Nov 13, 2015 LB 273, Physics I

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Today:

Chapter 8 – Angular Momentum

Irish Phrasebook

Deadly – *Fantastic, great, brilliant*

"That was a deadly film"

Announcements

- Grade update this afternoon (everything up to end of Ch7)

- LON-CAPA HW for Ch8 due tonight

What we have so far

Linear Motion

- $v_f = v_0 + at$
- $\Delta x = v_0 t + ½ at^2$
- $v_f^2 = v_0^2 + 2a\Delta x$

- $\vec{F}_{net} = m\vec{a}$
- $\vec{p} = m\vec{v}$

Angular Motion

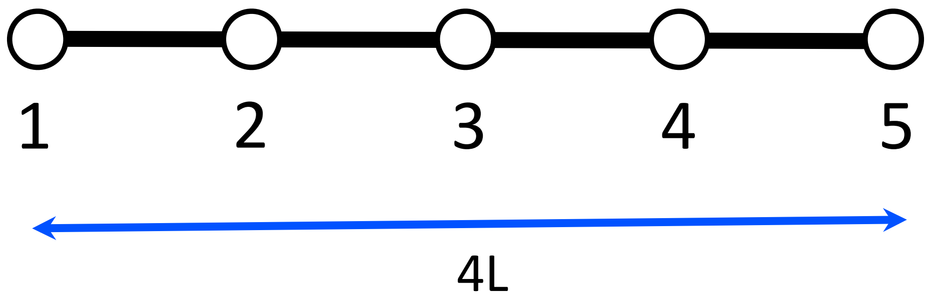
- $\omega_f = \omega_0 + \alpha t$
- $\Delta\theta = \omega_0 t + ½\alpha t^2$
- $\omega_f^2 = \omega_0^2 + 2\alpha\Delta\theta$

- $\vec{\tau}_{net} = \vec{r} \times \vec{F} = I\vec{\alpha}$
- $\vec{L} = \vec{r} \times \vec{p} = I\vec{\omega}$

Moment of Inertia

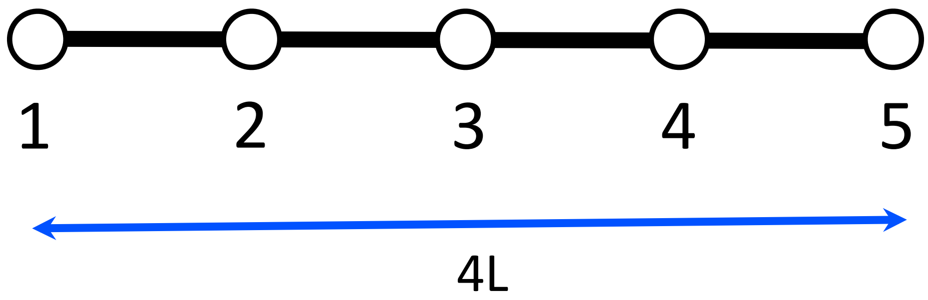
- Center of mass
- Telling us how each piece of mass contributes to the overall resistance to movement

$$I_{tot} = \sum m_i r_i^2 \qquad -> \int r^2\, dm$$



The massless rod shown above has a length of 4L and five equidistant point masses, each with mass M. What is the moment of inertia about mass 1, assuming rotation perpendicular to the rod?

A. 5 ML^2
B. 10 ML^2
C. 15 ML^2
D. 30 ML^2
E. None of the above



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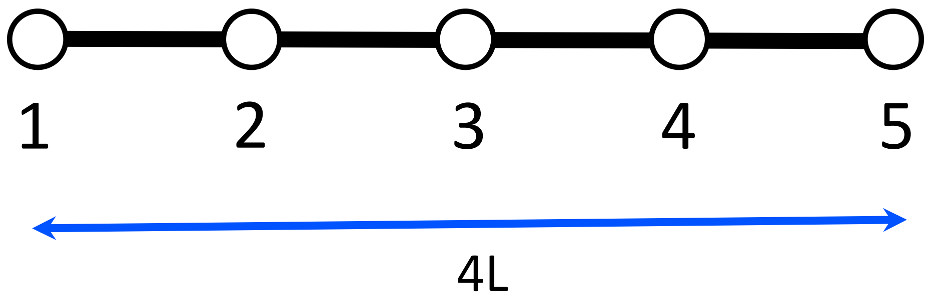
$$I_{tot} = \sum m_i r_i^2$$

