AP Physics 1
Rotational Motion Practice Problems

1.) A car on a Ferris wheel has an angular displacement of 0.34 rad. If the car moves through an arc length of 12 m, what is the radius of the Ferris wheel?

2.) How long does it take the second hand of a clock to move through 4.00 rad?

3.) If a flywheel increases its average angular speed by 2.7 rad/s in 1.9 s, what is its angular acceleration?

4.) A drill starts from rest. After 3.20 s of constant angular acceleration, the drill turns at a rate of 2628 rad/s.

a.) Find the drills's angular acceleration.

b.) Determine the angle through which the drill rotates during this period.

5.) A tire placed on a balancing machine in a service station starts from rest and turns through 4.7 revs in 1.2 s before reaching its final angular speed. Assuming that the angular acceleration of the wheel is constant, calculate the wheel's angular acceleration in rad/s^2.

6.) A bicycle wheel has an angular acceleration of 1.5 rad/s^2. If a point on its rim has a tangential acceleration of 48 cm/s^2, what is the radius of the wheel?

7.) A coin with a diameter of 2.40 cm is dropped onto a horizontal surface. The coin starts out with an initial angular speed of 18.0 rad/s and rolls in a straight line without slipping. If the rotation slows with an angular acceleration of magnitude 1.90 rad/s^2, how far does the coin roll before coming to rest?

8.) A fan rotating with an initial angular velocity of 1000 rev/min is switched off. In 2 seconds, the angular velocity decreases to 200 rev/min. Assuming the angular acceleration is constant, how many revolutions does the blade undergo during this time?

9.) A mass attached to a 50.0 cm string starts from rest and is rotated in a circular path exactly 40 times in 1.00 min before reaching a final angular speed. What is the angular speed (in rad/s) after 1.00 min?

10.) A car traveling at 30.0 m/s undergoes a constant negative acceleration of magnitude 2.00 m/s^2 when the brakes are applied. How many revolutions does each tire make before the car comes to a stop, assuming that the car does not skid and that the tires have radii of 0.300 m?

11.) A machine part rotates at an angular speed of 0.60 rad/s; its speed is then increased to 2.2 rad/s at an angular acceleration of 0.70 rad/s^2. Find the angle through which the part rotates before reaching this final speed.

12.) A horizontal 80 kg merry-go-round ($I = 1/2MR^2$) with a radius of 1.5 m is started from rest by a constant horizontal force of 50 N applied tangentially to the outer edge of the merry-go-round. Find the kinetic energy of the merry-go-round after 3 s. Assume it is a solid cylinder.

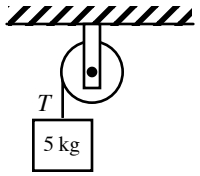
13.) A solid cylinder ($I = 1/2MR^2$) with a mass of 4.0 kg and a radius of 0.050 m starts from rest and rolls 4.0 m down a 30° slope. What is the translational speed of the cylinder when it leaves the incline?

14.) A 5 kg hoop ($I = MR^2$) with a radius of 3.0 m rolls without slipping. If the hoop is given an angular speed of 3.0 rad/s while rolling on the horizontal and allowed to roll up a ramp inclined at 20° with the horizontal, how far (measured along the incline) does the hoop roll?

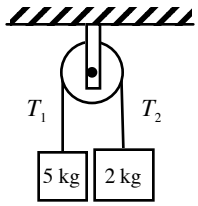
15.) A 30.0 kg solid cylinder has a radius of 0.180 m. If the cylinder accelerates at 0.023 rad/s^2 about an axis through its center, how large is the torque acting on the cylinder? . (For a solid cylinder $I = 1/2MR^2$ when the axis of rotation passes through its center.)

16.) A 350 kg merry-go-round in the shape of a horizontal disk ($I = 1/2MR^2$) with a radius of 1.5 m is set in motion by wrapping a rope about the rim of the disk and pulling on the rope. How large a torque would have to be exerted to bring the merry-go-round from rest to an angular speed of 3 rad/s in 2.0 s?

