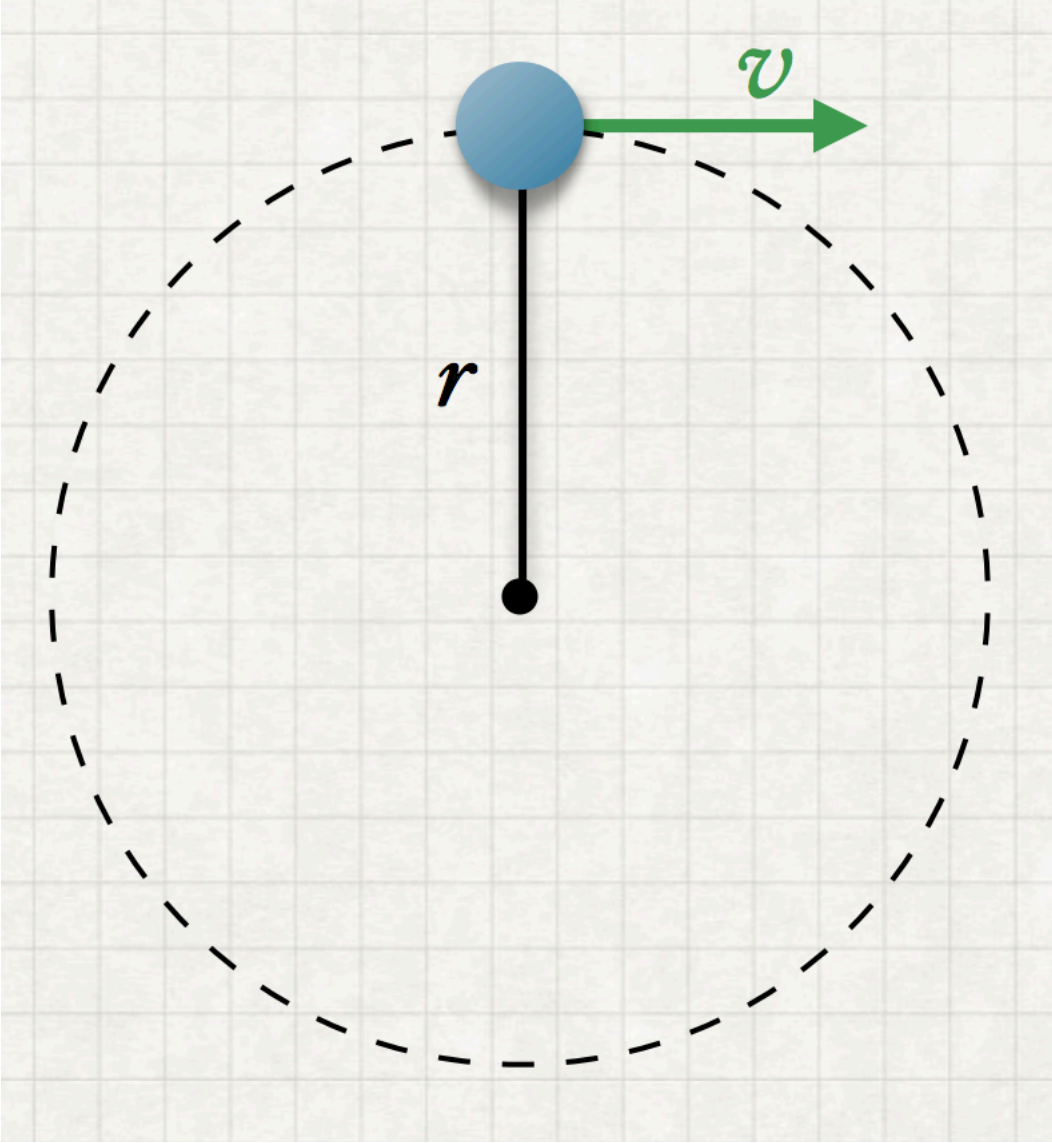
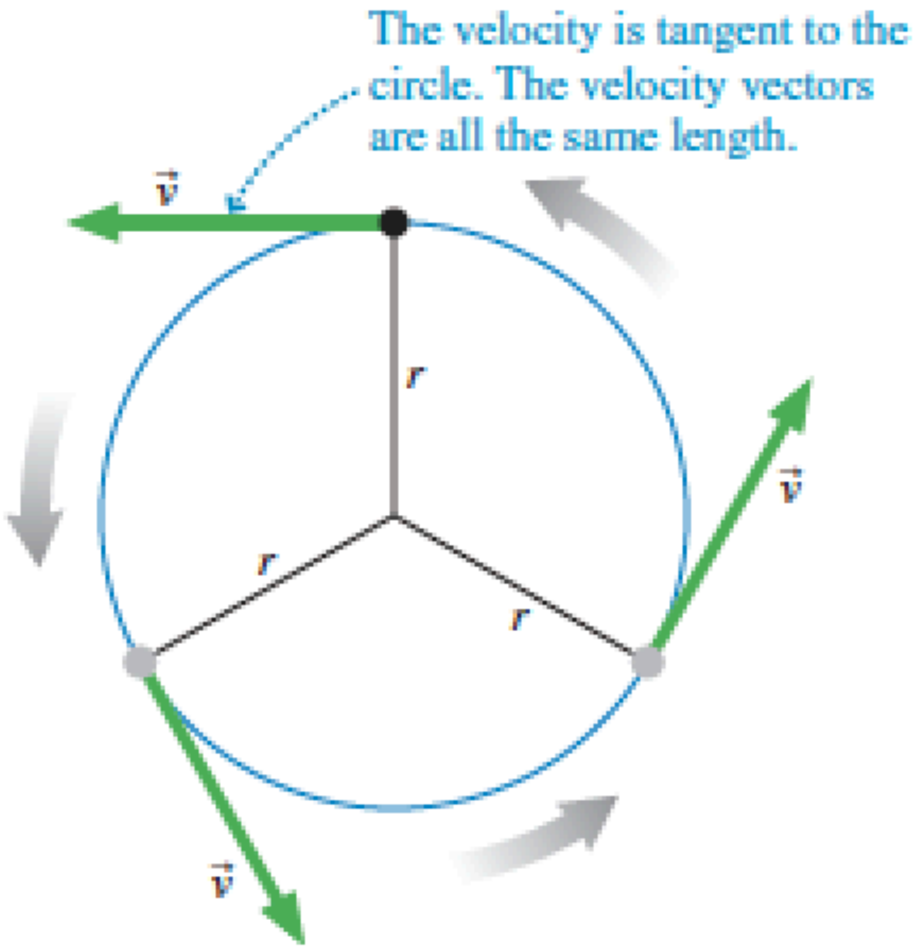

