Sample Exam IIII

MULTIPLE CHOICE (4 pts each)

1) Consider a solid sphere of radius R and mass M, and a disk of mass m (=½ M) and radius r (= ½ R). In a race rolling (without slipping) down an incline, the solid sphere wins. Which of the following is true?

   A) The solid sphere and disk have the same moment of inertia.
   B) The moment of inertia of the solid sphere is larger than that of the disk.
   C) The moment of inertia of the disk is larger than that of the solid sphere.
   D) There is no way to know which moment of inertia is larger.
   E) There is no Choice E.

2) Consider a rigid body, not necessarily in equilibrium. Which of the following statements is always true?

   A) If $\Sigma\vec{F}_n = 0$, then $\Sigma\vec{\tau}_n = 0$.
   B) If $\Sigma\vec{\tau}_n = 0$, then $\Sigma\vec{F}_n = 0$.
   C) If $\Sigma\vec{F}_n \neq 0$, then $\Sigma\vec{\tau}_n \neq 0$.
   D) If $\Sigma\vec{\tau}_n \neq 0$, then $\Sigma\vec{F}_n \neq 0$.
   E) None of these is always true.

3) Consider a solid sphere of mass M and radius R. What is the sphere's moment of inertia about an axis tangent to the surface of the sphere?

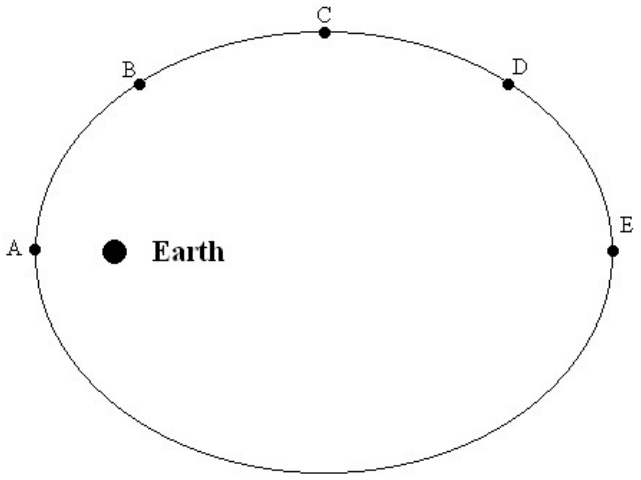
   A) $2/5\ MR^2$
   B) $3/5\ MR^2$
   C) $7/5\ MR^2$
   D) $3/2\ MR^2$
   E) $2\ MR^2$

4) Consider two point masses on the x-axis. M_1 has mass 45 kg and is at x = 4m, while M_2 has mass 35 kg and is located at x = 9m. Where is the center of mass?

   A) 1.0 m
   B) 6.2 m
   C) 6.5 m
   D) 6.8 m
   E) 38 m

5) The moon orbits the earth on a path that is not circular, but elliptical, as shown with great exaggeration in the figure. At which of the labeled points will the moon's speed be greatest?

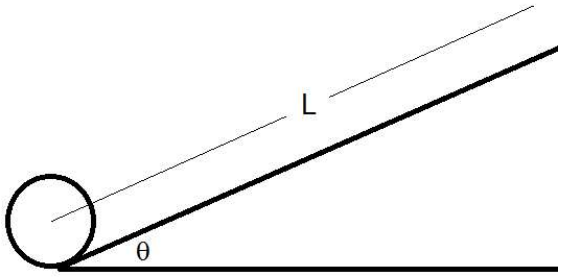
A) A
B) B
C) C
D) D
E) E



PROBLEM I (20 pts)

Suppose that a solid sphere (mass M and radius R) is launched up an incline, as shown, and subsequently rolls without slipping. How far up the incline (L) will the disk go before stopping?

Let M = 4 kg, R = 0.02 m, v_i = 12 m/s, and θ = 53°.

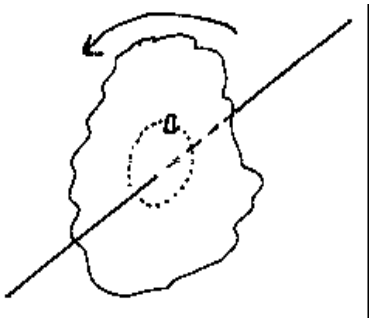


PROBLEM II (20 pts)

Consider a playground merry-go-round, a disk of mass 80 kg and radius 1.5 meters, rotating about a frictionless axis through its center. There are two twins, each of mass 30 kg, sitting at the edge of the disc. The angular speed of the ride is 7 rad/sec. Now, one of the twins moves to the center of the disk. What is the new angular speed?

PROBLEM III (20 pts)

Prove that the rotational kinetic energy of a rigid object as it turns about some axis with angular velocity ω is $KE_{rot} = \frac{1}{2}I\omega^2$, where I ($=\Sigma_n m_n r_n^2$) is the moment of inertia of the object about that axis.



PROBLEM IIII (20 pts)

The blade of a circular saw of diameter 0.3 m accelerates uniformly from rest to 2800 rev/min in 32 seconds.

A) Convert the final angular velocity to radians/second.

B) What is the angular acceleration of the blade?

C) Through what angle did the blade turn in this process?

D) If the mass of the blade is 0.1kg, and the blade can be considered to be a disk, what net torque was applied to the blade during this process?