PH202 Midterm 1 Review

Rotational Kinematics, Torque, Angular Momentum and Rotational Kinetic Energy

Warm-Up 1: 1 minute

- Say this equation in words

$$L_O = I_O \omega_O$$

Warm-Up 1 Solution

Angular Momentum

Moment of Inertia

Angular momentum

Angular Velocity

$$L_o = I_o \omega_o$$

In words: The **angular momentum** about axis o is equal to the **moment of inertia** multiplied by the **angular velocity** about axis o.

Warm-Up 2: 1 minute

- Say the equation in words

$$\sum \tau_{ext,0} \Delta t = \Delta L_o = I_o \Delta \omega_o$$

Warm-Up 2 Solution

Angular Impulse

Summation | External Torque | Change in time | Change in Angular momentum | Moment of inertia | Change in angular velocity

$$\sum \tau_{ext,0} \Delta t = \Delta L_o = I_o \Delta \omega_o$$

In words: The **net torque** external to the system multiplied by the **change in time** is equal to the change in **angular momentum** about axis o which is equal to the **moment of inertia** about axis o multiplied by the change in **angular velocity** about axis o.

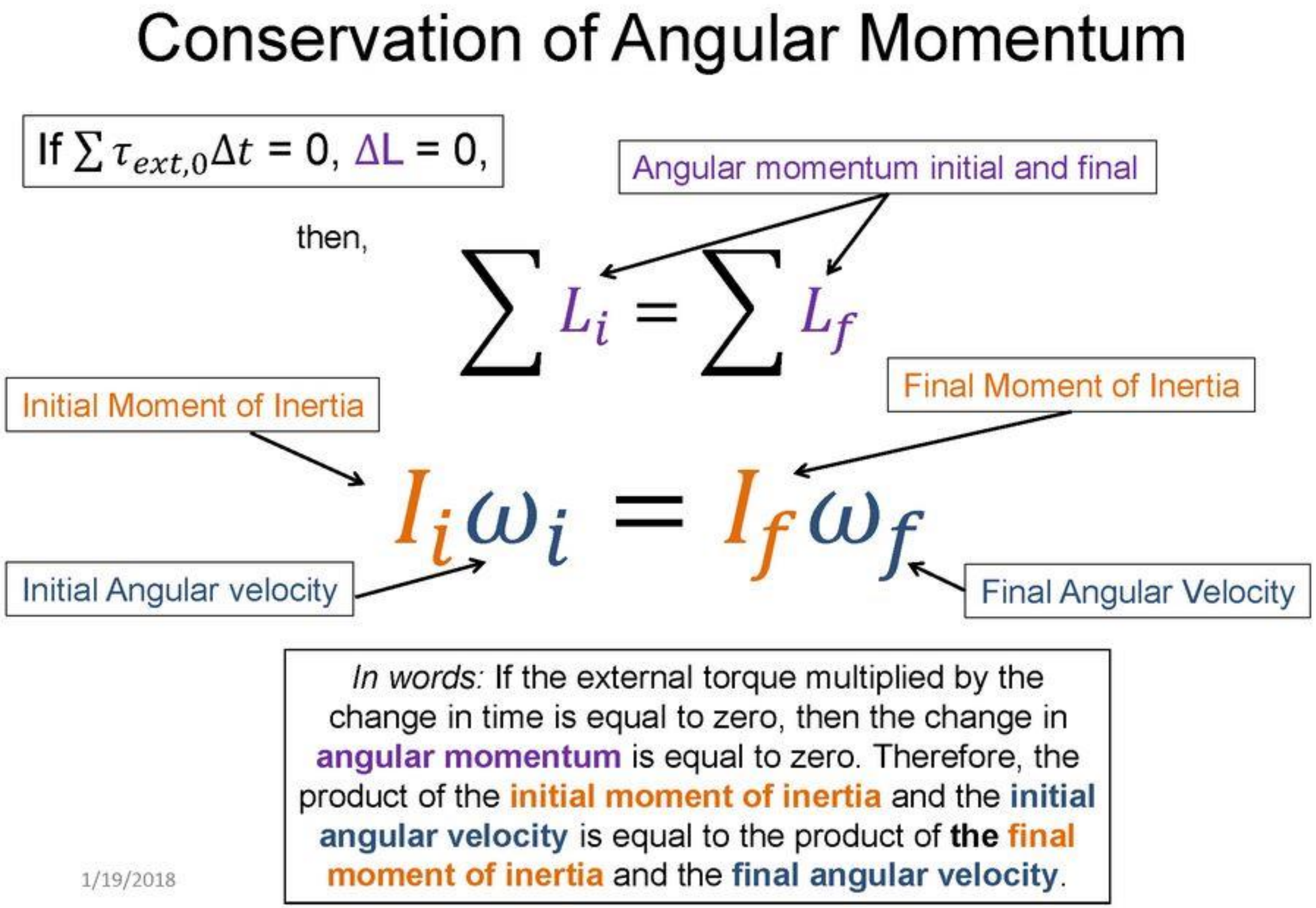
Warm-Up 3: 1 minute

- Say the equation in words

$$\sum L_i = \sum L_f$$

$$I_i \omega_i = I_f \omega_f$$

Warm-Up 3 Solution



Warm-Up 4: 1 minute

- Say the equation in words

$$KE_r = \frac{1}{2}I\omega^2 = \frac{1}{2}L\omega$$

Warm-Up 4 Solution

Rotational Kinetic Energy

Rotational Kinetic Energy — Moment of Inertia — Angular velocity — Angular Momentum — Angular velocity

$$KE_r = \frac{1}{2} I\omega^2 = \frac{1}{2} L\omega$$

In words: The rotational kinetic energy is equal to ½ the moment of inertia multiplied by the square of the angular velocity, which is equal to ½ the product of the angular momentum and the angular velocity.

Discussion Question 1: 3 minutes

- A small mass is placed on a record turntable that is rotating at 45rpm. The linear acceleration of the mass is
  A. Directed perpendicular to the line joining the mass and the center of rotation
  B. Independent of the position of the mass on the turntable
  C. Greater the closer the mass is to the center
  D. Greater the farther the mass is from the center
  E. Zero

Discussion Question 2: 3 minutes

- A hoop, a solid cylinder, a spherical shell, and a solid sphere are placed at rest at the top of an incline. All the objects have the same mass and radius. They are then released at the same time. What is the order in which they reach the bottom of the incline? Justify your answer.

Discussion Question 3: 3 minutes

- A well oiled merry-go-round (horizontal disk) is rotating with a girl walking from the outside edge towards the middle. Which of the following statements are true regarding this situation?