v
r

Circular Motion

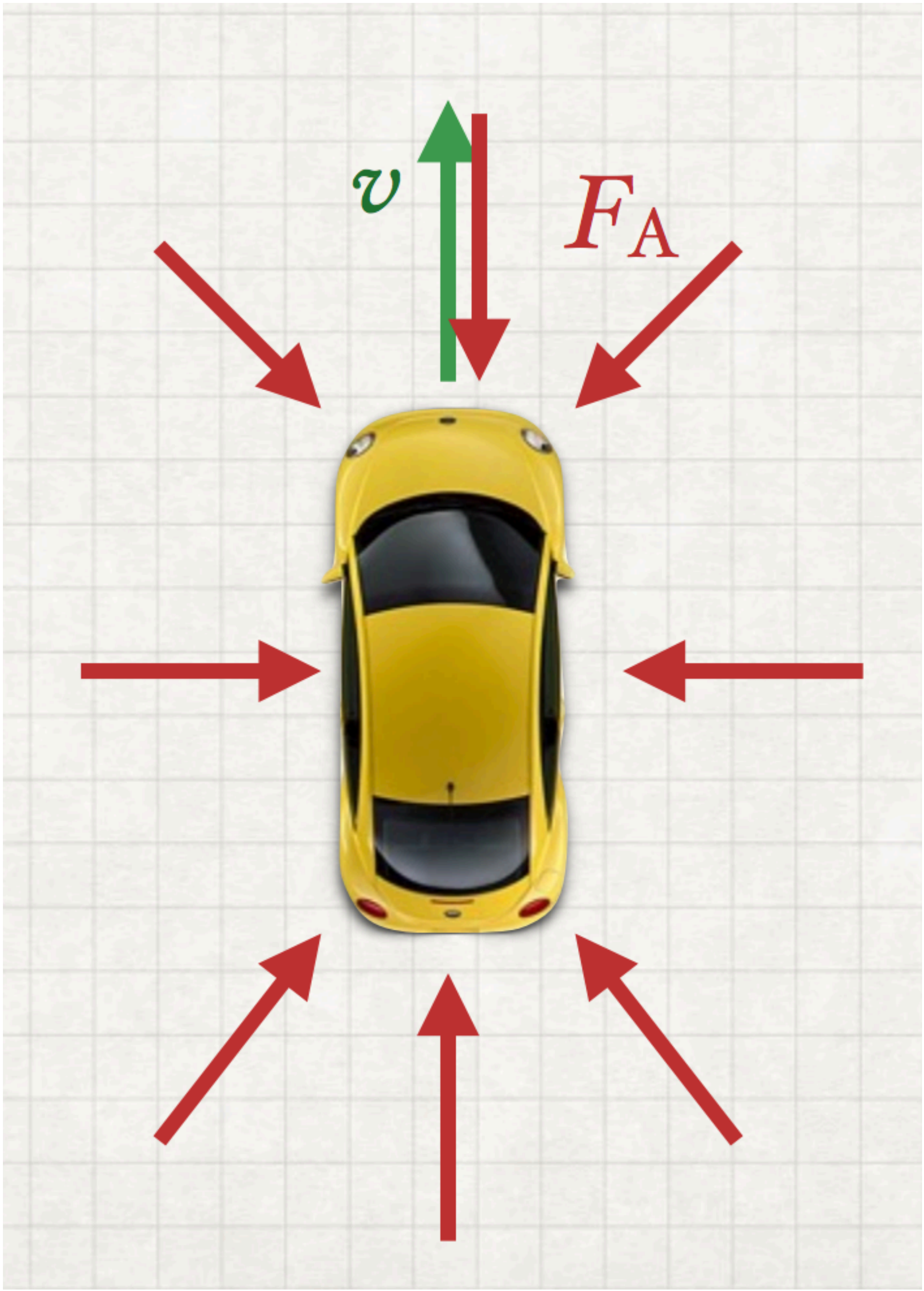
pc: Ken Christison

- Consider a particle moving at constant speed in a circle.
  - I.e. a satellite in orbit, a ball at the end of a string, an object on the side of a rotating wheel.
- This particle is in **uniform circular motion**: *v* is the same magnitude and always *tangent* to the edge of the circle, so *direction* is always changing

