Materials
Pasco Introductory Rotational Motion Apparatus
Masking Tape
Stop Watch
Large ball of clay

Introduction
In this experiment we will investigate several aspects of rotational motion including angular velocity, angular acceleration, torque, and moment of inertia. Our apparatus will consist of a turntable rotating on a low friction bearing.

Part I Angular Velocity
1. Given a piece of tape and a stop watch, describe a procedure for determining the angular velocity of the turntable as it spins.

2. Employ the procedure and measure the angular velocity of the turntable when you spin it at three different speeds, slow medium and fast. Create a data table in the space below and record your results in the table.

Part II Angular Acceleration
In this part of the lab, we will let the apparatus rotate freely, then slow it for a while using a light pressure due to our finger and then let it rotate freely again.

3. During which part of the motion will there be an angular acceleration?
4. Describe a procedure for determining the angular acceleration for this procedure using the same materials as in part I. Check your procedure with your instructor.

5. Start the turn table spinning and then slowly slow it with a light pressure from your finger. Record your data and your determination of the angular acceleration in a table in the space below.

Part III Torque
In this part we will examine the conditions necessary to produce an angular acceleration. With the turn table initially at rest, use your index finger to apply a force along the tangent at the edge of the turn table.

6. Describe the resulting motion of the turn table.

7. Was there an angular acceleration? Explain.

Trying to keep the force about the same, apply the force along the tangent but at four successively smaller radii. **Each time start the wheel from rest.**

8. Describe how the resulting motion of the turn table changes as you reduce the radius. In particular describe the affect on the angular acceleration.

Starting the turn table at rest each time, push on the edge of the turntable along the tangent with successively harder forces. Do this three or four times.

9. Describe how the angular acceleration changes when you increase the tangential force along the edge of the turn table.

   Now apply a force along a line directed towards the center of the turn table, i.e. radially.
10. Does directing the force radially produce the same angular acceleration as directing it tangentially? Explain.

The quantity that produces an angular acceleration is called *torque*.
In questions 7 – 10 we have investigated three things that might produce torque.

11. From your observations, describe how torque might depend on force.

12. From your observations, describe how torque might depend on the radius at which the force is applied.

13. From your observations, describe how torque might depend on the direction at which the force is applied.

We usually combine these observations into a single formula for torque given by $\text{Torque} = \text{Force} \times \text{Lever Arm}$, where force is the tangential force that is applied and the lever arm is the distance from the axis of rotation at which the force is applied.

**Part IV Moment of Inertia**
In this part we will examine the factors that affect the moment of inertia.

Spin the turn table so that it is rotating about 1/2 turn per second. Take a large ball of clay and drop it as close to the center of the turn table as you can.

14. Describe the effect on the rotation of the turn table.

Repeat but drop the clay further from the axis this time.

15. Describe the effect on the rotation of the turn table.

Repeat two more times dropping the clay further from the axis, with the last drop being about at the edge of the turntable.

16. Describe the effect on the rotation of the turn table.

Now again spin the turn table at about 1/2 rotation per second and drop along the edge clay balls of increasing mass.

17. Describe the effect on the rotation of the turn table.
**Summarize your observations:**
Dropping the clay ball further from the axis produced a __________ change in the rotation. Dropping larger clay balls at the edge produced a __________ change in the rotation.

Now place the clay ball at the center of the turntable and push gently along the tangent at the edge of the disk. Observe the angular acceleration of the disk.

Move the clay ball to a radius about ½ way from the center. Push on the edge with about the same force as before.

18. Compare the angular acceleration produced in the two cases.

Move the clay ball to edge of the turntable. Push on the edge with about the same force as before.

19. Compare the angular acceleration produced in all three cases.

In linear motion we saw that it was mass that resisted acceleration. In rotational motion, it is more complicated. It is not just mass, but also where it is located that resists motion. In fact what determines the resistance of an object to an angular acceleration is proportional to mass x radius$^2$. The quantity is called the moment of inertia. (Your text often refers to it as rotational inertia.)