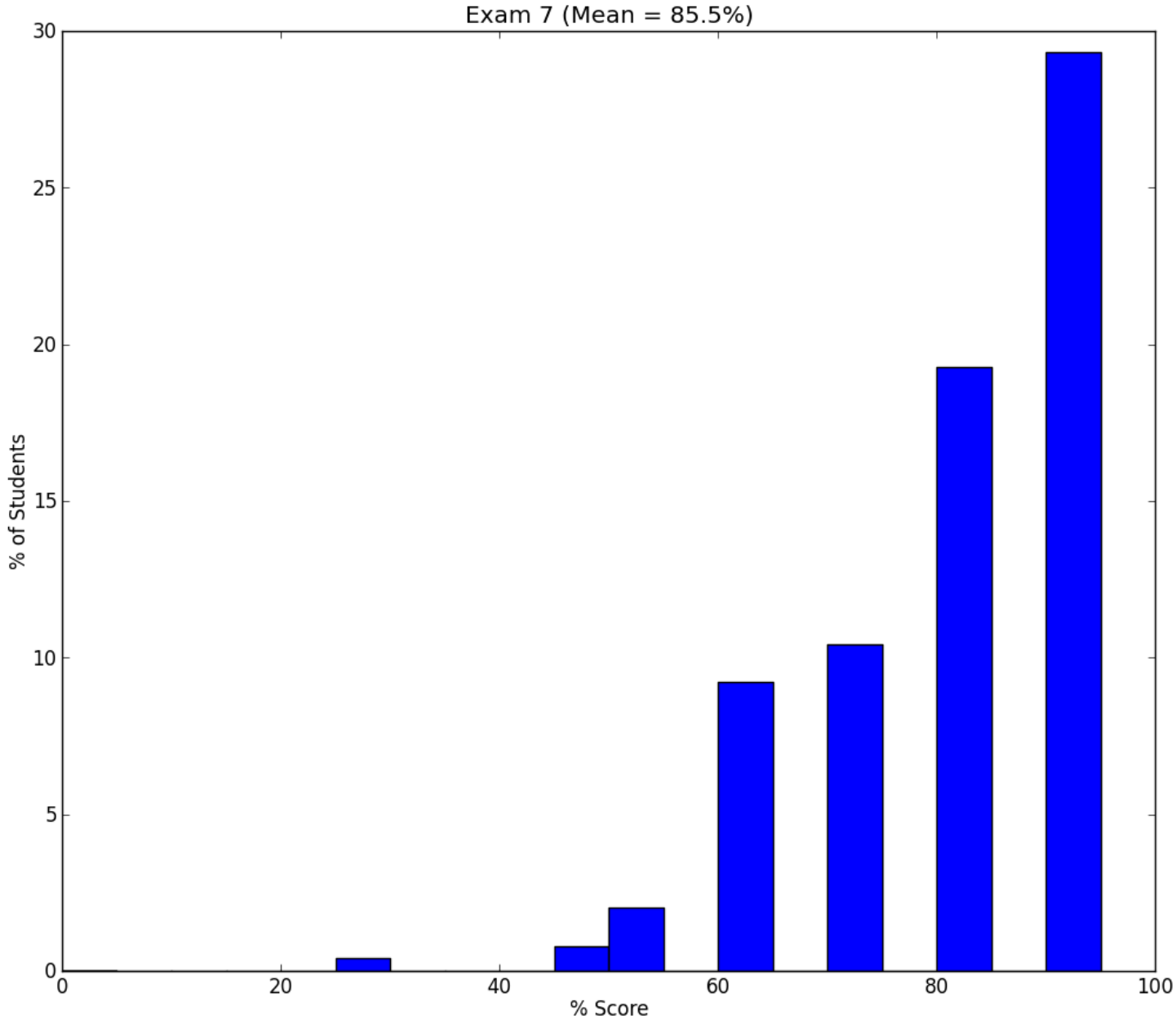
9-1) How many degrees in 1 radian?

A) 1 rad = $2\pi$ degrees
B) 1 rad = 180°
C) 1 rad = 10°
D) 1 rad = 57.3°
E) Radian is not a measure of angle, so the question makes no sense.


