Angular Acceleration

Purpose:

To determine the qualitative and quantitative relationship between the angular acceleration and the quantities that affect it.

Getting Ready:

Navigate to the **Angular Acceleration** Interactive at The Physics Classroom website:
https://www.physicsclassroom.com/Physics-Interactives/Balance-and-Rotation/Angular-Acceleration

Navigational Path:

www.physicsclassroom.com ==> Physics Interactives ==> Balance and Rotation ==> Angular Acceleration

Getting Acquainted:

The simulation animates the motion of a rotating system. The rotating system consists of a spindle to which one to three heavy platters can be attached. A mass attached to a string can be wrapped around the spindle. When released, the mass falls under the influence of gravity. As it does, the string exerts a torque upon the spindle to cause the spindle-platter system to begin rotating. The distance from the axis of rotation to where the string is attached (known as spindle radius) can be changed.

There are several output quantities in this simulation. You are likely familiar with the linear quantities –distance, speed, and acceleration. There are also three rotational quantities – **angular displacement** (*theta* or Θ), **angular speed** (*omega* or ω), and **angular acceleration** (*alpha* or α).

Take some time to get acquainted with the simulation interface. Tap to change the hanging mass, the number of platters, and the spindle radius. Learn how to use the **Go** button, the **Reset** button, and the **Step Forward** and **Step Backward** buttons.

Part 1: Angular Acceleration and Hanging Mass

1. Alter the **Hanging Mass** values and run the simulation. Keep the **Number of Platters** and the **Spindle Radius** constant. Gather data for the angular acceleration for all three mass values.

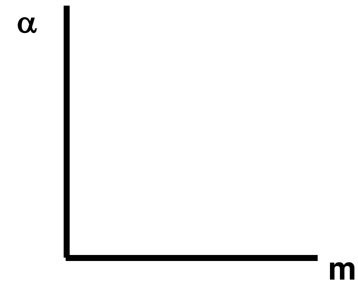
2. As the hanging mass is increased, the angular acceleration ______________ (↑, ↓).

3. Use your understanding of torque and rotation to propose a reason for why this relationship exists.

\# of Platters = _____
Spindle Radius = _____ m

Hanging Mass	Angular Acceleration
0.1 kg	
0.2 kg	
0.3 kg	

4. Is the relationship between angular acceleration (α) and the hanging mass (m) a linear or non-linear relationship? Sketch the graph at the right. Support your answer using data in your table.



5. For the data in your table, predict the value of the angular acceleration for a trial in which the hanging mass was …
   a. … 0.4 kg? a = ____________ rad/s^2 b. … 0.5 kg? a = ___________ rad/s^2

Part 2: Angular Acceleration and Number of Platters

6. Alter the **Number of Platters** and run the simulation. Keep the **Hanging Mass** and the **Spindle Radius** constant. Gather data for the angular acceleration for all three possible number of platters.

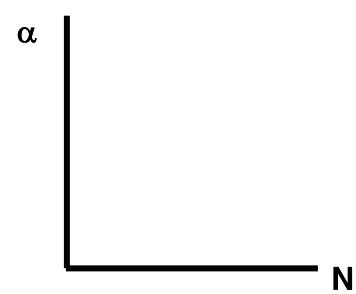
Hanging Mass = _____ kg
Spindle Radius = _____ m

# of Platters	Angular Acceleration
1	
2	
3	

7. As the # of platters is increased, the angular acceleration _____________ (↑, ↓).

8. Use your understanding of torque and rotation to propose a reason for why this relationship exists.

9. What would a plot of α vs. **N** look like? (N = # of platters) Draw it and explain why you drew it as is. Use the data in your table to support your explanation.



10. For the data in your table, predict the value of the angular acceleration for a trial in which the number of platters was …
    a. … 4? a = ____________ rad/s^2 b. … 5? a = ___________ rad/s^2

Part 3: Angular Acceleration and Spindle Radius

11. Alter the **Spindle Radius** and run the simulation. Keep the **Hanging Mass** and the **Number of Platters** constant. Gather data for the angular acceleration for all three possible radii.

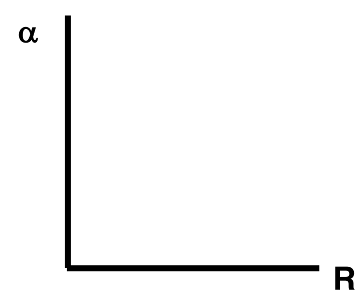
Hanging Mass = _____ kg
\# of Platters = _____

Spindle Radius	Angular Acceleration
0.01 m	
0.02 m	
0.03 m	

12. As the Spindle Radius is increased, the angular acceleration _____________ (↑, ↓).

13. Use your understanding of torque and rotation to propose a reason for why this relationship exists.

14. Is the relationship between angular acceleration (α) and the spindle radius (R) a linear or non-linear relationship? Sketch the graph at the right. Support your answer using data in your table.

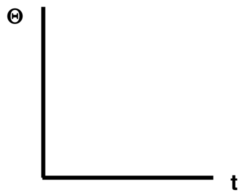


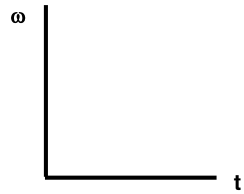
15. For the data in <u>your table</u>, predict the value of the angular acceleration for a trial in which the spindle radius was …
a. … 0.04 m? a = ____________ rad/s^2 b. … 0.06 m? a = ___________ rad/s^2

Part 4: The Other Angular Quantities

Now for something completely different. You will attempt to determine the relationship between the angular displacement (Θ) and the time and the angular velocity (ω) and the time (t). This will require that you collect a reasonable amount of good data for a single trial. It is recommended that you find a trial that lasts for at least 8.0 seconds. Then use the Step Forward/Backward buttons to acquire data for t, Θ, and ω at 0.5-second or 1.0-second intervals. Record a reasonable amount of data in the provided table. Use all 12 rows if needed. Then answer the three analysis questions.

16. Construct a sketch of the data below.





Trial	**t (s)**	**Θ (rad)**	**ω(rad/s)**
1	0	0	0
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

17. Describe the relationship between **Θ and t** as being linear, inverse, or quadratic. Use some data from the table as evidence and use some reasoning to support your claim.

18. Describe the relationship between **ω and t** as being linear, inverse, or quadratic. Use some data from the table as evidence and use some reasoning to support your claim.