Physics: Rotational Motion Investigation

Research Questions
1. How are mass, inner radius, outer radius, and rotational inertia related?
2. How are rotational inertia, angular acceleration and torque related?
3. How are rotational inertia, angular momentum and angular velocity related?
4. When is angular momentum conserved?
5. How are rotational inertia and angular momentum related to their translational counterparts?

Part 1 – Rotational Inertia Simulation Lab
Use the University of Colorado’s PhET Torque simulation: http://phet.colorado.edu/en/simulation/torque.
• Click on the “Rotational Inertia” tab. Set the simulation speed to slow until you become more familiar with all the parameter settings and graphs.
• Design and conduct an experiment to answer the first two research questions.

Procedure
1. Determine your independent and dependent variables. Be sure to test enough values so you can distinguish between a linear and second order polynomial relationship.
2. If there is more than one independent variable, design multiple trials that vary one independent variable at a time, while controlling the remaining ones.
3. Be sure to test enough values so you can distinguish between a linear and power relationship.
   [Hint: when investigating the effects of outer radius, set the inner radius to zero.]

Data
Create a data table on a separate sheet to record the independent, dependent and control variables.

Data Analysis
On separate sheets create Excel graphs showing the regression analysis and “best fit” equations that show the relationship between the independent variables and the dependent variables. Only explore linear and power relationships. Do not explore polynomial, exponential or logarithmic relationships. When determining your mathematical relationships, remember that the exponents of variables are usually integers or a fraction that is a ratio of two small integers.

Conclusions
1. Using your own words, explain the concept of rotational inertia.
2. How are mass and rotational inertia related?
3. How are inner radius, outer radius and rotational inertia related?

4. How are mass, outer radius and rotational inertia mathematically related when the inner radius is zero?

5. How are torque and angular acceleration related?

6. How are torque and rotational inertia related?

7. How are torque, rotational inertia, and angular acceleration related?
Part 2 – Angular Momentum Simulation Lab

Use the University of Colorado’s PhET Torque simulation: [http://phet.colorado.edu/en/simulation/torque](http://phet.colorado.edu/en/simulation/torque).

- Click on the “Rotational Inertia” tab. Set the simulation speed to slow until you become more familiar with all the parameter settings and graphs.
- Design and conduct an experiment to answer the third and fourth research questions.

Procedure

1. Determine your independent and dependent variables.
2. If there is more than one independent variable, design multiple trials that vary one independent variable at a time, while controlling the remaining ones.
3. Be sure to test enough values so you can distinguish between a linear and power relationship.  
   [Hint: when investigating the effects of outer radius, set the inner radius to zero.]

Data

Create a data table on a separate sheet to record the independent, dependent and control variables. Be sure to include any important qualitative observations.

Data Analysis

On separate sheets create Excel graphs showing the regression analysis and “best fit” equations that show the relationship between the independent variables and the dependent variables. Only explore linear and power relationships. Do not explore polynomial, exponential or logarithmic relationships. When determining your mathematical relationships, remember that the exponents of variables are usually integers or a fraction that is a ratio of two small integers.

Conclusions

8. Using your own words, explain the concept of angular momentum.

9. How are angular momentum and rotational inertia related?

10. How are angular momentum and angular velocity related?
11. How are angular momentum, rotational inertia, and angular velocity mathematically related?

12. When is angular momentum conserved?

**Tying it All Together (Research Question #5)**

13. How are rotational inertia and translational inertia similar to each other?

14. How is the relationship in #7 similar to Newton’s Second Law?

15. How are angular momentum and translational momentum similar?

16. How are the conservation of angular momentum and the conservation of translational momentum similar?