Exam 7 (Mean = 85.5%)
% of Students
% Score
0
5
10
15
20
25
30
0
20
40
60
80
100

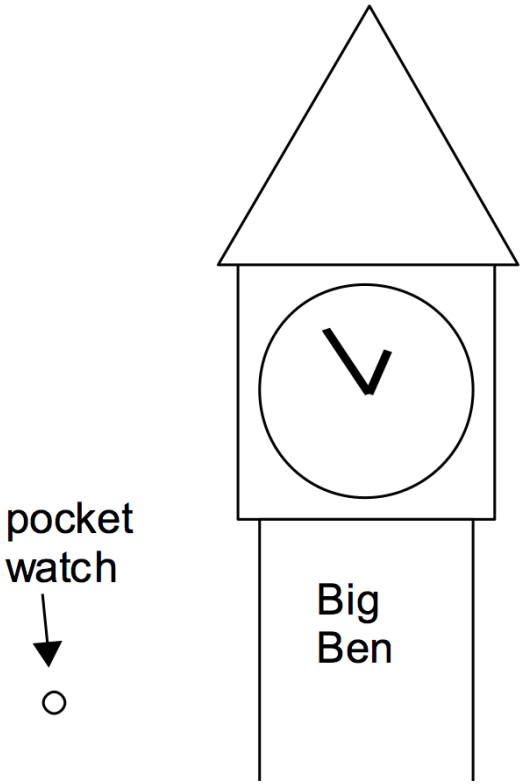
# Rotational Motion




# Full Size Hot Wheel Track

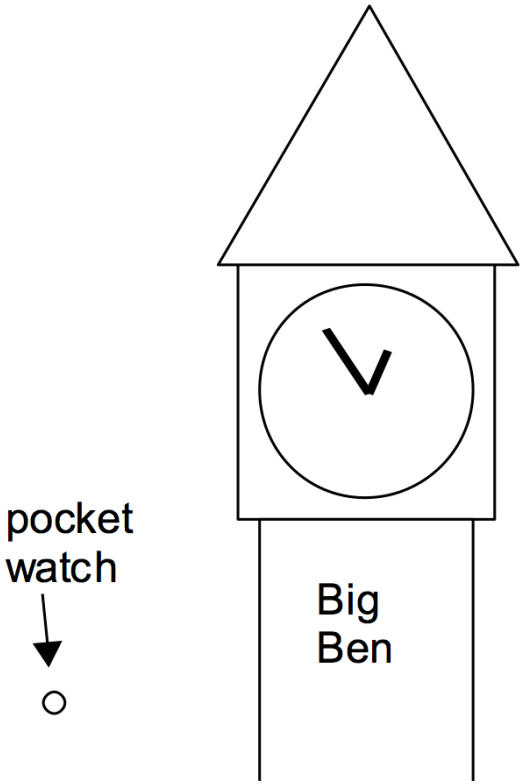
9-2a) A pocket watch and Big Ben are both keeping perfect time. Which minute hand has the larger magnitude angular velocity ω?

A) Pocket watch's
B) Big Ben's
C) Same ω on both.



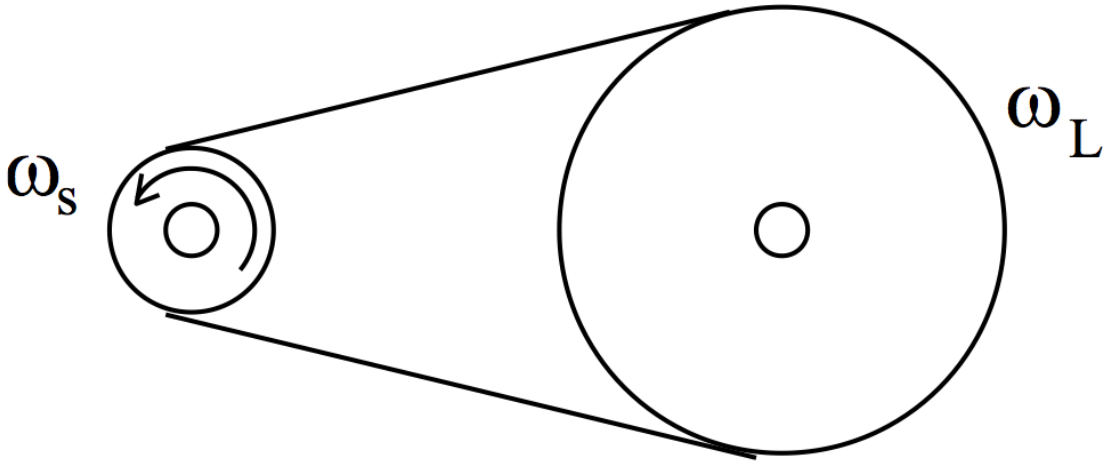
9-2b) A pocket watch and Big Ben are both keeping perfect time. Which minute hand's tip has the larger magnitude tangential velocity?

A) Pocket watch's
B) Big Ben's
C) Same ω on both.



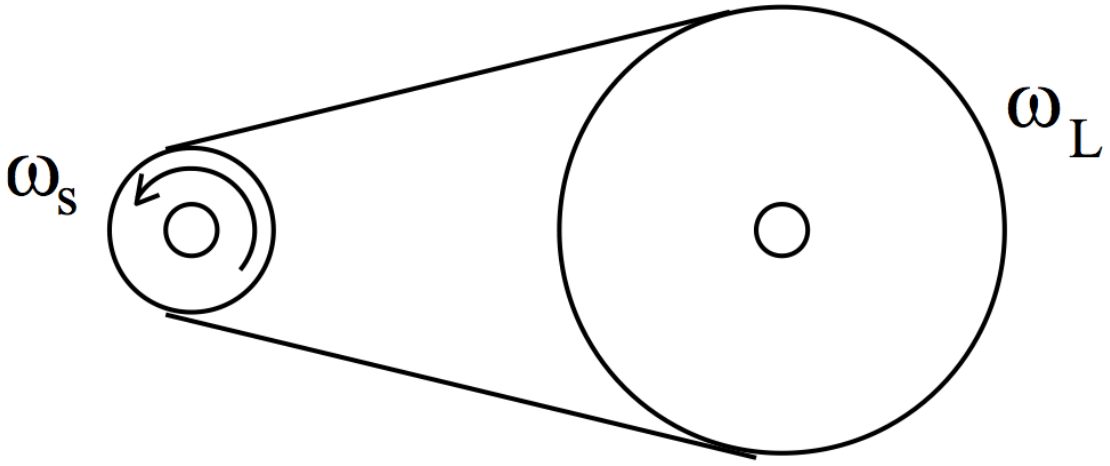
9-3a) A small wheel and a large wheel are connected by a belt. The small wheel is turned at a constant angular velocity $\omega_S$. How does the magnitude of the angular velocity of the large wheel $\omega_L$ compare to that of the small wheel?

