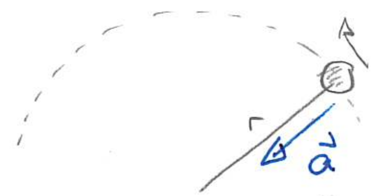
Thurs: Discussion /quiz

Ex: 181, 182, 183, 186, 187, 189

Fri:

Dynamics of uniform circular motion

Recall that for an object undergoing uniform circular motion the acceleration:



1) points radially inward
2) has magnitude

$$a_c = \frac{v^2}{r} = \omega^2 r$$

This helps assess the dynamics of circular motion.

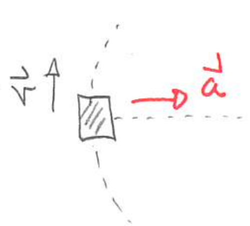
Quiz 1 30% - 40% { 30% - 60%

Warm Up 1

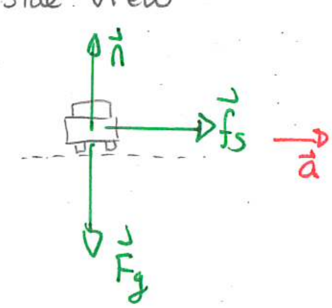
This is relevant to the motion of objects that turn corners.

Warm Up 2

Overhead view



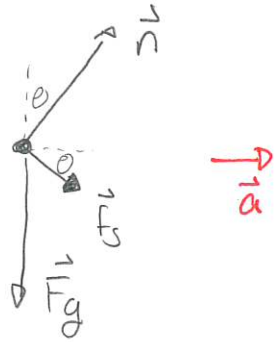
Side view



The static friction Force must be inward to prevent the car from sliding off the outer edge of the road

Quiz2 50% } 50%

In this case the acceleration is radially inward and the FBD is:



- note the friction prevents the car from sliding off the outer edge
- the friction assists with the net inward force

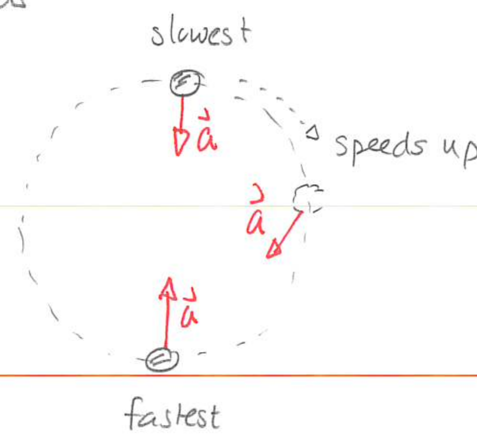
When analyzing this use the conventional axes with one axis oriented along the acceleration.

Objects moving in vertical circles

The motion of an object moving in a vertical circle can be complicated by the gravitational force. If the object speeds up or slows down then the acceleration will not always be radially inward. However, if it moves "symmetrically" about the highest and lowest points, then at those the acceleration is radially inwards

Then,

> At the top / bottom of this circular motion
>
> $$a = \frac{v^2}{r} = \omega^2 r$$



Quiz 3 70%

193 Sliding inside a hoop

A small 0.10 kg object slides around the inside a frictionless vertical hoop with radius 0.25 m. *(131Sp2023)*

a) The speed of the object at the top of the hoop is 2.0 m/s. Determine the normal force exerted by the hoop on the object at the top of the loop.

b) The object reaches the bottom of the hoop with speed 3.71 m/s. Determine the normal force exerted by the hoop on the object at the bottom of the loop.

c) Determine the minimum speed at the top of the loop so that the object stays on the inside surface of the loop.

Answer: a) At top $\quad \Sigma F_y = m a_y$

$$\Rightarrow -n - mg = -m a_c$$

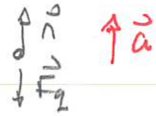
$$\Rightarrow n + mg = mv^2/r$$

$$\Rightarrow n = m\frac{v^2}{r} - mg$$

$$\Rightarrow \boxed{n = m\left[\frac{v^2}{r} - g\right]}$$

Thus $n = 0.10\,\text{kg}\left[\frac{(2.0\,\text{m/s})^2}{0.25\,\text{m}} - 9.8\,\text{m/s}^2\right] = 0.62\,\text{N}$

b) At bottom $\quad \Sigma F_n = m a_y$



$$\Rightarrow n - mg = mv^2/r \Rightarrow n = mg + mv^2/r$$

$$\Rightarrow n = m\left[g + \frac{v^2}{r}\right]$$

$$\Rightarrow n = 0.10\,\text{kg}\left[9.8\,\text{m/s}^2 + \frac{(\sout{2.0}\ 3.7\,\text{m/s})^2}{0.25\,\text{m}}\right]$$

$$= \sout{2.6\,\text{N}}\ 4.5$$

c) The normal force drops as the speed drops. We need $n > 0$

$$\Rightarrow \frac{v^2}{r} - g > 0 \Rightarrow v^2 > gr$$

$$\Rightarrow v > \sqrt{gr} = \sqrt{9.8\,\text{m/s}^2 \times 0.25\,\text{m}}$$

$$\Rightarrow v > 1.6\,\text{m/s}.$$