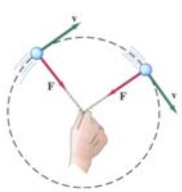
2 – Circular Motion and Gravitation

Dynamics of Uniform Circular Motion

- According to Newton's Second Law ($\Sigma F = ma$), an object that is accelerating must have a net force acting upon it.
- We call it centripetal force.
- $$\Sigma F_R = ma_R \text{ and } a_R = \frac{v^2}{r} \text{ therefore } \Sigma F_R = m\frac{v^2}{r}$$

~~Centrifugal~~ Force

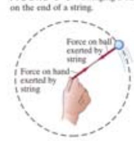
- Swinging a mass in a circle.
  - If the centripetal force were not applied then the mass would obey Newton's first law and fly off tangential to the circular path.



~~Centrifugal~~ Force

- The "pull" you feel on your hand is the Newton's 3rd Law reaction to the inward force that you are placing on the string.
- If ~~centrifugal~~ force existed, then the object would fly OUTward when you let go.
- DOESN'T HAPPEN

FIGURE 5-5 Swinging a ball on the end of a string.

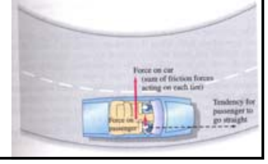


Rounding a Curve

- Is there anything more fun or more annoying to parents than playing "corners" and crushing your little brother in the back seat?
- That outward thrust you feel as the car rounds the curve is your tendency to continue in a straight line.
- The car exerts the inward force on you to move you in a curve.

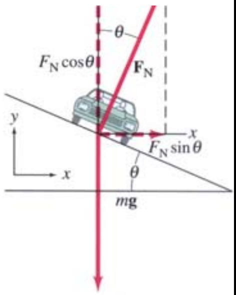
Rounding a Curve

- On a flat road the force is supplied by friction between the tires and the road.
- If there is not enough friction, the car skids out of a circular path an into a more nearly straight path.
- Wheel Lock
- ABS



Banking a Turn

- Banking a curve can reduce the chance of skidding because the normal force on the road will have a component toward the center of the circle.
- This reduces the reliance on friction to prevent skidding.



Banking a Turn

- For a given banking angle θ, there will be a speed where NO Friction at all is required.
- This is when the horizontal component of the normal force is equal to the centripetal acceleration.
- $F_N \sin\theta = \frac{mv^2}{r}$