Centripetal and Angular Acceleration Lab

Materials: Turntable or “lazy susan”, phone with app “PhyPhox” downloaded, meterstick, tape to attach phone to turntable

Part 1: In part 1 of this lab you will approximate the angular acceleration of a turntable due to friction, then compare with the measured value from an accelerometer in a smart phone.

1. Sketch plots of θ-t, ω-t, and α-t of the turntable as it slows down due to friction.
2. Approximate through calculation the angular acceleration, α, of your turntable due to friction without using any data from a phone.
3. State the assumptions that you made in your above calculation.

1. Tap “gyroscope” on your phone and experiment with it to find what it does. Explain what ωx, ωy, ωz, and the ωabsolute all measure.
2. Measure the angular acceleration of your turntable due to friction using the gyroscope in your phone. Explain what you did to find it. *(Look at the data for ωabsolute, tap “pick data”, then click and drag, and your phone will perform calculations for you.)*

X 100

1. Calculate the percent error in your calculation. What is a possible reason for the error present in your experiment? **Make sure that your reason is specific enough to establish the direction of error your experiment has. Make sure that the direction of error is in agreement with the reason you chose**. *(e.g. ‘timing error’ is too vague. Did the stopwatch get started too early or too late?)*

Part 2: In part 2 of this lab you will find the location of the accelerometer within your phone.

1. Tap “acceleration without g”. Click play, spin the turntable with your phone attached to it, allow it to slow to a stop. View the graphs for acceleration data that were collected. What direction does the app define as x, y, and z with regard to your phone’s orientation? Draw the axes on the phone in the picture below. Explain how you know. *(⨂ means an axis oriented into the page, and ⊙ means an axis oriented out of the page)*

Top of phone

1. Tap “centripetal acceleration”. Take data and find an approximate average of ceptripetal acceleration and angular velocity over a period of approximately constant speed. Use this to find the radius at which your accelerometer is located. Remember that the centripetal acceleration (v^2/r) will equal the total acceleration only in uniform circular motion. In the space below, draw a real-sized outline of the phone that you used in this experiment. Draw the curved line at which you predict the accelerometer lies upon.
2. The answer to the previous question gave a radius away from the center of rotation that the accelerometer is located within your phone. Figure out how to take another set of data in order to find a prediction of the location of the accelerometer. Take the data, then draw another line on the phone outline above at which you know the accelerometer lies upon. The intersection of the two lines is your prediction of the location of the accelerometer. *(We are not interested in how “high” off the turntable the accelerometer is, because a phone is so thin.)*
3. Place your phone on the turntable such that your accelerometer is directly on the axis of rotation. What would the centripetal acceleration be if your prediction were exactly right? Prove it with an equation. Test it using the same procedure as the last two questions and determine the radius of the accelerometer from the axis of rotation.
4. What are possible sources of error in this experiment that would lead to the error in the previous question?

Part 3: Extension Questions. *(No data needed for this section)*

1. If you had data for ωabsolute(t) from t=0 to t=tf where your turntable stops spinning, how could you find Δθ, the angular displacement?
2. On the dots below, sketch the acceleration vector that a particle on the top of the turntable would be experiencing if the turntable was speeding up or slowing down. Include components of acceleration. Assume your turntable is rotating clockwise.

 Speeding up Slowing down

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1. Assume that you oriented your phone such that the x axis always points tangent to the path of the phone around the circle, and then you push the turntable and then wait for it to stop spinning. Over what timeframe should be evaluated in order to ensure that it equals zero? Explain.