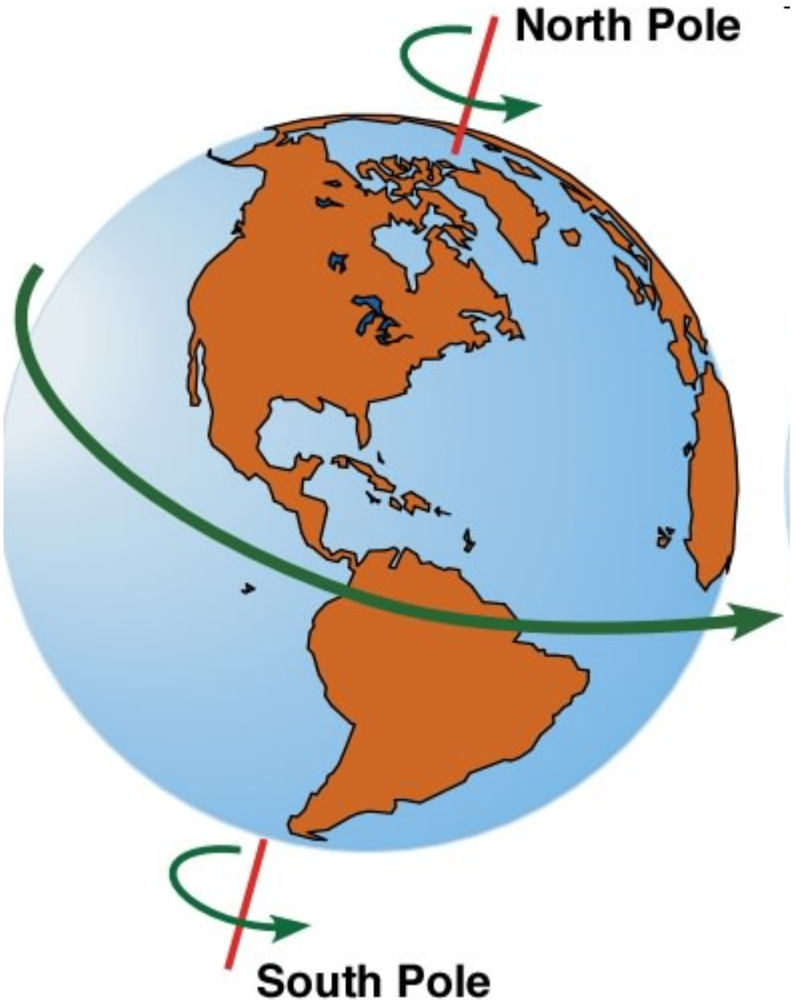


How do you make an object turn?

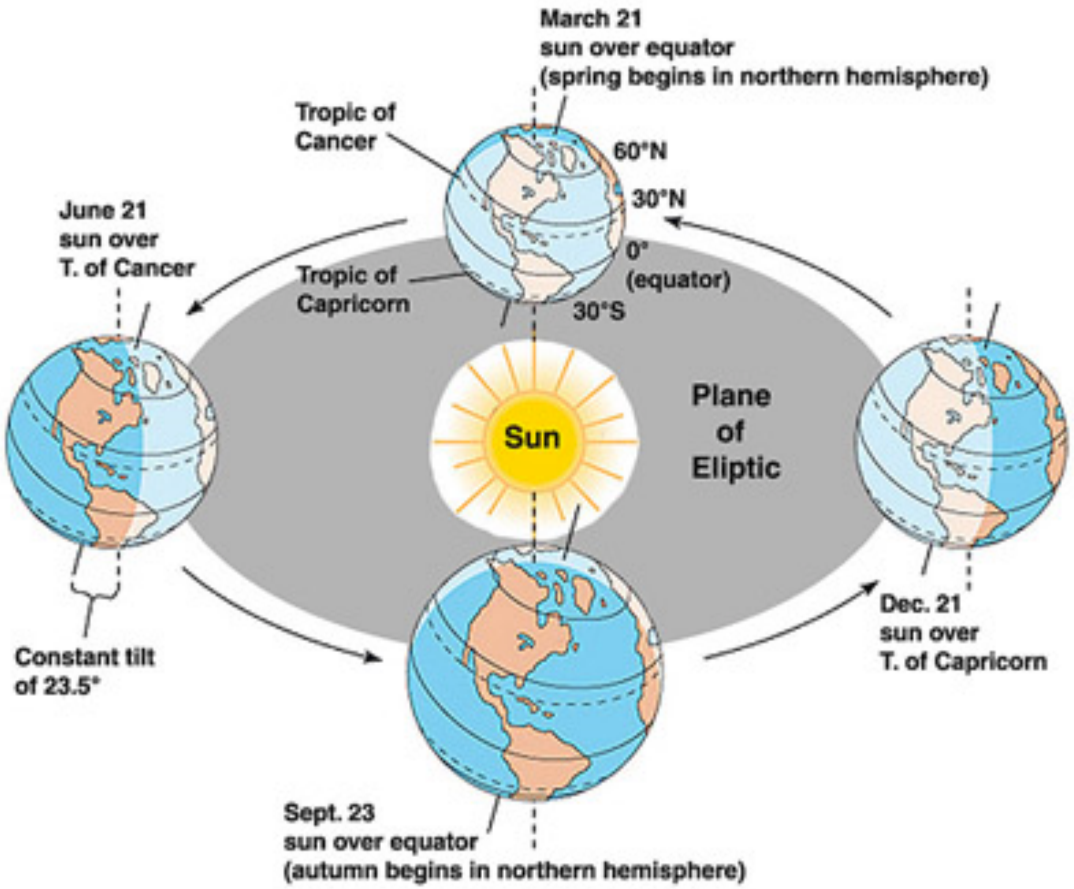
- So we need an unbalanced force. Where would be the most effective place to apply it?



