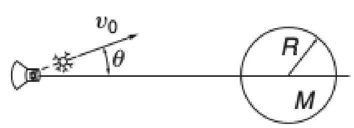
- Section —
assignment
date

7.{4,8,9,13,22}

Reading: Chapter 7

1 - Grazing instrument package - KK 7.4 A spaceship is sent to investigate a planet of mass M and radius R. While hanging motionless in space at a distance $5R$ from the center of the planet, the ship fires an instrument package with speed v_0, as shown in the sketch. The package has mass m, which is much smaller than the mass of the spaceship. For what angle θ will the package just graze the surface of the planet?



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2 - Moment of inertia of a sphere* - KK 7.8 Find the moment of inertia of a uniform sphere of mass M and radius R about an axis through the center.

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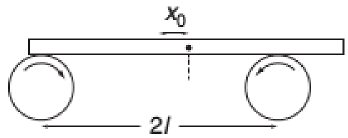
3 - Bar and rollers - KK 7.9 A heavy uniform bar of mass M rests on top of two identical rollers that are continuously turned rapidly in opposite directions, as shown. The centers of the rollers are a distance $2l$ apart. The coefficient of friction between the bar and roller surfaces is μ, a constant independent of the relative speed of the two surfaces. Initially the bar is held at rest with its center at distance x_0 from the midpoint of the rollers. At time $t = 0$ it is released. Find the subsequent motion of the bar. (Assume that the bar is thin.)



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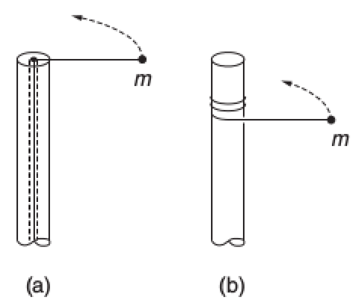
4 - Mass and post - KK 7.13 A mass m is attached to a post of radius R by a string. Initially it is distance r from the center of the post and is moving tangentially with speed v_0.
Case (a) The string passes through a hole in the center of the post at the top. The string is gradually shortened by drawing it through the hole.
Case (b) The string wraps around the outside of the post.
What quantities are conserved in each case? Find the final speed of the mass when it hits the post for each case.



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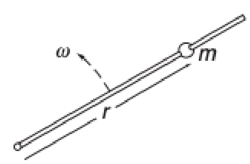
5 - Bead and rod - KK 7.22 A bead of mass m slides without friction on a rod that is made to rotate at a constant angular speed ω. Neglect gravity.

(a) Show that $r = r_0 e^{\omega t}$ is a possible motion of the bead, where r_0 is the initial distance of the bead from the pivot.

(b) For the motion described in part (a), find the force exerted by the bead on the rod.

(c) For the motion described above, find the power exerted by the agency that is turning the rod and show by direct calculation that this power equals the rate of change of kinetic energy of the bead.



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