1. The density of a thin rod of length l varies with the distance x from one end as $\rho = \rho_0 x^2/l^2$. Find the position of the center of mass.

2. Find the center of mass of a thin uniform plate in the shape of an equilateral triangle with edges a.

3. Chloroform molecule has three Cl ions forming an equilateral triangle. The carbon atom is at the apex of the pyramid. $C-Cl$ distance is 1.76 Å and each $Cl-C-Cl$ angle is 109^0. Hydrogen - Carbon distance is 1.1 Å. Find the CM relative to the carbon atom.

4. Determine the location of the center of mass of a uniform lamina occupying region between two concentric semicircles of radii 2 m and 1 m.

5. A system consists of two blocks of mass m_1 and m_2 connected by a massless spring with spring constant k and slides on a frictionless plane. The unstretched length of the spring is l. Initially m_2 is held so that the spring is compressed to $l/2$ and m_1 is forced against a stop, as shown. m_2 is released at $t = 0$. Find the motion of the center of mass of the system as a function of time.

6. A 60 Kg man is standing at the center of a barge of mass 240 Kg which is resting frictionlessly on still water. Initially the center is 20 m from the shore. The man walks up towards the shore with a constant speed of 1 m/s with respect to the barge. Calculate the speed with which he is approaching the shore.

7. A small block of mass m starts from rest and slides along a frictionless loop-the-loop as shown in figure. What should be the initial height z, so that m pushes against the top of the track
(at a) with a force equal to its weight ?

8. A small cube of mass m slides down a circular path of radius R cut into large block of mass M, as shown in figure. M rests on a table, and both blocks move without friction. The blocks are initially at rest, and m starts from the top of the path. Find the velocity v of the cube as it leaves the block.

9. The track shown in figure is straight in the horizontal section AB and is a semicircle of radius R in the vertical part BCD. A particle of mass m is given a velocity of $\sqrt{22Rg/5}$ to the left along the track. The particle moves up the vertical section, and ultimately loses contact with it. How far from point B will the mass land ?

10. A ring of mass m can slide over a smooth vertical rod as shown. The ring is connected to a spring of force constant $k = 4mg/R$, where $2R$ is the natural length of the spring. The other end of the spring is fixed to the ground at a horizontal distance $2R$ from the base of the rod. If the mass is released at a height of $1.5R$,

    (a) Calculate the work done by the spring.

    (b) Using the work-energy theorem, calculate the velocity of the ring as it reaches the ground.