A) $\omega_S = \omega_L$
B) $\omega_S > \omega_L$
C) $\omega_S < \omega_L$



9-3b) A small wheel and a large wheel are connected by a belt. The small wheel is turned at a constant angular velocity $\omega_S$. There is a bug S on the rim of the small wheel and another bug L on the rim of the large wheel. How do their speeds compare?

A) S = L
B) S > L
C) S < L



9-4) A student sees the following question on an exam:

*A flywheel with mass M = 120 kg, and radius r = 0.6 m, starting at rest, has an angular acceleration of $\alpha$ = 0.1 rad/s$^2$. How many revolutions has the wheel undergone after 10 s?*

Which formula should the student use to answer the question?

A) $\omega = \omega_0 + \alpha t$
B) $\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$
C) $\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$

9-5) A student in Physics 183 sees the following question on LON-CAPA due this Sunday.

*An engine flywheel turns with constant angular speed of 100 rev/min. When the engine is shut off, friction slows the wheel to rest in 2 hours. What is the magnitude of the constant angular acceleration of the wheel? Give the answer in units of rev/min².*

The student writes:

$$\alpha = \frac{\omega - \omega_0}{t}, \quad \text{so} \quad |\alpha| = \frac{\omega_0}{t} = \frac{2\pi f}{t} = \frac{2\pi(100 rev/\min)}{120\,\min}$$

Does the answer come out correctly with the desired units of rev/min²?

A) Yes B) No

# Example: Hard Disk Drive

Most modern HDD can spin up to 7200 rpm. If the platters get up to that speed in 0.25s, what angular acceleration is needed to do this?

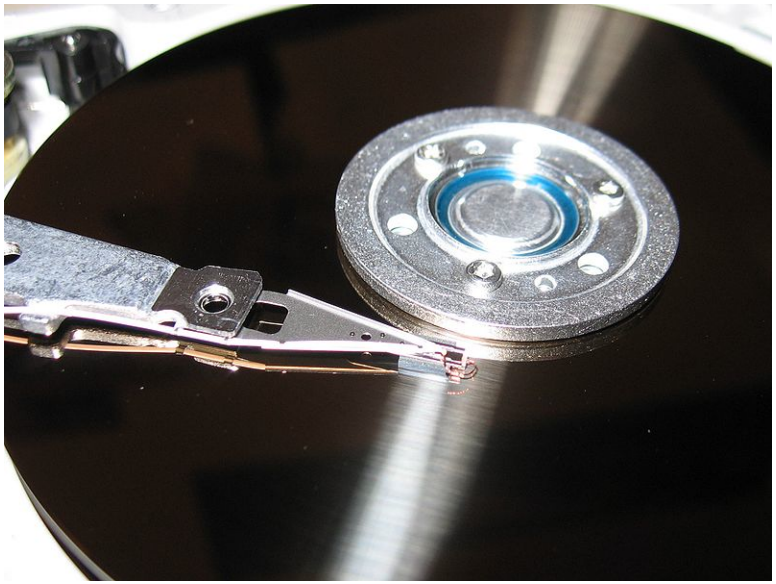
9-6a) Which equation should we work with?

A) $\omega = \omega_0 + \alpha t$

B) $\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$

C) $\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$

D) Something else



# Example: Hard Disk Drive

These platters are 3.5 in in diameter. How fast is the edge of the platter moving when it gets up to speed?

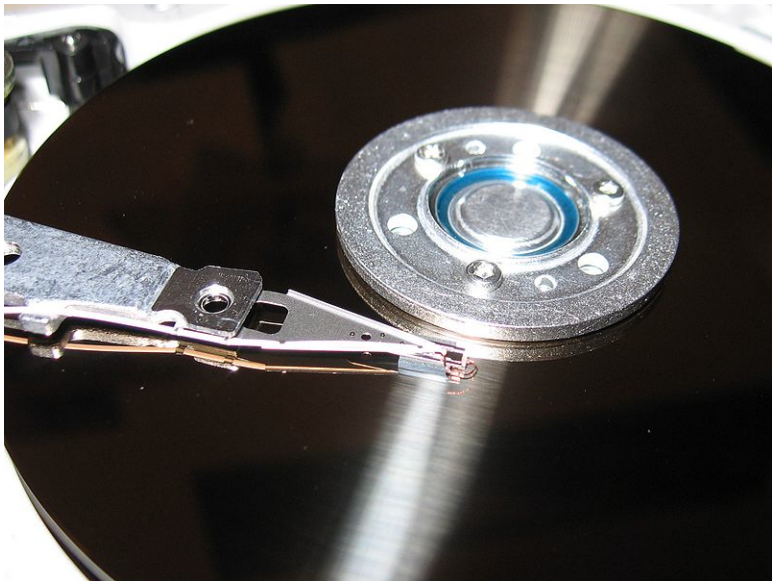
9-6b) Which equation should we work with?