$$I_{tot} = m_2 r_2^2 + m_3 r_3^2 + m_4 r_4^2 + m_5 r_5^2$$

$$I_{tot} = m (L)^2 + m_3 (2L)^2 + m_4 (3L)^2 + m_5 (4L)^2$$

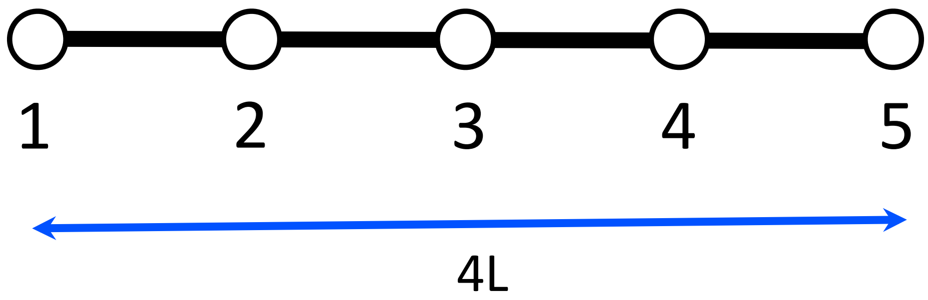
D. $30\ ML^2$

E. None of the above



The massless rod shown above has a length of 4L and five equidistant point masses, each with mass M. What is the moment of inertia about mass 3, assuming rotation perpendicular to the rod?

A. $5\ ML^2$
B. $10\ ML^2$
C. $15\ ML^2$
D. $30\ ML^2$
E. None of the above



The massless rod shown above has a length of 4L and five equidistant point masses, each with mass M. What is the moment of inertia <u>about mass 3</u>, assuming rotation perpendicular to the rod?

A. $5\ ML^2$

B. $10\ ML^2$

C. $15\ ML^2$

D

E

$$I_{tot} = \Sigma\, m_i\, r_i^2$$

$$I_{tot} = m_2\, r_2^2 + m_1\, r_1^2 + m_4\, r_4^2 + m_5\, r_5^2$$

$$I_{tot} = m_2\, (L)^2 + m_1\, (2L)^2 + m_4\, (L)^2 + m_5\, (2L)^2$$

Moment of Inertia

- Center of mass
- Telling us how each piece of mass contributes to the overall resistance to movement

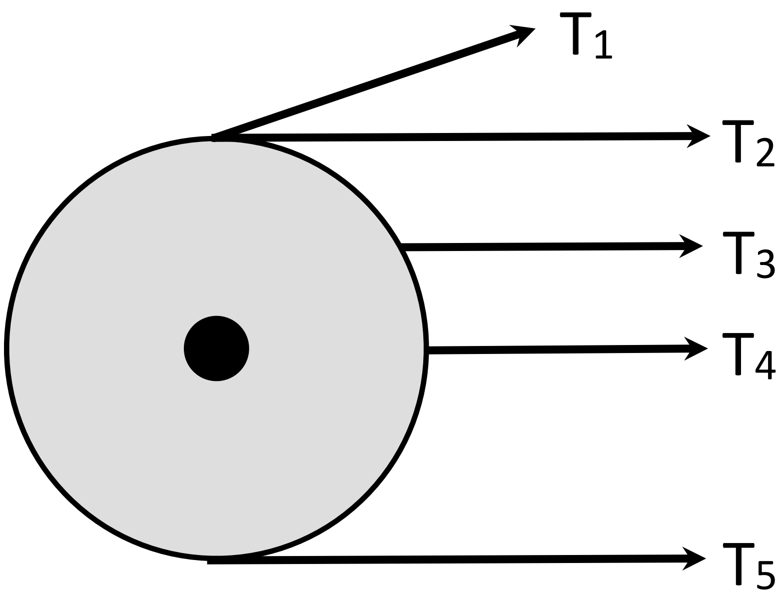
$$I_{tot} = \sum m_i r_i^2 \qquad -> \int r^2\, dm$$

- You can look up I for different shapes

Torque

- Torque is a vector quantity that describes how ω changes
  - Comparable to how F_{net} tells us how acceleration changes
  - $\tau_{net} = I\alpha$

