1. A record player is set to 45 rpm and plays an old vinyl single record. The song lasts 3.0 minutes. (a) What is the angular speed of the disk? (b) Find the angular displacement and number of revolutions.

2. The record player is switched from 45 rpm to 33.3 rpm (both clockwise) and it is noted that it takes 1.50 seconds to reach its new speed. (a) Find the angular acceleration. (b) Calculate the angular displacement.

3. When switched "on", the record player accelerates 6.3 rad/s^2. When switched "off", it decelerates 1.8 rad/s^2. Suppose it is switched on and accelerates for 1.2 s and then turned off. Determine the maximum angular speed and the total number of revolutions it will make, starting and ending at rest.

4. A disk is rotating at 2.0 rad/s. Two objects are atop the disk – one at a radius 0.10 m, the other at a radius of 0.20 m. (a) Determine the speed of each object. (b) Do this problem symbolically!

5. (a) Find the angular displacement and distance traveled by each object in 10.0 seconds using values from the previous problem. (b) Derive a formula relating angular displacement and distance.

6. Suppose the same two objects remain atop the disk as its angular speed increases to 5.0 rad/s in 4.0 s. Find the angular acceleration and the rate of change in the "linear" speed of each object.

7. Using a wrench of length 0.25 m a plumber tightens a pipe fitting by exerting a force of 150 N at the end of the wrench. (a) What is the most torque that can be generated with this much force? (b) If torque of amount 75 N m is required how much force must be exerted?

8. Kids on a teeter-totter sit on either side of a pivot. A 40.0 kg kid sits 1.5 m to the right and a 30.0 kg kid sits 1.6 m to the left.
(a) Determine the net torque.
(b) Repeat with teeter-totter tilted by 20.0°.
(c) Where should the 40.0 kg kid sit to balance the teeter-totter?

9. A string is wrapped around an axle of diameter 3.0 cm. It the tension in the string is 50.0 N what amount of torque acts on the axle?

10. A spinning yo-yo is placed on the ground and continues to spin as friction acts. Find the torque due to friction, given that yo-yo has mass 100.0 g, radius 2.5 cm, and the coefficient of friction is 0.30.

11. Find the rotational inertia of two 0.50 kg masses rotating about a midpoint separated by 0.40 m. Repeat for a separation of 0.80 m.

12. Find the rotational inertia of two 0.50 kg masses separated by 0.40 m, but rotating about a point 0.10 m from one and 0.30 m from the other.

13. Find the rotational inertia of a row of four identical objects rotating about one end. Each object is 2.0 kg evenly spaced 0.10 m apart.

14. Repeat the previous problem but now with 101 objects in a row of length L with total mass M! (Show that the result is essentially equivalent to the rotational inertia of a rod rotating about one end.) Make use of the partial sum:

$$\sum_{1}^{m} n^2 = \frac{m(m+1)(2m+1)}{6}$$

15. A particular electric drill is capable of delivering torque of amount 80.0 Nm and is attached to a grinding wheel with rotational inertia 1.26×10^{-4} kg m^2 and diameter 7.6 cm. It is used to grind a surface where $\mu = 0.30$. (a) What is the greatest possible angular acceleration of the wheel? (b) Find the greatest force with which the wheel can be pressed against the surface without it slowing down.

16. A force of 10.0 N acts tangentially on the rim of a wheel with moment of inertia 0.15 kg m^2 and radius 0.20 m. If the force acts on the wheel for 0.50 s, what is the resulting angular speed? Ignore friction.

17. The platter on a particular record turntable has mass 0.75 kg and radius 0.13 m and its rotational inertia is that of a cylinder: $I = \frac{1}{2} MR^2$. When the turntable is switched on it accelerates 5.0 rad/s^2; when it is powered off, the platter decelerates at 2.0 rad/s^2. (a) Find the torque due to friction within the machine. (b) Find the torque of the motor system. (c) What force would a person have to exert on the rim to move the platter at a constant angular speed with the motor turned off?

18. If a record of mass 220 g and radius 15.2 cm is played on the turntable described in the previous problem what will be the time required for it to reach 33.3 rpm?

19. A string of length 30.0 cm is wrapped around the 2.0 mm diameter axle of a toy gyroscope. A tension of 4.0 N is maintained in the string during the 2.5 s it takes to pull it off the axle and set the gyroscope spinning. Determine the rotational inertia of the gyroscope. Ignore friction in the axle bearings.

20. The rotational inertia of a pulley can be modelled by $I = nMR^2$ (n typically between 0.5 and 1). A string passing over the pulley has tension on either side: T_1 and T_2 and linear acceleration a. Derive an expression for the difference in the tension, $\Delta T = T_2 - T_1$ in terms of n, M, R, a, and appropriate constants.

21. A pulley with radius 2.54 cm is attached to the edge of a table. A string passing over the pulley at one end connects to a cart of mass 1.50 kg and at the other end hangs a mass of 0.100 kg. When the system is released the cart and mass accelerate at 0.600 m/s^2. Ignore friction on the cart and the pulley. (a) Determine the torque acting on the pulley. (b) If the mass of the pulley were doubled, what would be the acceleration of the system? Hint: use the result from the previous problem and substitute!

22. A thin rod of mass M and length L is suspended by two strings attached to its ends and held in a horizontal position. When the rod is rotated about its center the strings twist together causing the rod to be raised a vertical distance h. Suppose the rod is released from rest and falls distance h as the strings untwist – derive an expression for the maximum angular speed of the rod.

23. A meter stick is balanced on one end but then falls flat on the floor, pivoting around the bottom end without slipping. Find the speed of the free end of the stick hitting the floor.

24. A kid with rotational inertia 1.9 kg m^2 stands on a rotating platform that is not spinning. He holds a spinning wheel with rotational inertia 0.094 kg m^2 and mass 2.0 kg spinning with frequency 4.0 Hz about a vertical axis that is 0.40 m away from the axis of the platform. If the kid uses his hand to stop the wheel spinning, what is the resulting period with which the kid will rotate on the platform? Ignore friction. Does the manner in which he stops the wheel matter?

25. A lump of clay with mass 10.0 g and speed 4.0 m/s hits a rod with rotational inertia 5.2 g m^2 that is initially at rest. The clay hits the rod perpendicularly at radius 0.18 m and sticks there. (a) Determine the resulting angular speed of the rod. (b) Show mathematically whether or not this is an elastic collision.

26. Scientists tell us that the Moon is moving away from the Earth (very slowly). The radius of its orbit will change from 384 Mm to 548 Mm over billions of years. (a) Determine the change in its angular momentum. (b) As a result of this, the length of one day changes from 24 h to what?

27. Mars ($m = 6.42 \times 10^{23}$ kg) has an elliptical orbit in which its distance from the Sun varies from 207 Gm to 249 Gm. Given that its minimum speed is 22.0 km/s determine its angular momentum and its maximum speed. Find its change in kinetic energy and compare to the change in gravitational potential energy.

28. The Juno spacecraft orbits Jupiter (m = 1.898×10^{27} kg) and its distance from the center varies from 8.17×10^{9} m to 7.42×10^{7} m. Use conservation of angular momentum and conservation of energy to find its speed at these two points in its very elliptical orbit.