A) $\omega = \omega_0 + \alpha t$

B) $\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$

C) $\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$

D) Something else



# Example: Hard Disk Drive

How many times did the platter make a full rotation to get up to 7200 rpm?

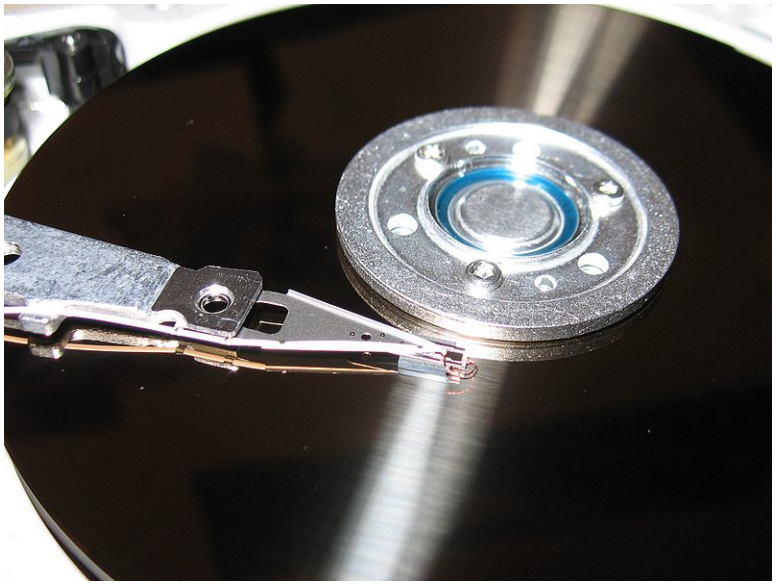
9-6c) Which equation should we start working with?

A) $\omega = \omega_0 + \alpha t$

B) $\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$

C) $\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$

D) Something else



# Announcements

- Prof. Caballero will be out of town Saturday-Tuesday (email contact should be fine)
  - Prof. Westfall will proctor the exam 8
  - Dr. Laverty will teach Tuesday's class
- You received an extra 0.4 points on Exam 6; it was applied to question 1.

# Example: Hard Disk Drive

How quickly can the cylinder head read 1 bit of information once the drive has spun up? Let's say the bit we want to read is 5μm ($5 \times 10^{-6}$ m) long and lives 2.5 cm from the center of the platter.

9-6d) Which equation should we work with?

A) $\omega = \omega_0 + \alpha t$

B) $\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$

C) $\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$

9-7) We want an object to move in a circle at constant speed, what kind of force should be applied?

I. A force with constant magnitude
II. A force with changing magnitude
III. A force that points towards the inside of the circle
IV. A force that points towards the outside of the circle

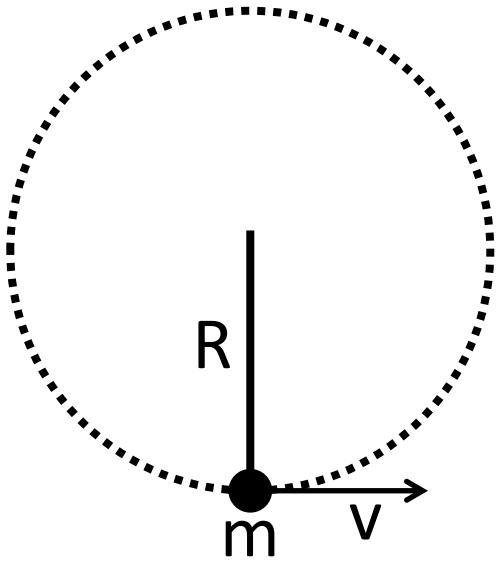
A) I & III C) I & IV
B) II & III D) II & IV E) None of these

# David hits a bowling ball

9-8) A rock (mass, m) is swung in a vertical circle (radius, R) **on the Earth**. At the bottom of the swing, the rock is moving at a speed v.

**True or False:** At this location, the force exerted on the rock **by the rope** is equal to $mv^2/R$.

A) True
B) False



9-9a) You are driving in your car and you make a quick left hand turn, which way do you “feel pushed”?