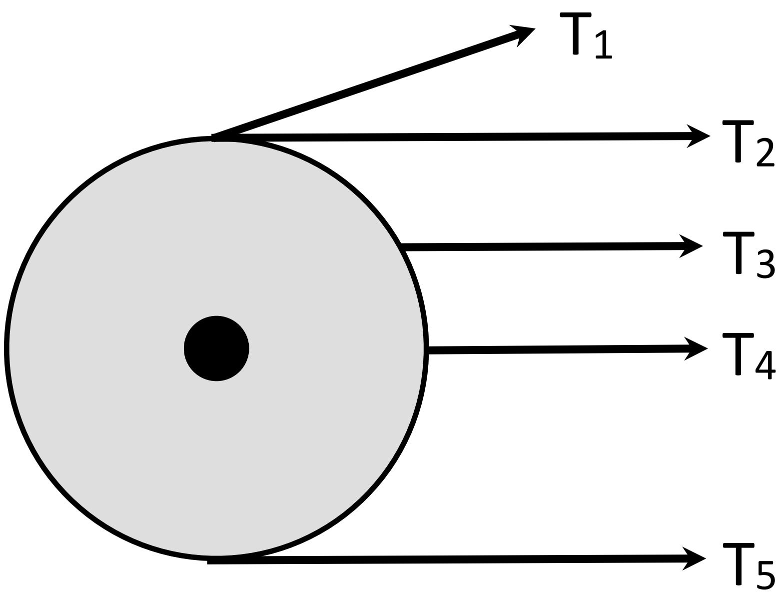
Acts like a "rotational" mass



A solid disk is mounted on an axis, as shown, and is initially at rest. The same force is applied along five different pieces of rope, as shown.

Which rope exerts the **smallest** torque on the disk?

A. T_1
B. T_2
C. T_3
D. T_4
E. T_5



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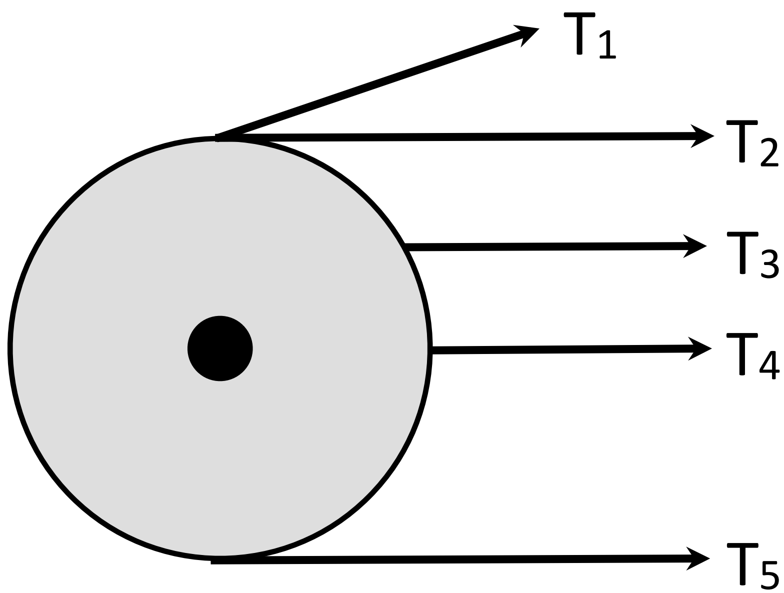
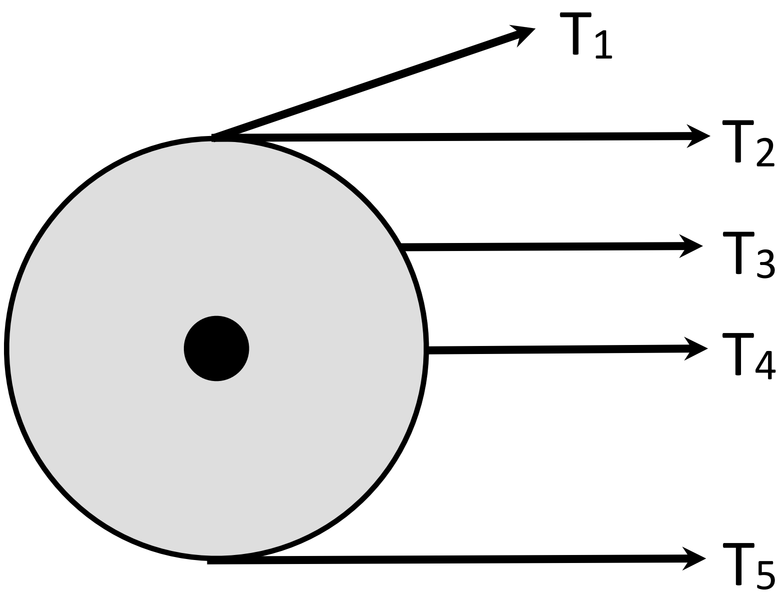