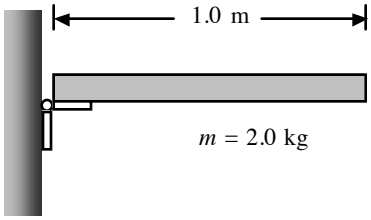
17.) A cable passes over a pulley. Because of friction, the force in the cable is not the same on opposite sides of the pulley. The force on one side is 120.0 N, and the force on the other side is 100.0 N. Assuming that the pulley is a uniform disk ($I = 1/2MR^2$) with a mass of 2.0 kg and a radius of 0.80 m, determine the angular acceleration of the pulley.

18.) 

A light string is wrapped around a solid cylinder ($I = 1/2MR^2$) spool with a radius of 0.075 m and a mass of 10.0 kg. A 5.00 kg mass is then attached to the free end of the string. causing the string to unwind from the spool. What is the angular acceleration of the spool and the tension in the string?

19.) 

A pulley has a mass of 40 kg and a radius of 0.50 m. A cord is wrapped over the pulley and attached to a hanging object on either end. Assume the cord does not slip, the axle is frictionless, and the two hanging objects have masses of 2.0 kg and 5.0 kg. Find the acceleration of each mass and the tension in the cord supporting each mass. (Assume that the pulley is a solid cylinder.)

20.) 

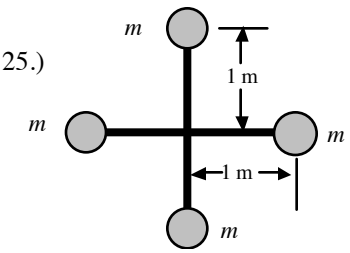
A uniform rod of mass 2.0 kg and length 1.0 m can pivot freely about a hinge attached to a wall as shown below. The rod is held horizontally and then released. At the moment of release, determine the angular acceleration of the rod. The moment of inertia for a uniform rod rotating about one end is $\frac{1}{3}M\ell^2$.

21.) A solid, vertical cylinder with a mass of 10.0 kg and a radius of 1.00 m rotates with an angular speed of 7.00 rad/s about a fixed vertical axis through its center. A 0.450 kg piece of putty ($I = MR^2$) is dropped vertically at a point 0.800 m from the cylinder's center of rotation and sticks to the cylinder. Determine the final angular speed of the system.

22.) A merry-go-round rotates at the rate of 0.30 rad/s with an 80.0 kg man standing at a point 2.0 m from the axis of rotation. What is the new angular speed when the man walks to a point 1.0 m from the center? Assume that the merry-go-round is a solid 650 kg cylinder with a radius of 2.00 m.

23.) A 15.0 kg turntable with a radius of 0.25 m is covered with a uniform layer of dry ice that has a mass of 9.0 kg. The angular speed of the turntable and dry ice is initially 0.75 rad/s, but it increases as the dry ice evaporates. What is the angular speed of the turntable once all the dry ice has evaporated?

24.) A thin rod has a length of 0.20 m and rotates in a circle on a frictionless tabletop. The axis is perpendicular to the length of the rod at one of its ends. The rod has an angular velocity of 0.40 rad/s and a moment of inertia of 1.2 x 10^{-3} kg·m^2. A bug standing on the axis decides to crawl out to the other end of the rod. When the bug (mass = 5 x 10^{-3} kg) gets to the end of the rod, what is the angular velocity of the rod?

25.) 

The system of point masses (m = 2 kg) shown in the figure to the left is rotating at an angular speed of 2.0 rev/s. The axis of rotation is perpendicular to the page and passes through the center of mass of the system. The masses are connected by light, flexible spokes that can be lengthened or shortened. What is the new angular speed if the spokes are shortened to 0.5 m?