Rotation: motion or spin on an *internal* axis

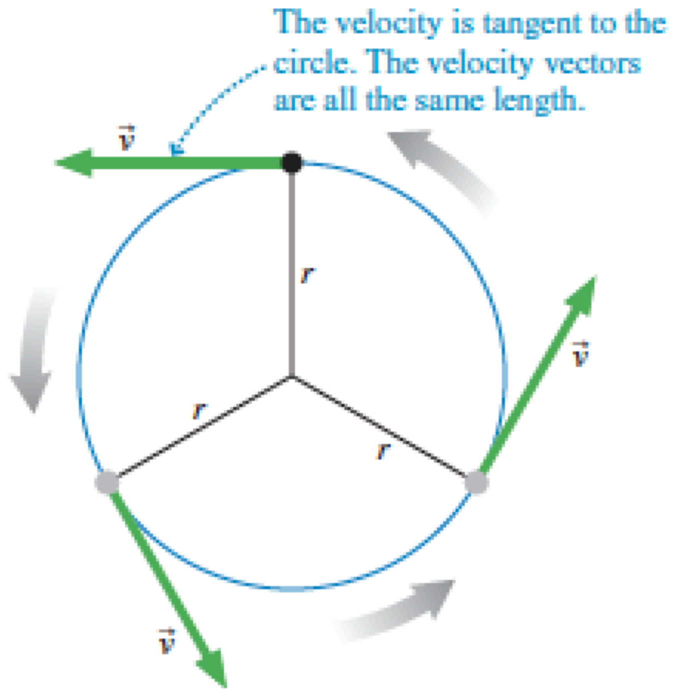


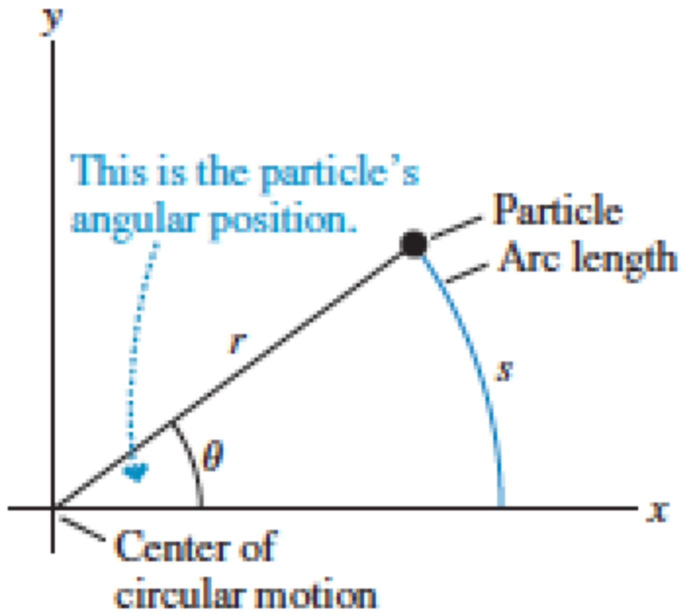
Revolution: motion or spin on an *external* axis



Some vocab:

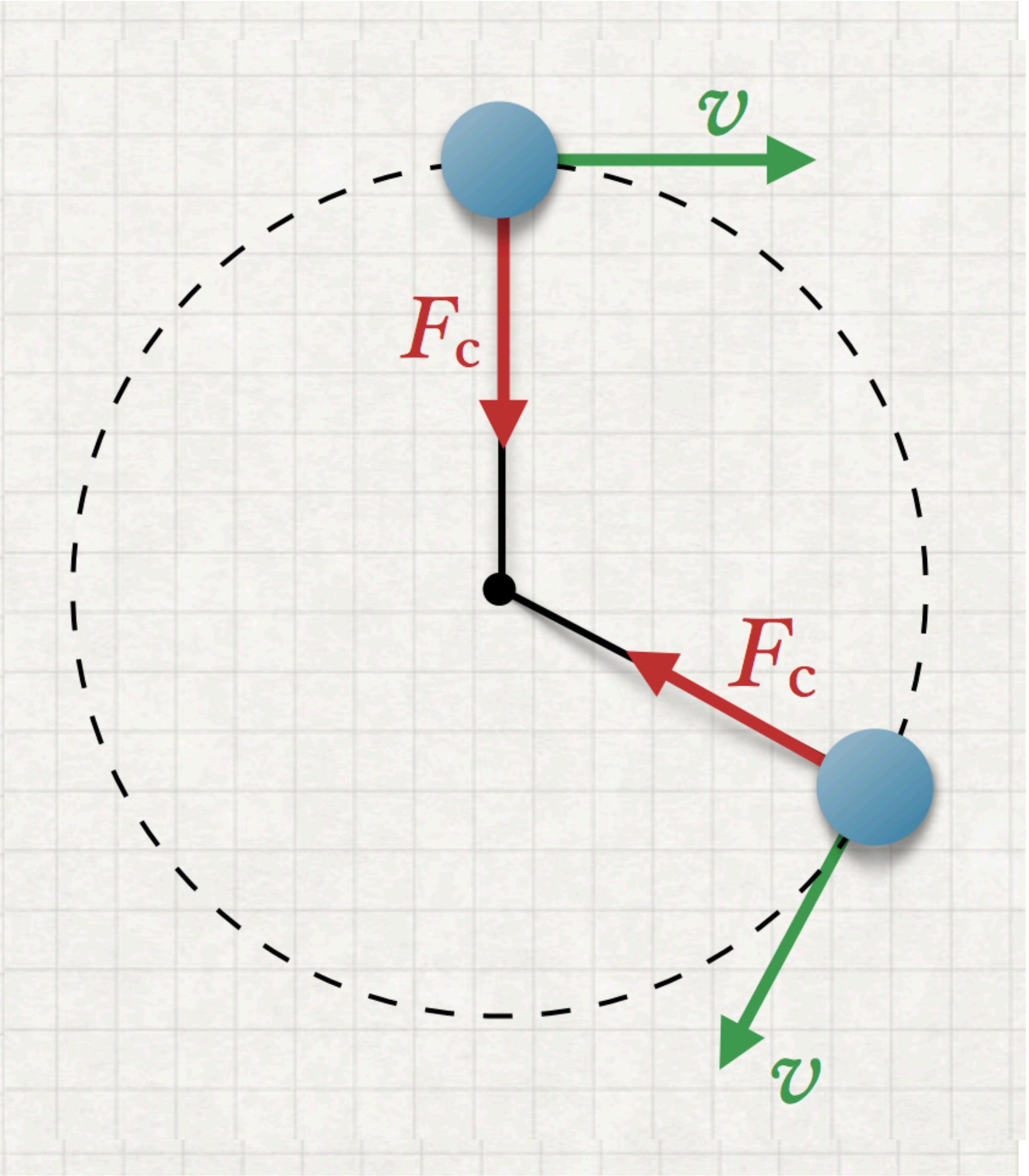
- **Radial** – behavior toward and away from the center of the circle
- **Angular/rotational** – behavior measured in reference to the axis of revolution/rotation.
- **Tangential** – behavior along the edge of the circle
  - *v* is the tangential velocity (v_t)
  - May also see "**linear**"