A solid disk is mounted on an axis, as shown, and is initially at rest. The same force is applied along five different pieces of rope, as shown.

Compare the magnitudes of T_1 and T_2.

A. $|T_1| > |T_2|$
B. $|T_1| < |T_2|$
C. $|T_1| = |T_2|$
D. None of the above



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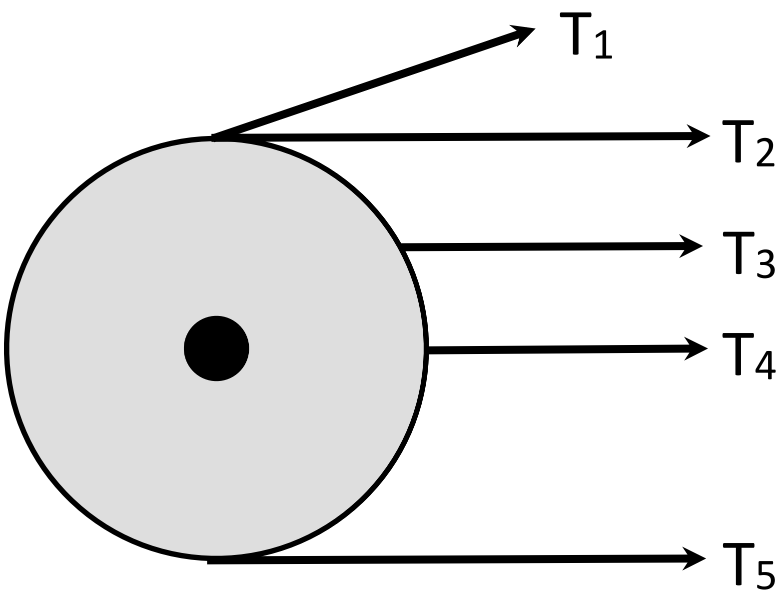
A. $|T_1| > |T_2|$
B. $|T_1| < |T_2|$
C. $|T_1| = |T_2|$
D. None of the above

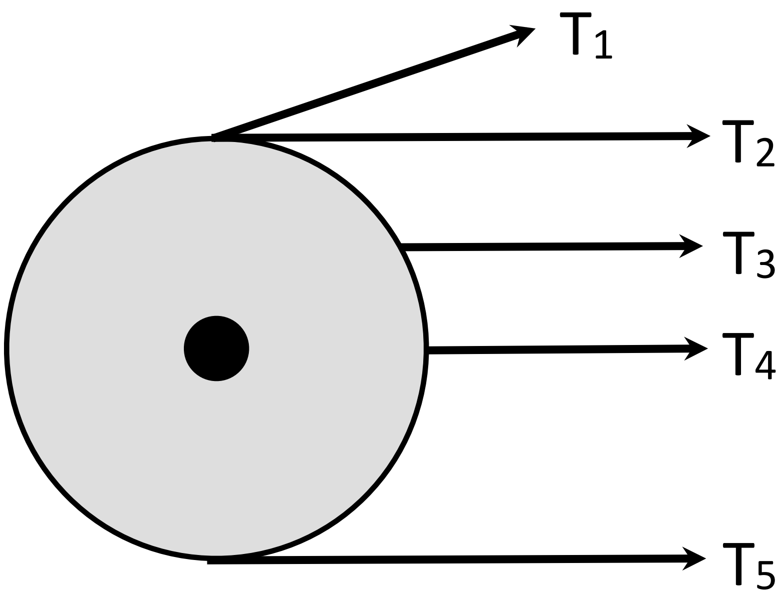
Only a piece of T_1 contributes to the torque whereas all of T_2 contributes. So $T_1 < T_2$



A solid disk is mounted on an axis, as shown, and is initially at rest. The same force is applied along five different pieces of rope, as shown.

