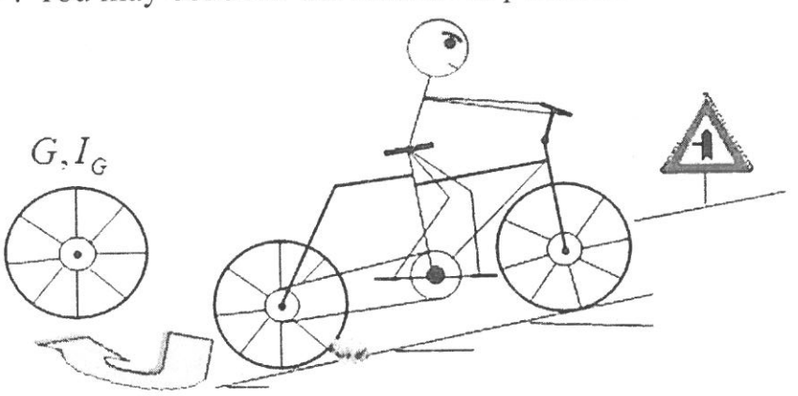

Figure 4

5. (20%) George is to choose a cylinder of bucket for carrying water to his cottage. As the bucket is high, it inclines to topple over on the truck that is in an urgent driving or brake. As for a lower bucket, it carries less water. If the maximum amplitude of acceleration that the truck can have is a, then what is the optimal dimension of the bucket that can carry the most water without possibility of toppling down? Do a simple analysis and let the answer be in terms of its diameter d and its height h, as indicated in Figure 5.

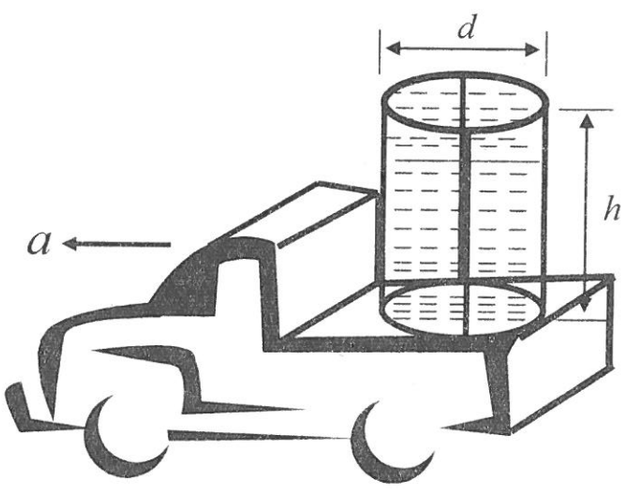

Figure 5