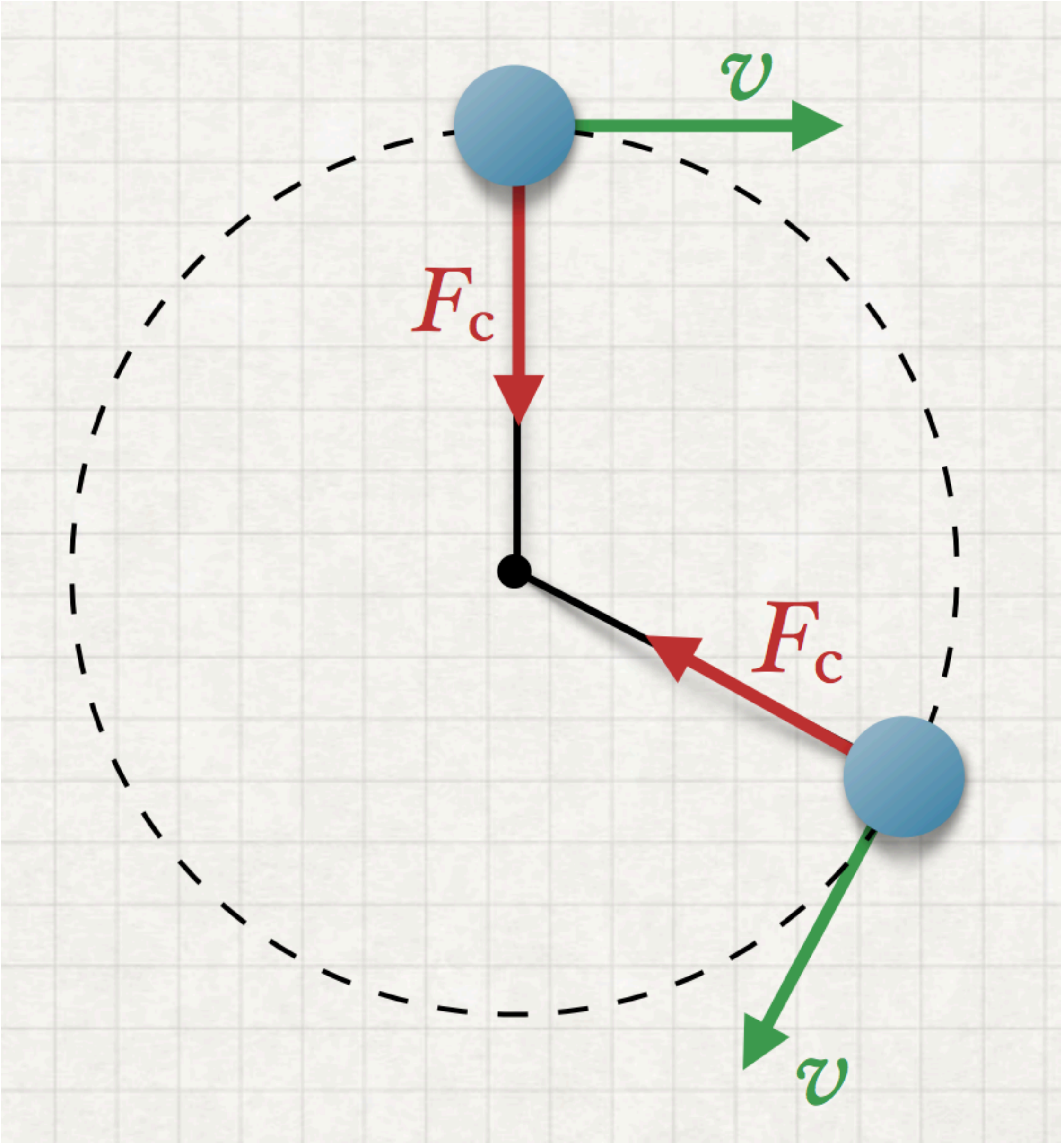
Which way should the force be applied to make the object move in a circle?

- Forces that point toward the center of rotation are called centripetal forces, meaning "center-seeking" forces
- Keep an object in rotation



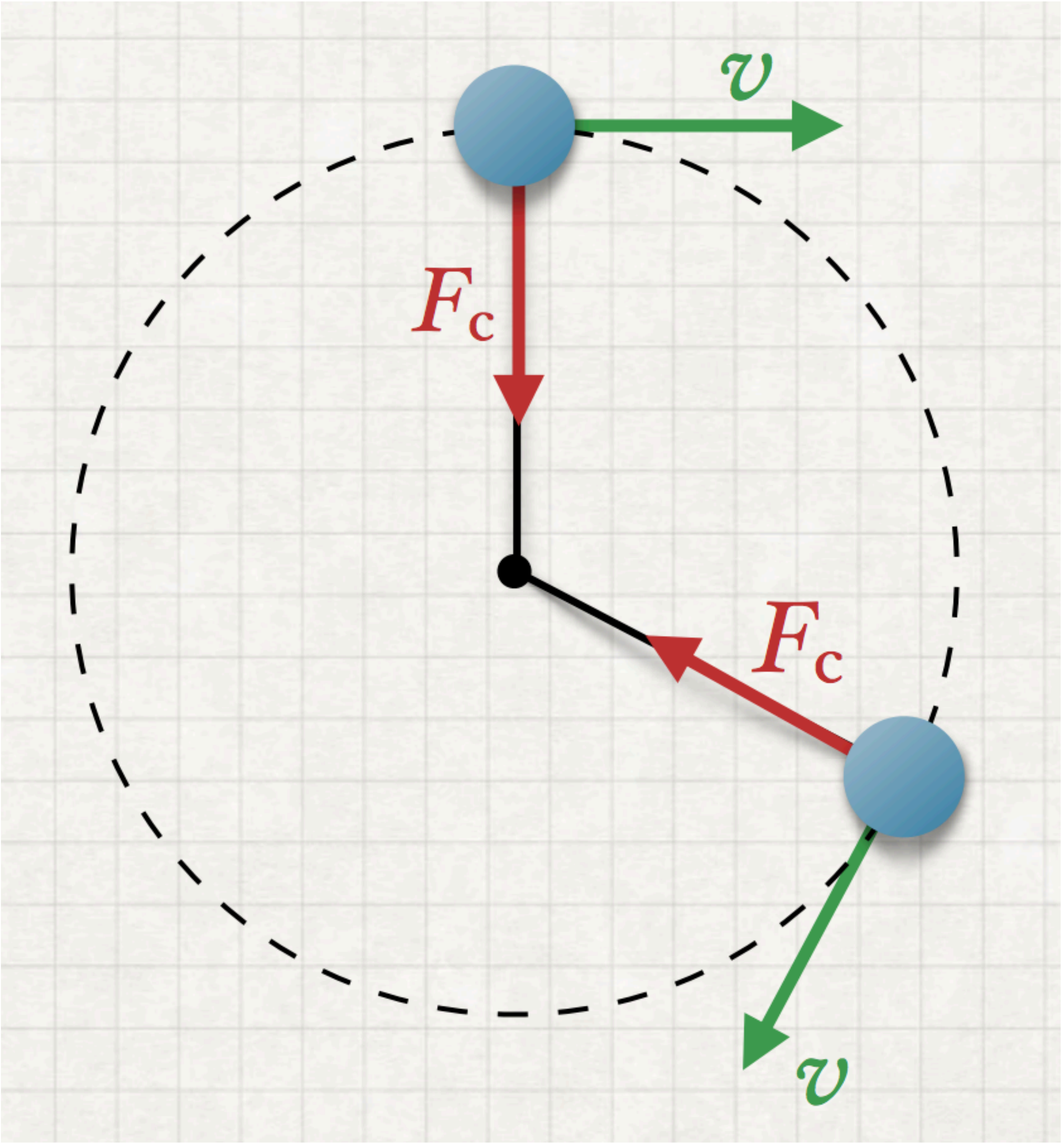
Centripetal forces aren’t new forces, they’re the same ones we’ve talked about before:

