SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

1) A lawn roller in the form of a uniform solid cylinder is being pulled horizontally by a horizontal force $B$ applied to an axle through the center of the roller, as shown in the figure. The roller has radius 0.65 meters and mass 51 kg and rolls without slipping. What magnitude of the force $B$ is required to give the center of mass of the roller an acceleration of 2.8 m/s²?

2) A long thin rod of length $L$ has a linear density $\lambda(x) = Ax$ where $x$ is the distance from the left end of the rod.
   (a) How far is the center of mass of the rod from the left end of the rod?
   (b) What is the mass of the rod?

3) The angular velocity of a 755-g wheel 15.0 cm in diameter is given by the equation $\omega(t) = (2.00 \text{ rad/s}^2)t + (1.00 \text{ rad/s}^4)t^3$.
   (a) Through how many radians does the wheel turn during the first 2.00 s of its motion?
   (b) What is the angular acceleration (in rad/s²) of the wheel at the end of the first 2.00 s of its motion?
4) In the figure, a uniform ladder 12 meters long rests against a vertical frictionless wall. The ladder weighs 400 N and makes an angle $\theta$ of 79° with the floor. A man weighing 790 N climbs slowly up the ladder When he has climbed to a point that is 7.8 m from the base of the ladder, the ladder starts to slip. What is the coefficient of static friction between the floor and the ladder?

![Diagram of a ladder](image)

5) When a 2.75-kg fan, having blades 18.5 cm long, is turned off, its angular speed decreases uniformly from 10.0 rad/s to 6.30 rad/s in 5.00 s.
   (a) What is the magnitude of the angular acceleration of the fan?
   (b) Through what angle (in degrees) does it turn while it is slowing down during the 5.00 s?
   (c) If its angular acceleration does not change, how long after it is turned off does it take the fan to stop.

6) If the magnitude of the cross product of two vectors is one-half the dot product of the same vectors, what is the angle between the two vectors?

7) A 3.45-kg centrifuge takes 100 s to spin up from rest to its final angular speed with constant angular acceleration. A point located 8.00 cm from the axis of rotation of the centrifuge moves with a speed of 150 m/s when the centrifuge is at full speed.
   (a) What is the angular acceleration (in rad/s$^2$) of the centrifuge as it spins up?
   (b) How many revolutions does the centrifuge make as it goes from rest to its final angular speed?

8) A uniform solid sphere of mass 1.5 kg and diameter 30.0 cm starts from rest and rolls without slipping down a 35° incline that is 7.0 m long.
   (a) Calculate the linear speed of the center of the sphere when it reaches the bottom of the incline.
   (b) Determine the angular speed of the sphere about its center at the bottom of the incline.
   (c) Through what angle (in radians) does this sphere turn as it rolls down the incline?
   (d) Does the linear speed in (a) depend on the radius or mass of the sphere? Does the angular speed in (b) depend on the radius or mass of the sphere?
9) A futuristic design for a car is to have a large solid disk-shaped flywheel within the car storing kinetic energy. The uniform flywheel has mass 370 kg with a radius of 0.500 m and can rotate up to 230 rev/s. Assuming all of this stored kinetic energy could be transferred to the linear velocity of the 1600-kg car, find the maximum attainable speed of the car.

10) For the apparatus shown in the figure, there is no slipping between the cord and the surface of the pulley. The blocks have mass of 3.0 kg and 5.7 kg, and the pulley has a radius of 0.12 m and a mass of 10.3 kg. At the instant the 5.7 kg mass has fallen 1.5 m starting from rest, find the speed of each block. (Assume the pulley is in the shape of a uniform solid disk and has no friction in its axle.)

![Diagram of pulley system]

11) An 82.0 kg diver stands at the edge of a light 5.00-m diving board, which is supported by two narrow pillars 1.60 m apart, as shown in the figure. Find the magnitude and direction of the force exerted on the diving board (a) by pillar A. 
(b) by pillar B.

![Diagram of diving board]

12) An extremely light rod 1.00 m long has a 2.00-kg mass attached to one end and a 3.00-kg mass attached to the other. The system rotates at a constant angular speed about a fixed axis perpendicular to the rod that passes through the rod 30.0 cm from the end with the 3.00-kg mass attached. The kinetic energy of the system is measured to be 100.0 J. (a) What is the moment of inertia of this system about the fixed axis? (b) What is the angular speed (in revolutions per second) of this system?
13) A 20.0-kg uniform door has a width of 1.20 m and a height of 2.50 m. The door is mounted on a post by a pair of hinges, marked 1 and 2 in the figure, at the top and bottom of the door. An external force of 60.0 N, at an angle of 30.0° above the horizontal, is applied to the small doorknob, as shown in the figure. The doorknob is 1.00 m above the bottom of the door.

(a) Find the $x$ component of the force that hinge 1 exerts on the door at the top.
(b) Find the SUM of the $y$ components of the forces that hinges 1 and 2 together exert on the door.

![Diagram of a door with forces applied](image1.png)

14) In the figure, a 10.0- m long bar is attached by a frictionless hinge to a wall and held horizontal by a rope that makes an angle $\theta$ of 53° with the bar. The bar is uniform and weighs 39.9 N. How far from the hinge should a 10.0- kg mass be suspended for the tension $T$ in the rope to be 125 N?

![Diagram of a bar with a mass and forces](image2.png)
15) In the figure, a uniform rectangular crate 0.40 m wide and 1.0 m tall rests on a horizontal surface. The crate weighs 930 N, and its center of gravity is at its geometric center. A horizontal force $F$ is applied at a distance $h$ above the floor. If $h = 0.61$ m, what minimum value of $F$ is required to make the crate start to tip over? Static friction is large enough that the crate does not start to slide.
1) 210 N
2) (a) $2L\beta$  (b) $AL^2/2$
3) (a) 8.00 rad  (b) 14.0 rad/s^2
4) 0.12
5) (a) 0.740 rad/s^2  (b) 2330°  (c) 13.5 s
6) 26.6°
7) (a) 18.8 rad/s^2  (b) $1.49 \times 10^4$ revolutions
8) (a) 7.5 m/s  (b) 50 rad/s  (c) 47 rad
   (d) The linear speed depends on neither the radius nor the mass of the sphere. The angular speed depends on the radius of the sphere.
9) 246 m/s
10) 2.4 m/s
11) (a) 1.71 kN downwards  (b) 2.51 kN upwards
12) (a) 1.25 kg·m^2  (b) 2.01 rev/s
13) (a) -53.4 N  (b) 166 N
14) 8.15 m from the hinge
15) 305 N