1. (20%) A 0.2-kg ball is thrown from the ground with the initial velocity $\bar{v}_o$ as shown in Fig 1.

   In addition to its weight, there is a constant wind force of 8 newtons acting in the y direction. Please find (a) (10%) the position of the ball at the instant it returns to the elevation from which it was thrown, and (b) (10%) the velocity of the ball at that instant.

   Note: *(i) Use g (graviational acceleration) = 9.81m/s².*
   (ii) $\sqrt{2} = 1.414$.
   (iii) Please use the vector form to express the answers (position and velocity), e.g. $\bar{r} = a\bar{i} + b\bar{j} + c\bar{k}$, *where a, b, and c are the calculated results;* $\bar{i}$, $\bar{j}$, *and* $\bar{k}$ *are the unit vectors along the x-, y-, and z- directions, respectively.*

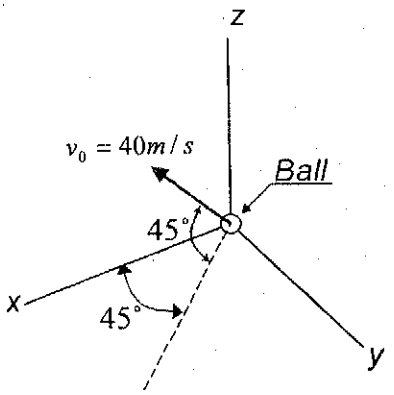

Fig. 1

2. (20%) Two steel balls, each of mass m, are welded to a light rod of length L and neglible mass and are initially at rest on a smooth horizonal surface. A horizontal force of magnitude F is suddenly applied to the rod as shown in Fig. 2. Please determine
   (a) (10%) the instaneous acceleration $\bar{a}$ of the mass center G.
   (b) (10%) the corresponding rate $\ddot{\theta}$ at which the angular velocity of the assembly about G is changing with time.

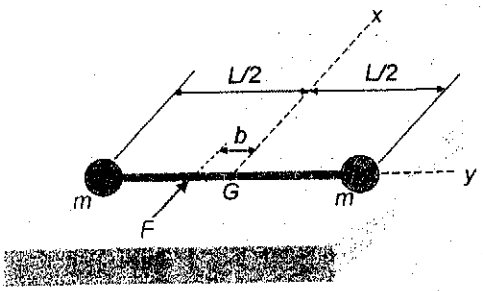

Fig. 2

3. (30%) Two spheres of uniform density, A and B, start from rest and roll, without slipping, down the same incline (Fig. 3). If the radius of Sphere A is larger than that of Sphere B, then
   (a) (10%) which sphere gets to the bottom first?
   (b) (20%) Explain your answer to (a).

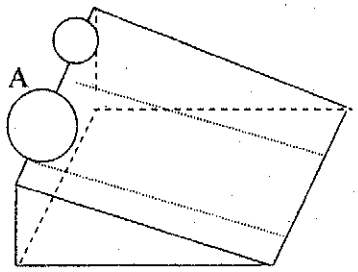

Fig. 3

4. (15%) Given a rigid body in the three-dimensional space, please answer the following questions.
   (a) (5%) How many principal axes does the rigid body possess? What are the differences between these principal axes?
   (b) (10%) Suppose that we want to rotate the rigid body with respect to a fixed axis at a constant angular velocity. Which axis (relative to the rigid body) will yield the minimum rotational energy? Why?

5. (15%) A simplified model for the suspension of a car is shown in Fig. 4, where m is the total mass of the car and k is the effective stiffness. The car is moving along a bumpy road with bumps equally separated by a distance d. Please find the velocity of the car, v, that will result in largest vibration in the vertical direction.

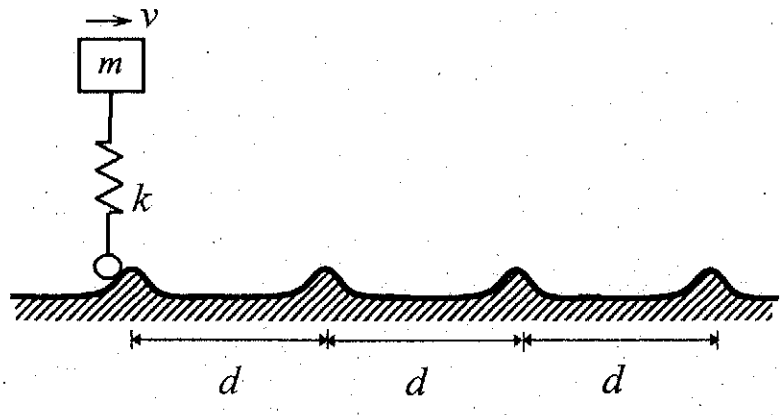

Fig. 4