- Ball swung on a string-
- Car making a turn-
- Moon orbiting the Earth-
- Rollercoaster car going around a loop-



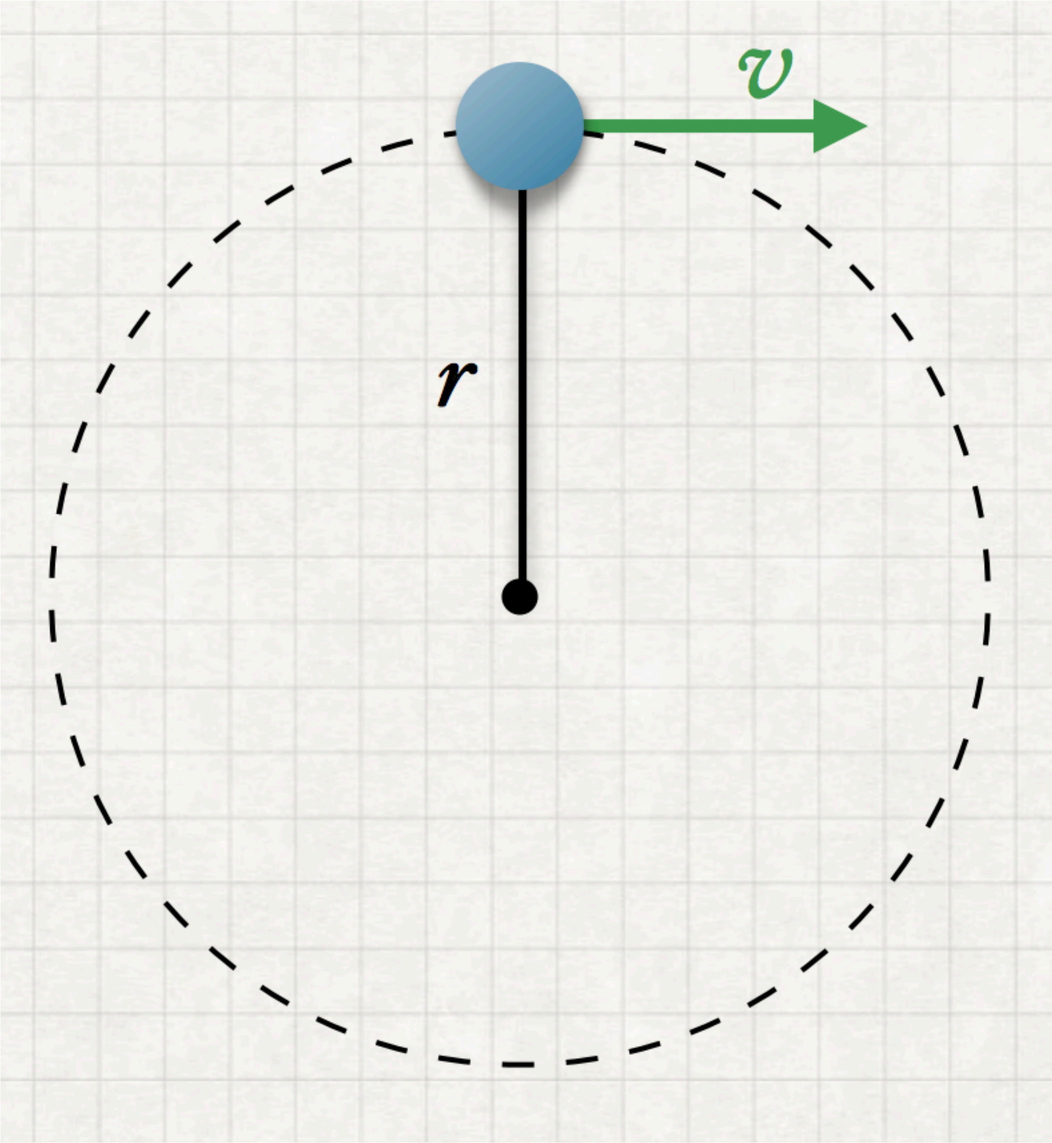
What's needed to determine the magnitude of the necessary centripetal force:

- Mass of object (*m*)
- How big is the circular path (*r*)
- How fast the object is moving around the circle (tangential velocity, *v*)



