

Good News: Yes, we will curve !!!

Quiz on every Thursday

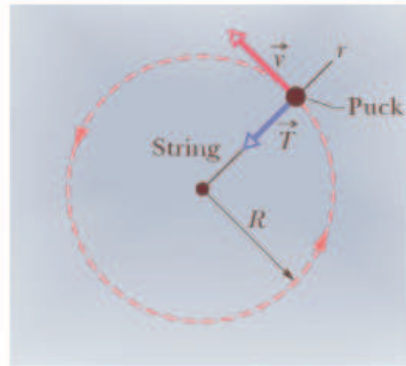
HW #7 due : March 23, Friday

Ch. 6, Force and Motion-II

Frictional Force

Uniform Circular Motion
(Ch.4-Sec.7 & Ch.6-Sec.5)

More applications of Newton's Laws



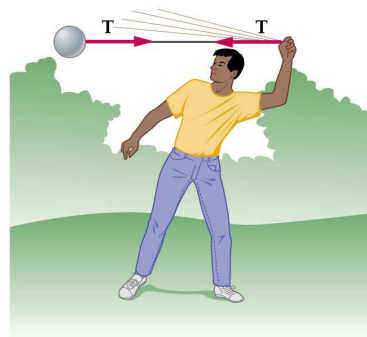
Uniform circular motion

Constant speed, or,
constant magnitude of velocity

Motion along a circle:
Changing direction of velocity

I: Circular Motion: Observations

- Object moving along a curved path with **constant speed**
 - Direction of velocity: changing
 - Velocity: changing
 - Acceleration is NOT zero!
 - **Net force acting on an object is NOT zero.**
 - “Centripetal force”



$$\vec{F}_{net} = m\vec{a}$$

Circular Motion: Developing a Model (constant speed)

$$\frac{\Delta v}{v} = \frac{v \Delta t}{R}$$

$$\frac{\Delta v}{\Delta t} = \frac{v^2}{R}$$

$$a_R = \frac{\Delta v}{\Delta t} = \frac{v^2}{R}$$

$\Delta \vec{v} = v_2 - v_1$

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$$

$$\vec{F}_{net} = m \vec{a}_R$$

$$F_{net} = m \frac{v^2}{R}$$

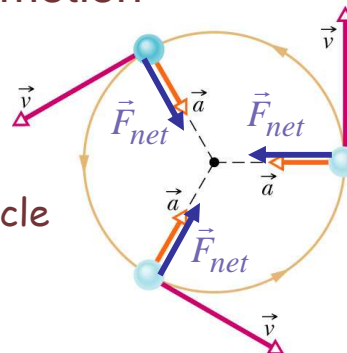
The Δv is always directed towards the v_2

Uniform circular motion

Centripetal acceleration

Magnitude: $a = \frac{v^2}{r}$

Direction: toward center of circle



Centripetal force

Magnitude: $F_{net} = \frac{mv^2}{r}$

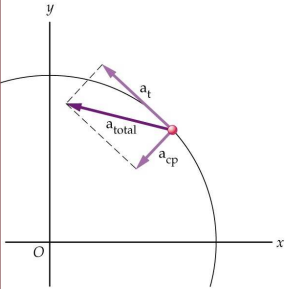
Direction: toward center of circle

Period

$$T = \frac{2\pi r}{v}$$

Angular velocity

$$\omega = \frac{2\pi}{T}$$



An object moving along a circular path with a **constant speed:**

- Only radial acceleration
- Net force directed toward the center of a curvature (circle).

An object moving along the circular path with a **changing speed :**

- Both radial and tangential accelerations
- Net force NOT directed toward the center of a curvature (circle).

Radial acceleration: for turning

Tangential acceleration: for changing speed

→

Looking for Acceleration...

Where to look for acceleration: $\vec{a} = \Delta\vec{v}/\Delta t$

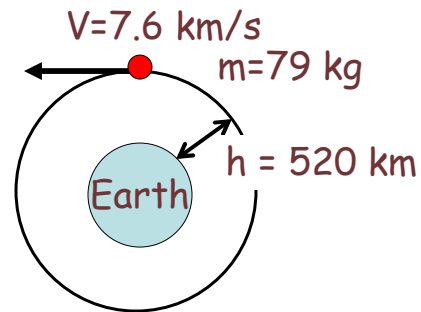
Changing magnitude of velocity	Changing direction of velocity	Changing magnitude and direction of v
Speeding up or slowing down along a straight line	Moving with constant speed along a curved line	Speeding up or slowing down along a curved line
Tangential a: a_t	Radial a: a_R	a_R and a_t

Sample Problem 6-6

Igor is a cosmonaut on the International Space Station, in a circular orbit around Earth, at an altitude h of 520 km and with a constant speed v of 7.6 km/s. Igor's mass m is 79 kg. Radius of earth is $R_{Earth} = 6.37 \times 10^6 m$

(a) What is his acceleration?