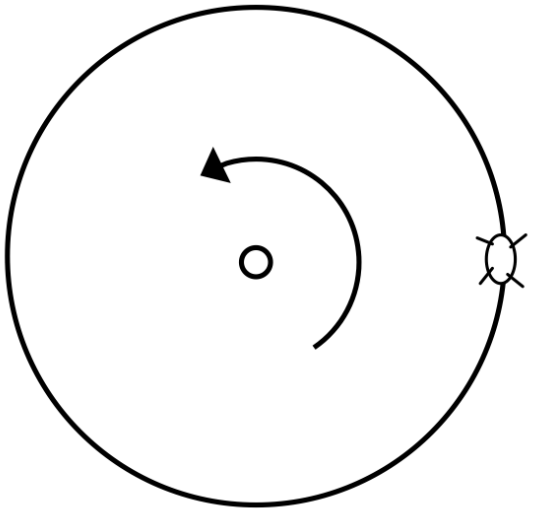
A) Left
B) Right

9-9b) You are riding a merry-go-round, which way do you “feel pushed”?

A) Inward
B) Outward

9-10) A ladybug is clinging to the rim of a spinning wheel which is spinning CCW and is speeding up. At the moment shown, when the bug is at the far right, what is the approximate direction of the ladybug's acceleration?

A) ↙
B) ↑
C) →
D) ←
E) ↖



9-11) For objects that move in circles, it's useful to think about their tangential and radial accelerations.

In the kinematic equations we discussed earlier,

$\omega = \omega_0 + \alpha t$ $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$

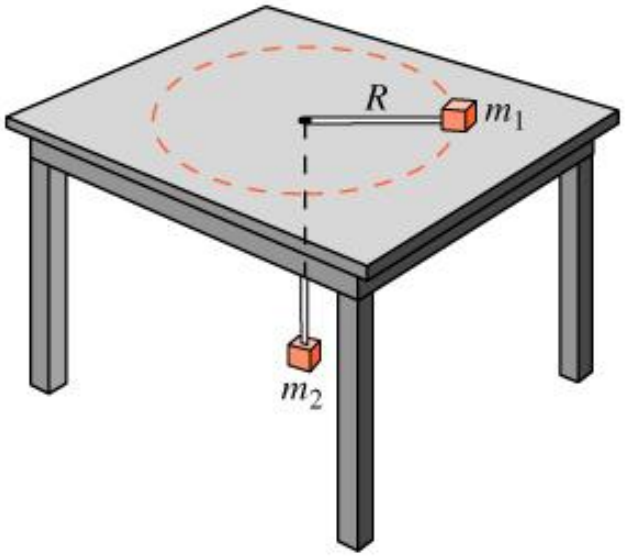
$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$

Which linear acceleration is the angular acceleration, α, related to?

A) Tangential, $a_{\parallel}$
B) Radial, $a_{\perp}$
C) Both
D) It depends

# Example: Uniform Circular Motion

An object (mass, $m_1$) slides on a horizontal frictionless table. It is tied to an object of mass $m_2$, which is under the table. The string is fed through a hole in the table.

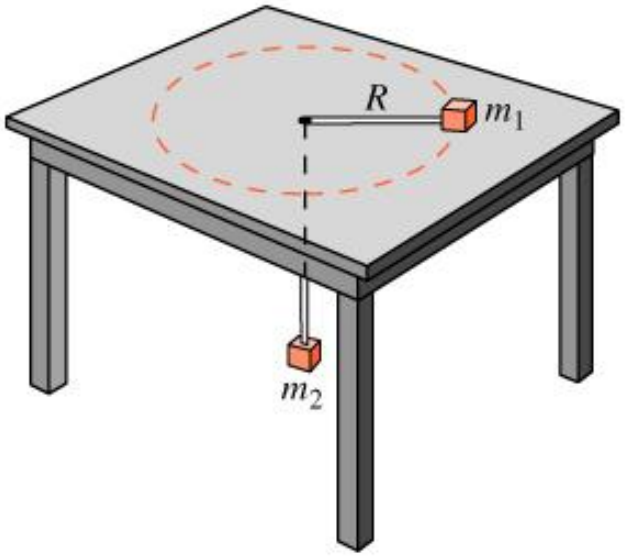



What is the speed needed to keep the mass from falling down?