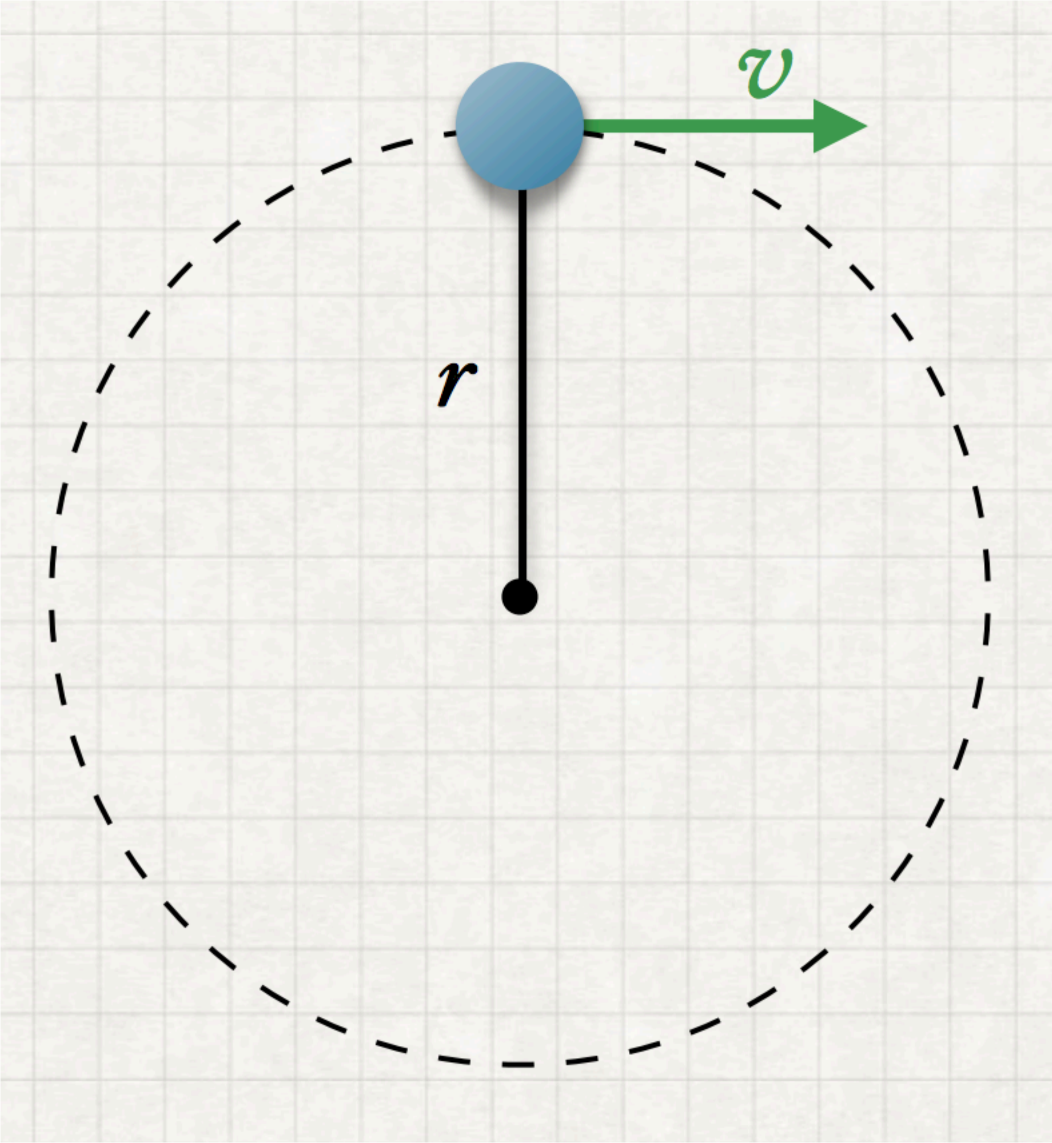
How to find the tangential velocity *v:*

- Frequency (*f*) = # revolutions/second
  - Measured in Hertz (Hz)
  - 1 Hz = 1 rev/sec = 1 s^{-1}
- Period (T) = time to make 1 full revolution
  - Measured in seconds
  - T = 1/*f*



Swinging a cup from a string of length *r* and, using a stopwatch, measure a period of T

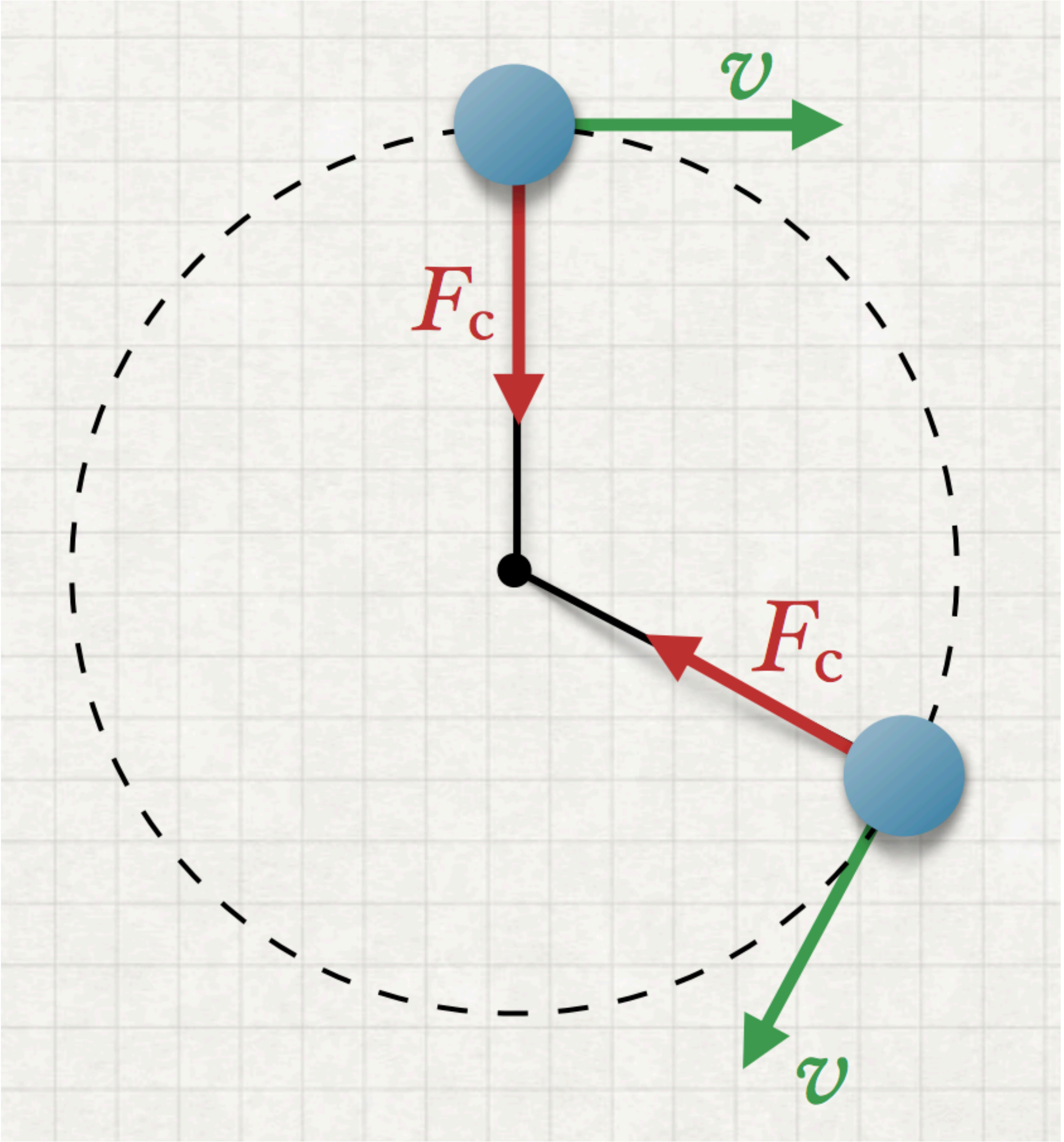
- How fast are you swinging the cup?
- *v = distance/time*
- $v = \frac{2\pi r}{T}$



