

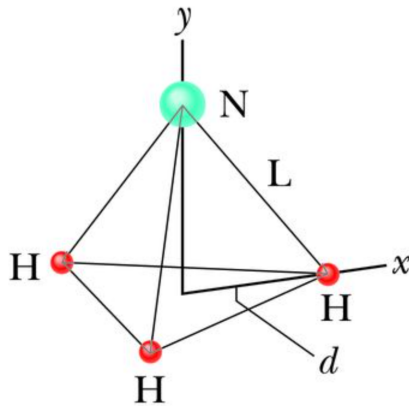
## General Physics B1 - Homework Set 3

Due 11/18/2022, 5:00PM sharp. Please hand in your homework via eLearn.

1 points for each problem. Total:5 points

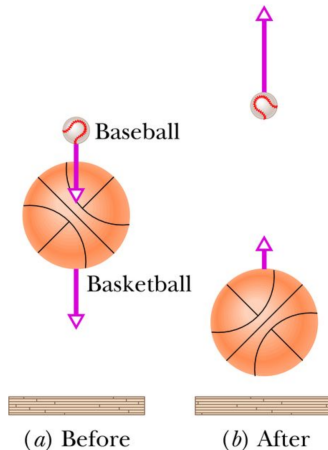
### 1.Center of Mass of an Ammonia Molecule

In the ammonia ( $\text{NH}_3$ ) molecule, three hydrogen (H) atoms form an equilateral triangle, with the center of the triangle at distance  $d = 9.40 \times 10^{-11} \text{m}$  from each hydrogen atom. The nitrogen (N) atom is at the apex of a pyramid, with the three hydrogen atoms forming the base. The nitrogen-to-hydrogen atomic mass ratio is 13.9, and the nitrogen-to-hydrogen distance is  $L = 10.14 \times 10^{-11} \text{m}$ . What are the (a) x and (b) y coordinates of the molecule's center of mass if the coordinate system sets as shown in the following figure? (1point)



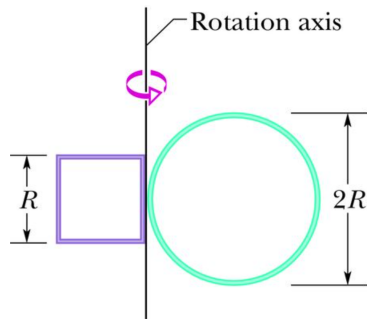
### 2.Elastic Collision

A small ball of mass  $m$  is aligned above a larger ball of mass  $M = 0.63 \text{ kg}$  (with a slight separation, as with the baseball and basketball of Fig.(a)), and the two are dropped simultaneously from a height of  $h = 1.8 \text{ m}$ . (Assume the radius of each ball is negligible relative to  $h$ .) (a) If the larger ball rebounds elastically from the floor and then the small ball rebounds elastically from the larger ball, what value of  $m$  results in the larger ball stopping when it collides with the small ball? (0.5points) (b) What height does the small ball then reach Fig.(b)? (0.5points)



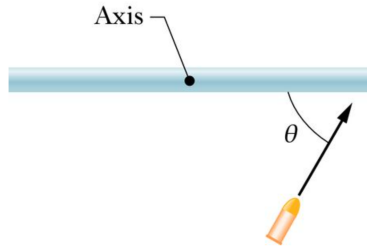
### 3. Rotational Inertia and Angular Momentum

As shown in the following figure, a rigid structure consisting of a circular hoop of radius  $R$  and mass  $m$ , and a square made of four thin bars, each of length  $R$  and mass  $m$ . The rigid structure rotates at a constant speed about a vertical axis, with a period of rotation of  $2.5 \text{ s}$ . Assuming  $R = 0.50 \text{ m}$  and  $m = 2.0 \text{ kg}$ , calculate (a) the structure's rotational inertia about the axis of rotation and (0.5points) (b) its angular momentum about that axis. (0.5points)



#### 4. Conservation of Angular Momentum

In the following fig. (an overhead view), a uniform thin rod of length 0.500 m and mass 4.00 kg can rotate in a horizontal plane about a vertical axis through its center. The rod is at rest when a 3.00 g bullet traveling in the rotation plane is fired into one end of the rod. In the view from above, the bullet's path makes angle  $\theta = 60.0^\circ$  with the rod. If the bullet lodges in the rod and the angular velocity of the rod is 10 rad/s immediately after the collision, what is the bullet's speed just before impact?



#### 5. Oscillation with two springs

In the following figure, two springs are attached to a block that can oscillate over a frictionless floor. If the left spring is removed, the block oscillates at a frequency of 30 Hz. If, instead, the spring on the right is removed, the block oscillates at a frequency of 45 Hz. At what frequency does the block oscillate with both springs attached? (1point)