# Example: Uniform Circular Motion

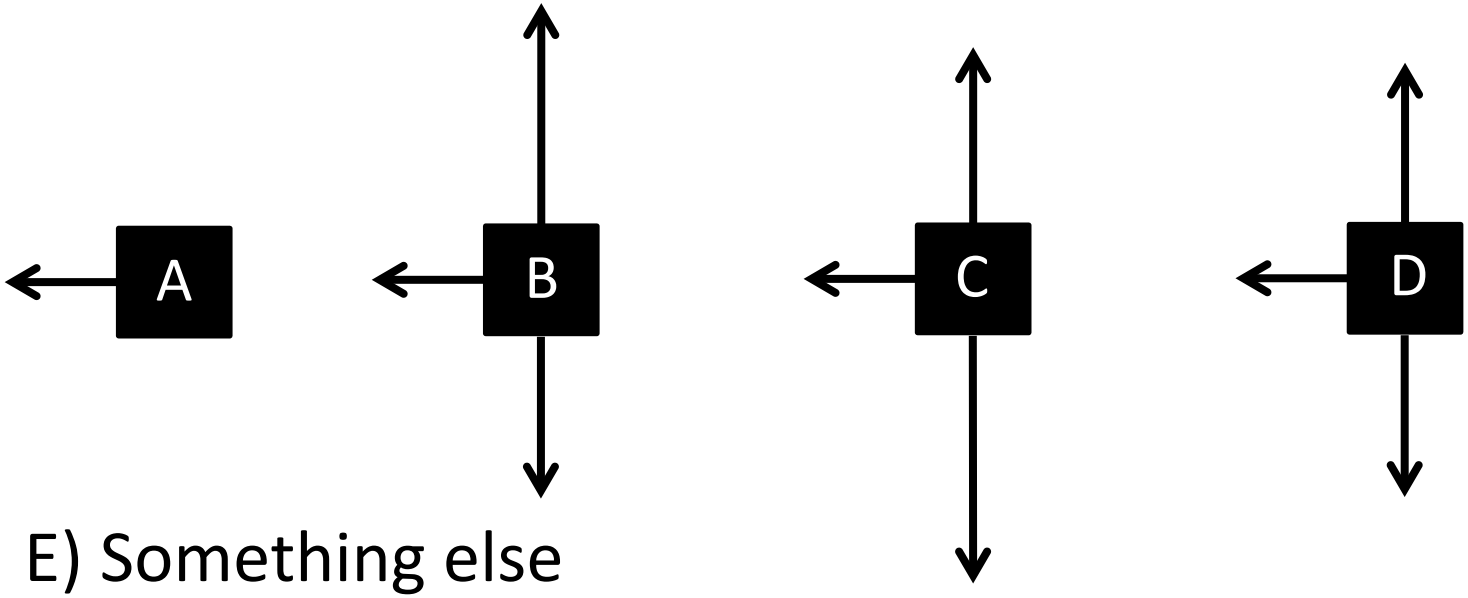
9-12a) Ok, where do we start?

A) Find the right kinematic equation
B) Use the circular motion equations
C) Draw the free-body diagrams
D) Something else



# Example: Uniform Circular Motion

9-12b) Which is the correct FBD for $m_1$?
(I've left the labels off.)

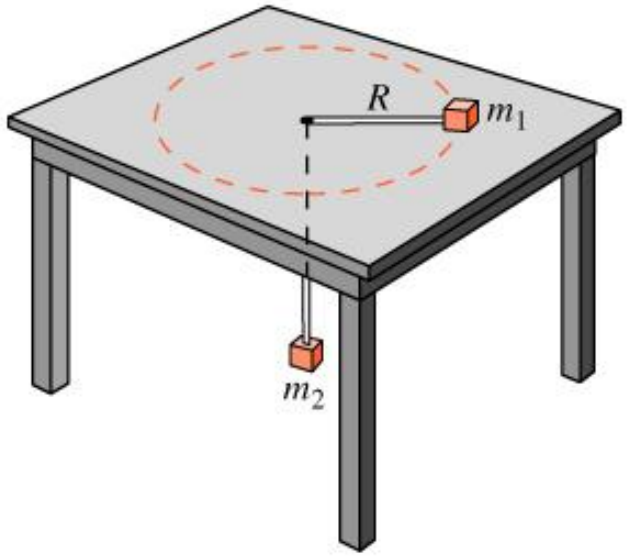



E) Something else

# Example: Uniform Circular Motion

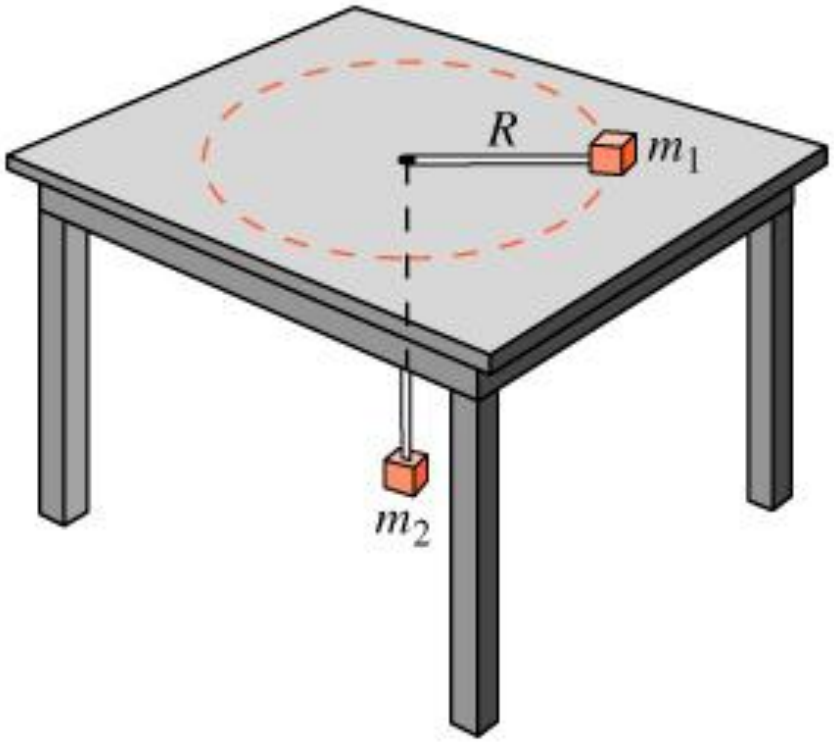
9-12c) What is the force the rope exerts on $m_1$ equal to?