Centripetal Force

$$\Sigma F_c = ma_c$$

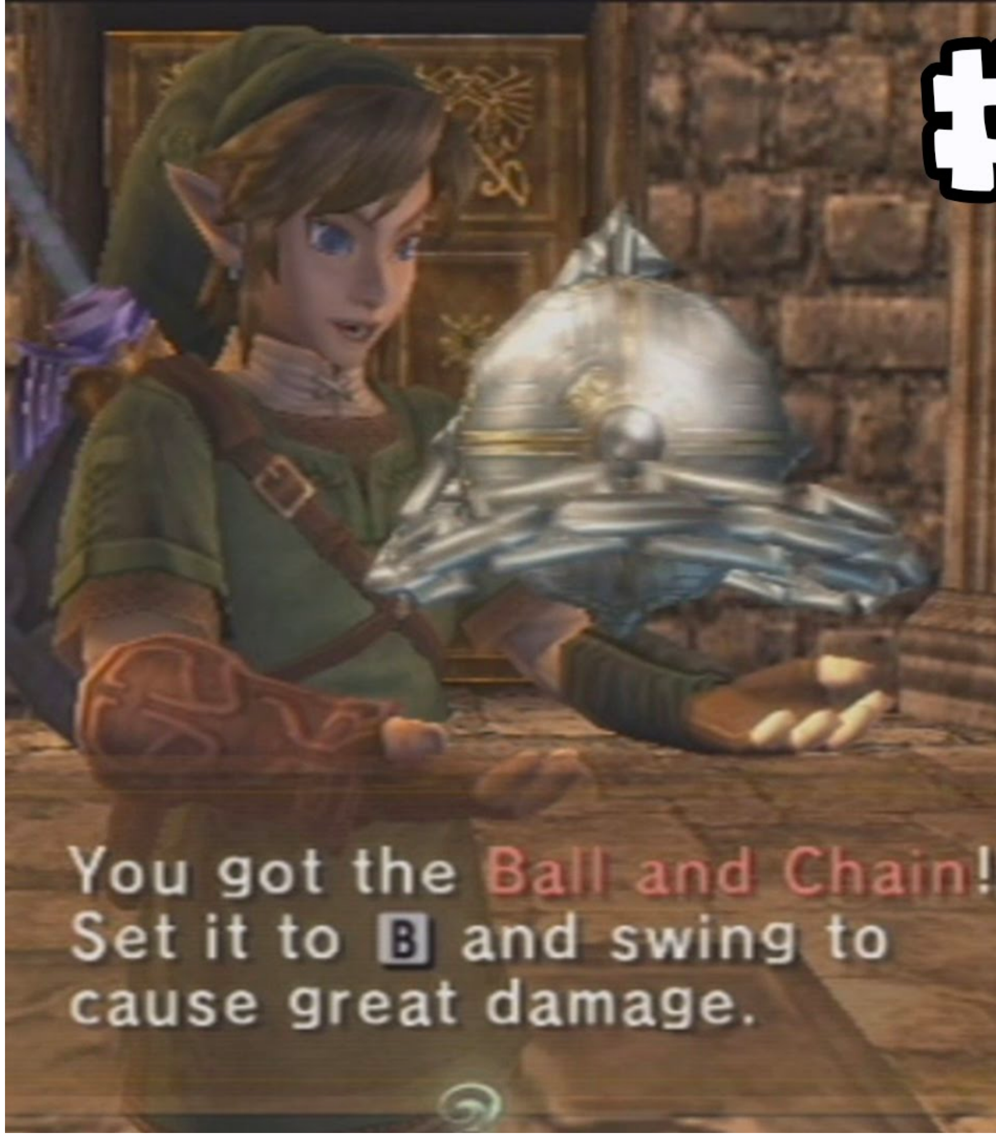
$$a_c = v^2/r$$



Proof: https://www.youtube.com/watch?v=TNX-Z6XR3gA

You can swing the 18.0 kg ball from its 1.50 m long chain through 2.00 revolutions per second. What is the force of tension in the chain?

4,260 N



The moon's nearly circular orbit about the Earth has a radius of about 384,000 km and a period *T* of 27.3 days. Determine the acceleration of the Moon towards the Earth.

2.72×10^{-3} m/s^2