(b) What force does Earth exert on Igor?



Sample Problem 6-7

In a 1901 circus performance, Allo "Dare Devil" Diavolo introduced the stunt of riding a bicycle in a loop-the-loop. Assuming that the loop is a circle with radius $R = 2.7 m$, what is the least speed v Diavolo could have at the top of the loop to remain in contact with it there?

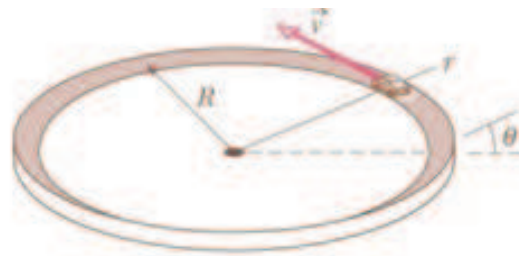


(a)

Following materials are not covered during Lecture 8.

Sample Problem 6-10

Curved portions of highways are always banked (tilted) to prevent cars from sliding off the highway. When a highway is dry, the frictional force between the tires and the road surface may be enough to prevent sliding. When the highway is wet, however, the frictional force may be negligible, and banking is then essential. Figure represents a car of mass m as it moves at a constant speed v of 20 m/s around a banked circular track of radius $R = 190$ m. If the frictional force from the track is negligible, what bank angle θ prevents sliding?



(a)

More applications of Newton's Laws



Frictionless surface

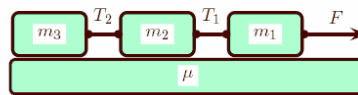
What is the tension in the rope between two objects?

(Related to HW#6, Prob. 8 & 9, for which friction exists.)

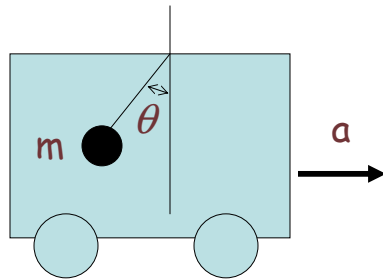
008 (part 1 of 2) 10 points

Consider a force of 71.4 N, pulling 3 blocks of identical masses, where each mass is 0.6 kg, along a rough horizontal surface. The coefficient of kinetic friction between the blocks and the surface is given by 0.5. The acceleration of the blocks is a .

The acceleration of gravity is 9.8 m/s^2 .



Find the acceleration a . Answer in units of m/s^2 .



$$m = 2 \text{ kg}$$

$$a = 2.0 \text{ m/s}^2$$

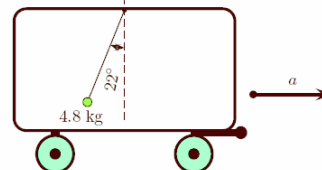
$$\theta = ?$$

Tension ?

(Related to HW#6-Prob.6)

006 (part 1 of 1) 10 points

A 4.8 kg object hangs at one end of a rope that is attached to a support on a railroad boxcar. When the car accelerates to the right, the rope makes an angle of 22° with the vertical. The acceleration of gravity is 9.8 m/s^2 .



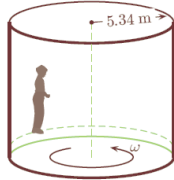
Hints for HW #7

006 (part 1 of 2) 10 points

The coefficient of static friction between the person and the wall is 0.69. The radius of the cylinder is 5.34 m.

The acceleration of gravity is 9.8 m/s^2 .

An amusement park ride consists of a large vertical cylinder that spins about its axis fast enough that any person inside is held up against the wall when the floor drops away.



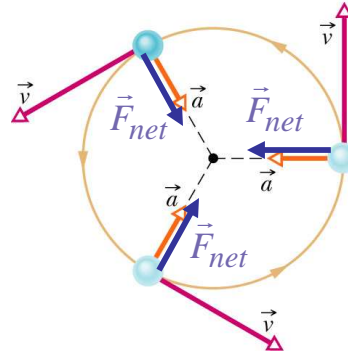
What is the minimum angular velocity ω_{min} needed to keep the person from slipping downward? Answer in units of rad/s.

007 (part 2 of 2) 10 points

Suppose the person, whose mass is m , is being held up against the wall with an angular velocity of $\omega' = 2\omega_{min}$.

The magnitude of the frictional force between the person and the wall is

See Sample Prob 6-8



Period

$$T = \frac{2\pi r}{v}$$

Angular velocity $\omega = \frac{2\pi}{T}$

Velocity $v = \frac{2\pi r}{T} = \omega r$