A) The net force on $m_1$
B) $M_2g$
C) $M_1v^2/R$
D) Two of these
E) All of these



# Example: Uniform Circular Motion

Discussion: How do you feel about the fact the $m_1$ is accelerating, but $m_2$ is not?

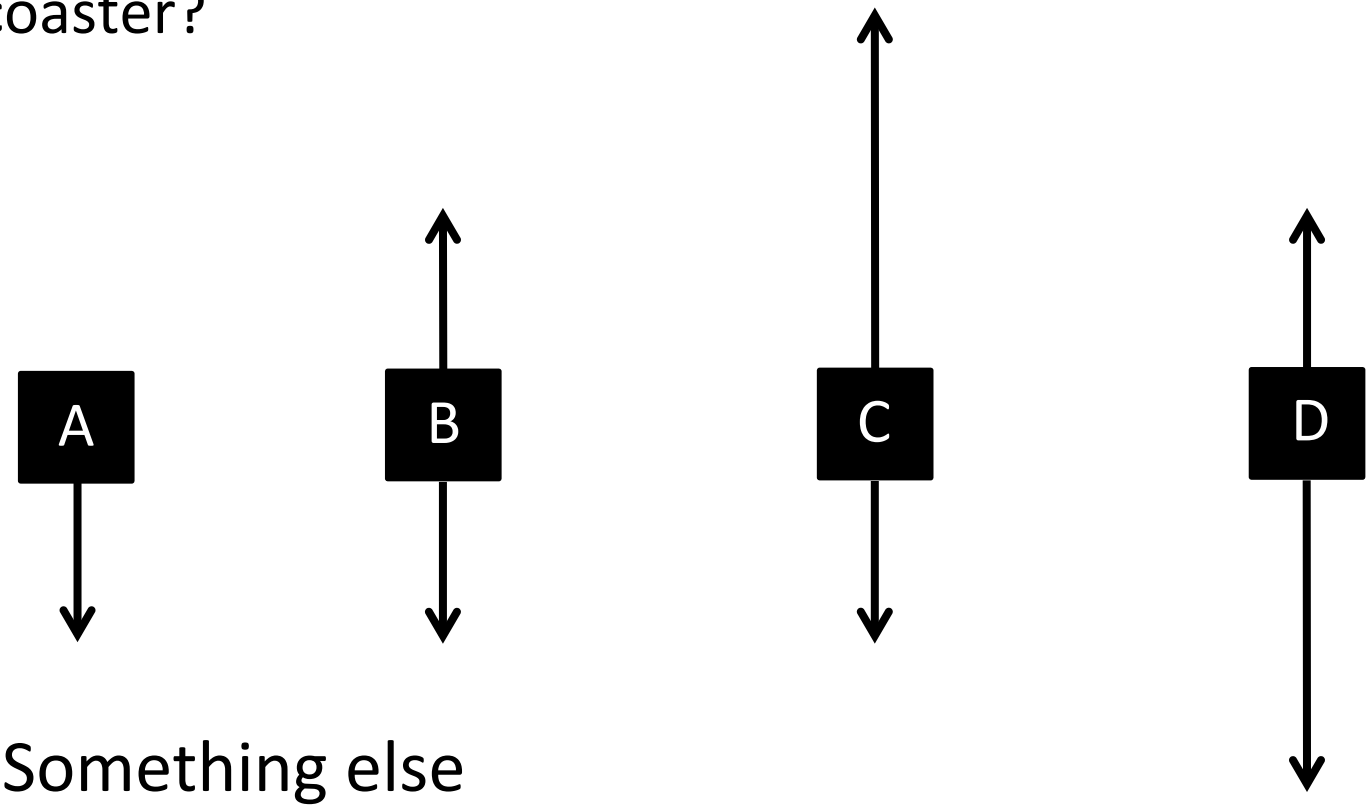


# Example: Greezed Lightnin’

Greezed Lightnin’ was a roller coaster at Astroworld (RIP 2005, ☹) with a 40 m loop in the middle. It was designed so you felt 3 times heavier at the bottom of the loop. How fast did the coaster car have to be moving to make you feel this way?


# Example: Greezed Lightnin’

9-13a) Which is the most correct FBD for you at the bottom of the coaster?



