

Lab 7a: Rotational Dynamics

Goals: Improve communication and teamwork capacities; Improve confidence in hands-on work with equipment; Improve ability to make, describe, and record observations; Learn to use a data logger with a rotary motion sensor to measure rotational kinematics data; Gain more practice with graphical representations of (rotational) motion; Use Newton's 2nd Law for rotations and translations to determine moments of inertia.

Equipment: You will be oriented to the equipment, set-up, and use of the equipment for today's investigation, which involves a rotary motion sensor and various accessories. Make sure you include a sketch of your experimental set-up in your lab notebook.

Groups & Lab Notebook: Groups of 2. Update Table of Contents. General Lab Notes guidelines.

Part 0: Getting Started

- a) You will be oriented to equipment and today's investigation in the opening remarks.
- b) Make a folder in the program share Workspace named 'Lab 7 Name 1 Name 2' as suitable for your team.
- c) Set up the equipment as in the demonstration version.
- d) Make sure that the released mass doesn't crash into the table.
- e) Draw a sketch of your experimental set-up in your lab notebook.

Part 1: Predictions

As described in the equipment orientation, consider (without yet setting anything up!) which scenario will result in the greater acceleration: with the point masses **close to** the axis of rotation or **far from** the axis of rotation. Discuss with your partner, and record your prediction and reasoning. Discuss your prediction with your instructor.

Part 2: Observations

Set up your equipment, and test your predictions. There's no need to make measurements in this step (that comes next), so just concentrate on observing the motion to test your prediction. Record your observations, especially as to which scenario has the greater acceleration, and compare to your predictions.

Part 3: Measurements

Use LoggerPro to measure rotational kinematics data for the two scenarios, with the goal of experimentally determining the angular acceleration in each situation. As needed, show your data to your instructor if you're not sure of its quality. Record the angular acceleration, noting how you determined it from the data you obtained. Save any graphs for later inclusion in your lab notebook, and save your LoggerPro file.

Analysis:

Use Newton's Second Law for rotations and translations and your experimentally measured quantities to determine the moments of inertia of the rotating objects in the two configurations you observed.

Lab 7b: Round and Round

Goals: Improve communication, teamwork capacities, observational skills, and record-keeping; gain exposure to and experience with a wide variety of rotational phenomena; have fun with physics phenomena

Equipment: varies depending on station.

Groups & Lab Notebook: Groups of 2. Record activity and qualitative observations. Update Table of Contents. General Lab Notes guidelines.

Part 0: Getting Started

You will be oriented to the stations involved with today's investigation in the opening remarks. For each station, record the activity and qualitative observation. Some of what you observe/experience can be explained with physics we have previously studied, and the rest can be understood with physics we are about to study.

Station: Ramp and Roll

If needed, set up the ramp. Assemble (or identify) the disks so that one has the four steel marbles symmetrically arranged close to the center and the other has the four steel marbles symmetrically arranged farther from the center. Release both disks from rest from the same height on the ramp, so that they have a "race" to reach the bottom. Which configuration wins, or do they tie?

Station: Hoberman Sphere

- With the Hoberman sphere fully expanded and not rotating at all, pull down on the central string to see it collapse. What direction is the string pulling? Does this result in any net external torque with respect to the axis of the sphere?
- Now, release the string to expand the sphere. Give it a little bit of spin about its central axis, and pull the string again. What do you observe about the motion of the sphere? What do you observe about the effort required to pull the string (compared to the previous case when the sphere wasn't spinning)?

Station: Wheel Walk

- Hold the bicycle wheel (not spinning) in your hands in front of you (like you are a zombie holding a bicycle wheel). Orient the wheel so that it is vertical. Walk forward. While walking, turn right. While walking, turn left.
- Now, spin the wheel as fast as you can. For consistency with fellow students, spin the wheel so that it spins away from you; you hold the handles and your partner gets the wheel spinning very fast. Repeat your previous motion: walk forward; then, while walking, turn right; then, while walking, turn left. What do you feel? What do you observe the wheel to do?

Station: Sit and Spin

Note: Partner needs to act as spotter

Note: If you are prone to motion sickness, make sure to have your partner spin you very gently, or you can just observe your partner.

- Sit on the stool with your arms close to your body and your legs close to the chair (optional: hold a weight in each hand, close to your body). Make sure that when you extend your arms and legs that you won't hit anything. Bring your arms and legs close in again. Your partner should (gently! less than 1 revolution per second) spin you. You should be spinning freely, and your partner should step back. Extend your arms and legs out. What happens? Bring your arms and legs back in. What happens?
- If you are feeling adventurous, you can repeat this activity, starting with a faster initial spin.
- If you are feeling REALLY adventurous, you can start with your arms and legs extended for the initial spin, and then bring your arms and legs in – but please be very careful and make sure your partner is ready to spot you!

Station: Wheel Sit and Spin

- Sit on the stool with your feet firmly planted on the ground. Your partners should get the bicycle wheel spinning as fast as they can, then hand it to you (with your feet still on the ground). You should hold the wheel so that is oriented horizontally, spinning clockwise as viewed from above. Now, lift your feet off the ground. You should be stationary. Next, flip the wheel so that now it is spinning counterclockwise as viewed from above. What happens?
- Next: flip the wheel back so that it is again spinning clockwise as viewed from above. What happens?
- If needed, have your partners spin the wheel back up to speed. Put your feet back on the ground so that you are stationary. Again, lift your feet off the ground. You should be stationary. As before, hold the wheel horizontally, spinning clockwise as viewed from above. This time, bring the wheel in contact with the seat of the stool or with your pants (but not bare skin) so that the friction brings the wheel to a stop. What happens?