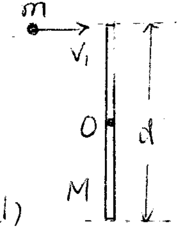
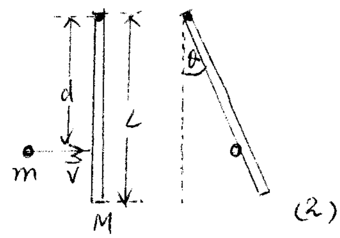
HW Chapter 11 (Rotation II)





1. A projectile of mass m to the right with a speed vi. The projectile strikes and sticks to the end of a stationary rod of mass M, length d, pivoted about a frictionless axle perpendicular to the page through O. (a) What is the angular momentum of the system before the collision about an axis through O? (b) What is moment of inertia of the system about an axis through O after the projectile sticks to the rod? (c) Find the angular speed ω after collision in terms of the given quantities. (d) Determine the fractional change of kinetic energy due to the collision.

$\frac{m v_i d}{2}$

$(\frac{1}{12}M+\frac{1}{4}m)d^2$

$\frac{6 m v_i}{(M+3m)d}$

$-\frac{M}{M+3m}$

2. A thin rod of mass M and length L is attached to a pivot at the top. A piece of clay of mass m and speed v hits the rod a distance d from the pivot and sticks to it. Find the maximum angle θ where the clay and rod come to rest. (The rotational inertia of the rod is ⅓ ML^2)

3. A cube of mass m sliding without friction at speed v_0. It undergoes a perfectly elastic collision with the bottom tip of a rod of length d and mass M = 2m. The rod is pivoted about a frictionless axle through its center, and initially it hangs straight down and is at rest. What is the cube's velocity – both speed and direction – after the collision? $\frac{1}{5}v_0 \rightarrow$

4. A door 1.00 m wide, of mass 15 kg, can rotate freely about a vertical axis through its hinges. A bullet with a mass of 10 g and a speed of 400 m/s strikes the center of the door, in a direction perpendicular to the plane of the door, and embeds itself there. Find the door's angular speed. Is kinetic energy conserved? $\omega = 0.40$ rad/s No.

5. A puck of mass m is attached to a taut cord passing through a small hole in a frictionless, horizontal surface. The puck is initially orbiting with speed vi in a circle of radius ri. The cord is then slowly pulled from below, decreasing the radius of the circle to r. (a) What is the puck's speed when the radius is r? (b) Find the tension in the cord as a function of r. (c) How much work I down by the hand in pulling the cord so that the radius of the puck's motion changes from ri to r? $v_i r_i / r$ $\quad m v_i^2 r_i^2 / r^3$ $\quad \frac{1}{2} m v_i^2 (\frac{r_i^2}{r^2} - 1)$

6. A wad of sticky clay with mass m and velocity Vi is fired at a solid cylinder of mass M and radius R. The cylinder is initially at rest and is mounted on a fixed horizontal axle that runs through its center of mass. The line of motion of the projectile is perpendicular to the axle and at a distance d < R from the center. (a) Find the angular speed of the system just after the clay strikes and sticks to the surface of the cylinder. (b) Is the mechanical energy of the clay-cylinder system constant in this process? (c) Is the momentum of the clay-cylinder system constant in this process?

$\frac{2 m v_i d}{(M+2m)R^2}$

7. A solid cube of side 2a and mass M is sliding on a frictionless surface with uniform velocity v. It hits a small obstacle at the end of the table that causes the cube to tilt as show in the diagram. Find the minimum value of the magnitude of v such that the cube tips over and falls off the table. (The cube undergoes an inelastic collision at the edge.) $4\sqrt{\frac{1}{3}ga(\sqrt{2}-1)}$