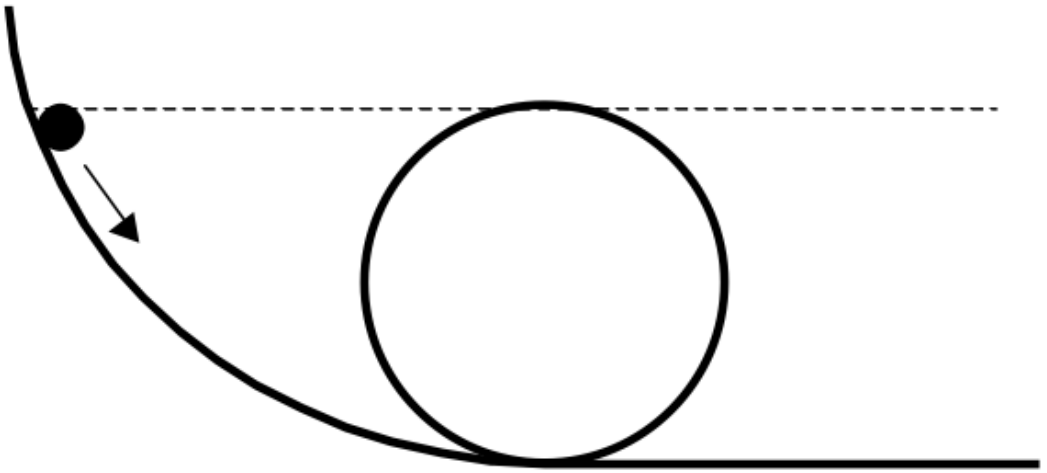

E) Something else

# Example: Greezed Lightnin'

9-13b) For you to feel 3 times your weight, how big is the normal force?

A) N = 2mg
B) N = 3mg
C) N = 4mg
D) Something else

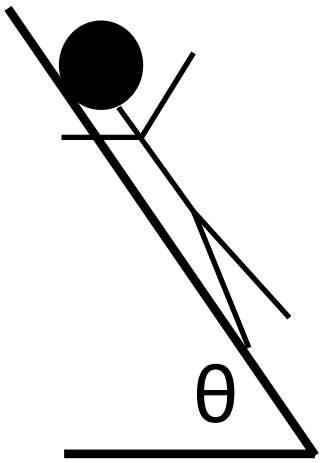
6-12b) A ball is released from the same height as the loop below. The loop is a rail with no top. Will the ball make it around the loop?



A) Yes B) No C) Impossible to tell

# Example: The Gravitron

The Gravitron is a carnival ride that give you a sense of "weightlessness" by exploiting static friction. With what speed does a Gravitron of radius R need to be spinning to make you feel weightless? (There's static friction, $\mu_s$, between you and the Gravitron.)

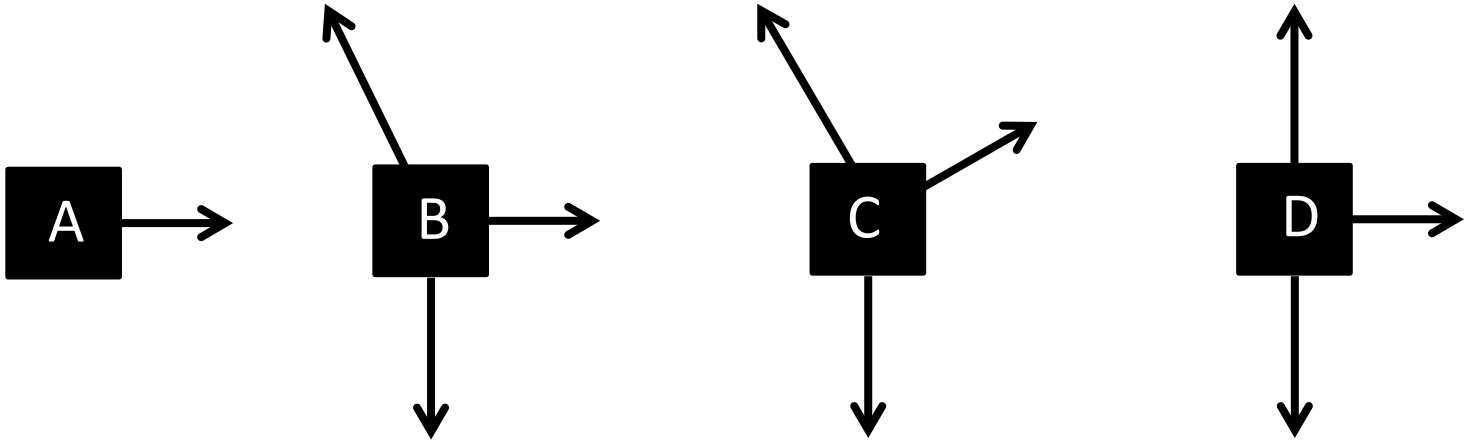
# Example: The Gravitron

9-14a) Ok, where do we start?

A) Find the right kinematic equation
B) Use the circular motion equations
C) Draw the free-body diagrams
D) Something else

# Example: The Gravitron

9-14b) Which is the most correct FBD for you?
(I've left the labels off. Neglect the relative lengths here.)




E) Something else

# Example: The Gravitron

9-14c) What is the condition for feeling "weightless"?

A) No frictional force
B) No acceleration up the ramp
C) No acceleration in the vertical direction
D) Something else