  A. The rotational velocity of the girl+merry-go-round system remains constant
  B. The rotational velocity of the girl increases
  C. The angular momentum of the merry-go-round increases
  D. The angular momentum of the girl+merry-go-round system increases
  E. The kinetic energy of the girl+merry-go-round system increases
  F. The kinetic energy of the girl+merry-go-round system remains constant

POTD: Read/Visualize the Problem: 2 minutes

- I have a rod of mass 10kg (uniformly distributed) that has a length of 1m and is aligned vertically, and is bolted at the top end of the rod. 3 forces are acting on the rod. F_1 = 25N and is perpendicular to the rod acting at the halfway point of the rod and pushing the rod to the left. F_2 = 10N, is acting ¾ of the length of the rod from the pivot point pulling the rod to the right and the angle between the 2 vectors is 30 degrees. F_3 = 15N, is acting at the end of the rod away from the pivot point, pushing the rod to right and is perpendicular to the rod. If I = 1/3 ML^2 for a rod pivoting about an end, what is the angular acceleration of the rod?

POTD: Draw a Picture and Knowns/Unknowns: 2 minutes

- I have a rod of mass 10kg (uniformly distributed) that has a length of 1m and is aligned vertically, and is bolted at the top end of the rod. 3 forces are acting on the rod. F_1 = 25N and is perpendicular to the rod acting at the halfway point of the rod and pushing the rod to the left. F_2 = 10N, is acting ¾ of the length of the rod from the pivot point pulling the rod to the right and the angle between the 2 vectors is 30 degrees. F_3 = 15N, is acting at the end of the rod away from the pivot point, pushing the rod to right and is perpendicular to the rod. If I = 1/3 ML^2 for a rod pivoting about an end, what is the angular acceleration of the rod?

POTD: Solve the problem: 10 minutes

- I have a rod of mass 10kg (uniformly distributed) that has a length of 1m and is aligned vertically, and is bolted at the top end of the rod. 3 forces are acting on the rod. F_1 = 25N and is perpendicular to the rod acting at the halfway point of the rod and pushing the rod to the left. F_2 = 10N, is acting ¾ of the length of the rod from the pivot point pulling the rod to the right and the angle between the 2 vectors is 30 degrees. F_3 = 15N, is acting at the end of the rod away from the pivot point, pushing the rod to right and is perpendicular to the rod. If I = 1/3 ML^2 for a rod pivoting about an end, what is the angular acceleration of the rod?