Lecture 16

Goals:

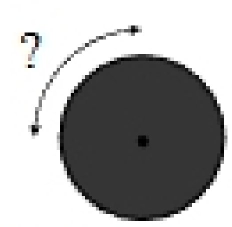
- Chapter 12
  - ❖ Extend the particle model to rigid-bodies
  - ❖ Understand the equilibrium of an extended object.
  - ❖ Analyze rolling motion
  - ❖ Understand rotation about a fixed axis.
  - ❖ Employ "conservation of angular momentum" concept

Assignment:

- HW8 due March 17th

Exercise Rotational Definitions

- A friend at a party (perhaps a little tipsy) sees a disk spinning and says "Ooh, look! There's a wheel with a negative ω and positive α!"
- Which of the following is a true statement about the wheel?



A. The wheel is spinning counter-clockwise and slowing down.

B. The wheel is spinning counter-clockwise and speeding up.

C. The wheel is spinning clockwise and slowing down.

D. The wheel is spinning clockwise and speeding up

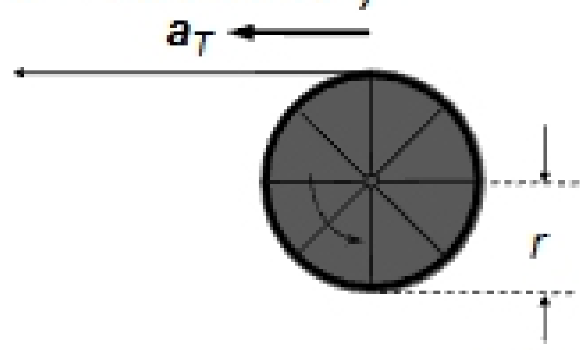
Home Exercise (review) : Wheel And Rope

- A wheel with radius $r = 0.4$ m rotates freely about a fixed axle. There is a rope wound around the wheel.

  Starting from rest at $t = 0$, the rope is pulled such that it has a constant acceleration $a_T = 4\ m/s^2$.

  How many revolutions has the wheel made after *10* seconds?

  (One revolution = 2π radians)



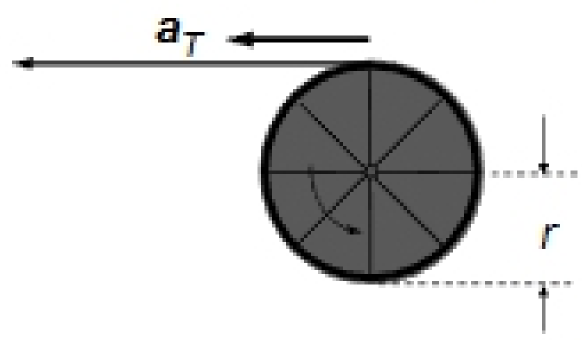
Home exercise: Wheel And Rope

- A wheel with radius $r = 0.4$ m rotates freely about a fixed axle. There is a rope wound around the wheel. Starting from rest at $t = 0$, the rope is pulled such that it has a constant acceleration $a_T = 4$ m/s². How many revolutions has the wheel made after 10 seconds? (One revolution = 2π radians)
- Revolutions = $\mathbf{R} = (\theta - \theta_0) / 2\pi$ and $a_T = \alpha r$

  $\theta = \theta_0 + \omega_0 \Delta t + ½ \alpha \Delta t^2 \rightarrow$

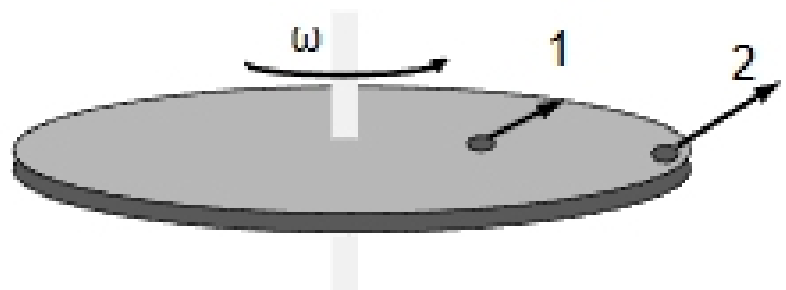
  $$\mathbf{R} = (\theta - \theta_0) / 2\pi = 0 + ½ (a_T/r) \Delta t^2 / 2\pi$$

  $$\mathbf{R} = (0.5 \times 10 \times 100) / 6.28$$



System of Particles (Distributed Mass):

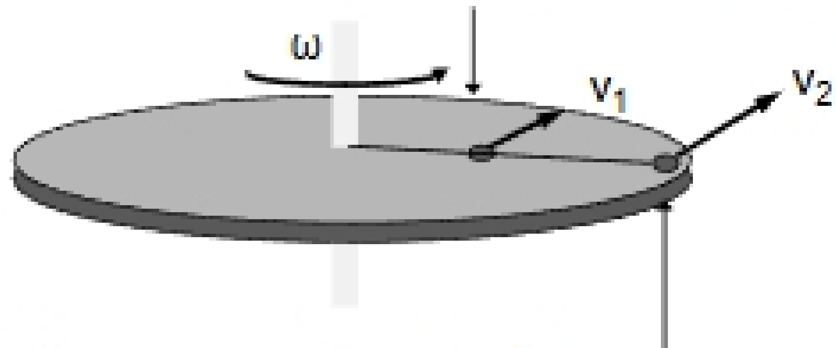
- Until now, we have considered the behavior of very simple systems (one or two masses).
- But real objects have distributed mass !
- For example, consider a simple rotating disk and 2 equal mass *m* plugs at distances *r* and *2r*.



- Compare the $v_{tangential}$ and kinetic energies at these two points.

System of Particles (Distributed Mass):

1 K= ½ m v^2 = ½ m $(\omega r)^2$



- The rotation axis matters too!

2 K= ½ m $(2v)^2$ = ½ m $(\omega 2r)^2$

- Twice the radius, four times the kinetic energy

$$K_{Rotational} = \tfrac{1}{2} m v^2 = \tfrac{1}{2} m (\omega r)^2$$

- KEY POINT: It matters where you put your mass!