

BdPhO Camp 2014
Mechanics

Duration- 2 hours

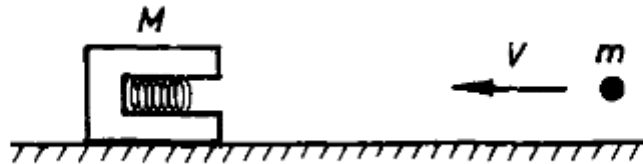
Total points-40

Question 1 (5 points)

Lumps of mud fly from the car's wheel of radius a , the car moving at a velocity u ($u^2 \geq ga$). Find the maximum height attained by the lumps.

Question 2 (5 points)

A projectile of mass m is shot (at velocity V) at a target of mass M , with a hole containing a spring of constant k . The target is initially at rest and can slide without friction on a horizontal surface. Find the maximum compression Δx of the spring.



Question 3 (10 points)

A uniform solid ball of radius a rolling with velocity v on a level surface collides inelastically with a step of height $h < a$, as shown in Fig. Find, in terms of h and a , the minimum velocity v for which the ball will "trip" up over the step. Assume that no slipping occurs at the impact point, and remember that the moment of inertia of a solid sphere with respect to an axis through its center is

$$\frac{2}{5}MR^2$$

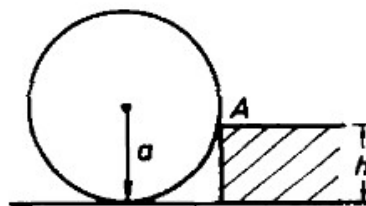
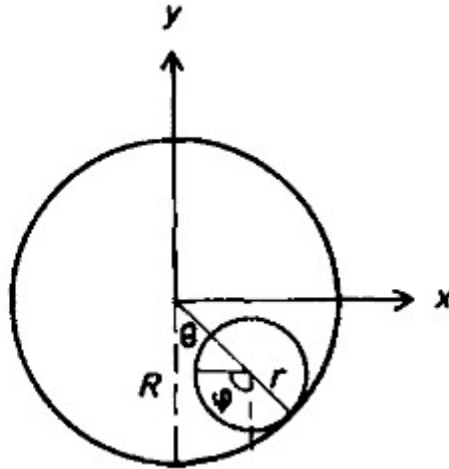


Fig. 1.172.

Question 4 (20 points)

A solid homogeneous cylinder of radius r and mass m rolls *without slipping* on the inside of a stationary larger cylinder of radius R as shown in fig.



- If the small cylinder starts at rest from an angle θ_0 with the vertical, what is the total downward force it exerts on the outer cylinder as it passes through the lowest point? (5 points)
- Write the co-ordinates of the center of mass of the smaller cylinder. Take the co-ordinate as shown in figure (2 points)
- Write down the condition of rolling without slipping in terms of R, r, θ and ϕ (3 points).
- Find the equation of motion of the cylinder. (8 points)
- Find the period of small oscillation (2 points).