Compare the magnitudes of T_2 and T_5.

A. $|T_2| > |T_5|$
B. $|T_2| < |T_5|$
C. $|T_2| = |T_5|$
D. None of the above



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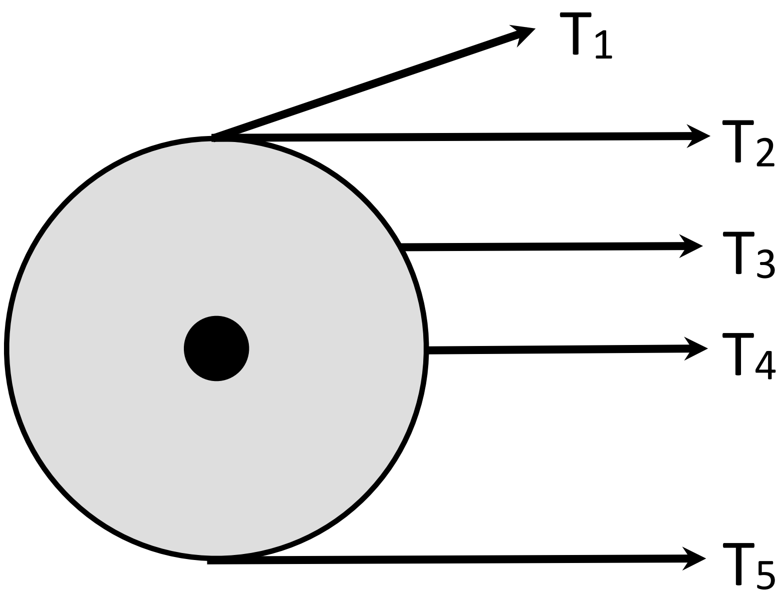
Compare the magnitudes of T_2 and T_5.

A. $|T_2| > |T_5|$
B. $|T_2| < |T_5|$
C. $|T_2| = |T_5|$
D. None of the ab

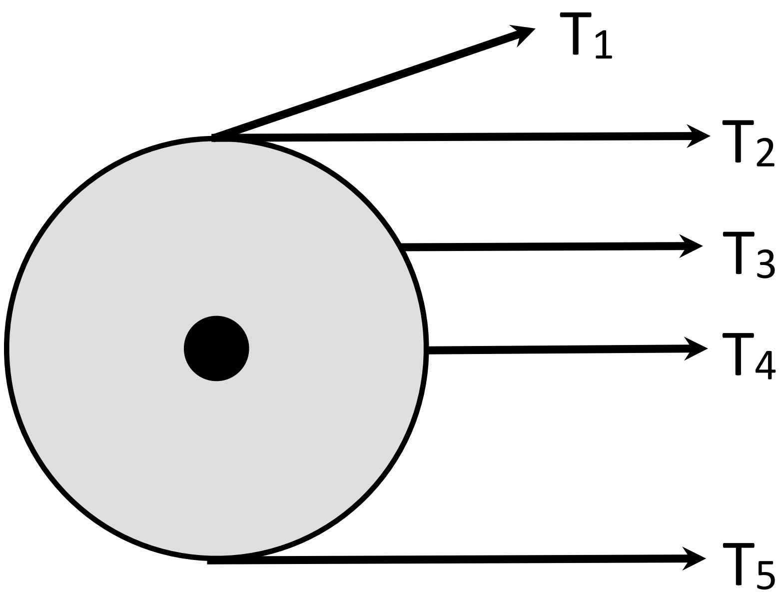
Both are equal in how much of the force is perpendicular to the momentum arm, so while the directions are different, the magnitudes are the same.



A solid disk is mounted on an axis, as shown, and is initially at rest. The same force is applied along five different pieces of rope, as shown.

If T_5 is the one that is actually used, what direction does the torque point?

A. Into the screen
B. Out of the screen
C. Neither



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B. Out of the screen
C. Neither

Point your figures in the direction of the torque, and curl them in the direction of the rotation -> your thumb will point in the direction of the torque.

Torque and Angular Momentum

$$\vec{\tau}_{net} = d\vec{L}/dt$$