ROTATIONAL INERTIA VERSUS ANGULAR ACCELERATION

Equal torque, mass distribution, and rotational response

Name: ____________________________	Period: ____________	Date: ______________

INVESTIGATION QUESTION **For the same torque, how does angular acceleration depend on rotational inertia?**

TIME	SIMULATION	UNIT 5
30 minutes	BuildPhysics > Rotational inertia versus angular acceleration	Torque & Rotational Dynamics

Learning targets

- Compare angular accelerations for objects with different mass distributions.
- Test the relationship $\alpha = \tau/I$.
- Determine how torque changes angular acceleration at fixed rotational inertia.

Model before you measure

A tangential force applied at radius r produces torque $\tau = rF$. Rotational inertia measures resistance to angular acceleration.	$\Sigma\tau = I\alpha$ $\alpha = \tau/I$ $I = cMR^2$

Important: Keep torque constant in Part A. Record rotational inertia from the Object Inspector rather than assuming all objects have the same I.

Pre-lab prediction | 4 minutes

1. For equal mass and radius, which has greater rotational inertia: a solid disk or a hoop?

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2. Which should have greater angular acceleration under the same torque?

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3. If torque doubles at fixed I, what should happen to α?

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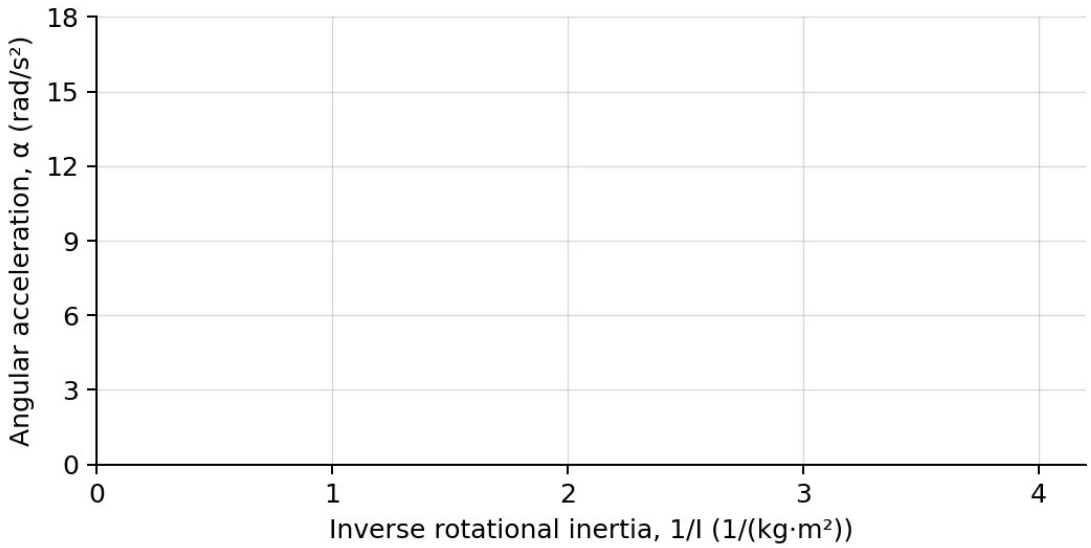
PART A Change rotational inertia at constant torque

Setup | 3 minutes

- ☐ Load Rotational inertia versus angular acceleration. Confirm the two rotors receive equal tangential forces at equal radii.
- ☐ Record mass, radius, inertia factor c, rotational inertia I, torque, and angular acceleration.
- ☐ Create additional trials by changing one rotor's inertia factor or mass distribution while keeping torque fixed.
- ☐ Reset and run briefly so the initial angular acceleration can be measured before large angular speeds develop.

Data table | 10 minutes

Rotor	Mass M (kg)	Radius R (m)	Inertia I ($kg \cdot m^2$)	1/I ($1/(kg \cdot m^2)$)	Angular acceleration α (rad/s^2)
Solid disk					
Hoop					
Modified rotor 1					
Modified rotor 2					



4. Plot angular acceleration versus inverse rotational inertia. Draw a best-fit line.

PART B Change torque at fixed rotational inertia

Torque test | 7 minutes

Fixed rotor: Choose one rotor and keep its mass, radius, and inertia factor unchanged. Change only the applied tangential force.

Trial	Applied force (N)	Torque τ (N·m)	Angular acceleration α (rad/s²)
1			
2			
3			
4			

Analysis | 7 minutes

5. What should the slope of the α-versus-1/I graph represent?

6. How did moving mass farther from the axis affect I and α?

7. What relationship did Part B show between torque and angular acceleration?

8. Explain why equal masses and radii do not guarantee equal rotational inertia.

Claim-Evidence-Reasoning conclusion

Evaluate this claim: Objects with the same mass always have the same angular acceleration when the same torque is applied.

CLAIM	Accept, reject, or revise the statement.
EVIDENCE	Cite at least two measured trials or graph features.
REASONING	Use mass distribution, rotational inertia, and $\Sigma\tau = I\alpha$.

Exit ticket

A rotor's rotational inertia doubles while applied torque stays constant. Predict the new angular acceleration relative to the original.