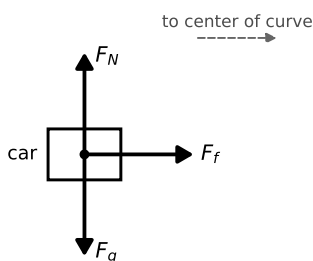


Part A: What Provides the Centripetal Force?

1. For each object moving in a circle, name the real force that points toward the center and acts as the centripetal force.
 - a. A tetherball whipping around its pole on a rope
 - b. A car turning a corner on a flat, dry road
 - c. A weather satellite orbiting Earth
 - d. Wet clothes pressed against the wall of a washing machine during the spin cycle
 - a. Tension** in the rope
 - b. Static friction** from the road on the tires
 - c. Gravity** (Earth's pull on the satellite)
 - d. The normal force** from the drum wall, pushing the clothes toward the center

2. A car turns right on a flat road at a steady speed. The box shows the car seen from behind.



- a. Draw a free-body diagram showing every force on the car. Label each force.
- b. Jordan adds a fourth arrow labeled F_c pointing toward the center. Explain why that is a mistake.
 - a.** F_N up and F_g down, equal lengths (no vertical motion). Static friction F_f points right, **toward the center of the curve**. Friction is the centripetal force.
 - b.** Centripetal force is not a separate force. It is the job done by a real force, here friction, which is already drawn. Adding F_c would count the same force twice.

Part B: Calculations

Use $F_c = mv^2/r$. Name the real force first, then show your knowns, equation, substitution, and answer with units.

3. Kenji swings a 0.250 kg ball on a string in a horizontal circle of radius 0.800 m at 4.00 m/s. What is the tension in the string? (Ignore gravity's small effect on the string.)

Source of F_c : tension, so $F_T = mv^2/r$

Knowns: $m = 0.250$ kg, $v = 4.00$ m/s, $r = 0.800$ m

Substitute: $F_T = (0.250 \text{ kg})(4.00 \text{ m/s})^2 / 0.800 \text{ m} = (0.250 \text{ kg})(16.0 \text{ m}^2/\text{s}^2) / 0.800 \text{ m}$

Answer: $F_T = 5.00 \text{ N toward the center}$

4. The tires of a 1,200 kg car can supply at most 9,000 N of static friction on a flat curve of radius 60.0 m.
- What is the fastest the car can safely take the curve?
 - What happens to the car if it goes faster than this? Describe its path.

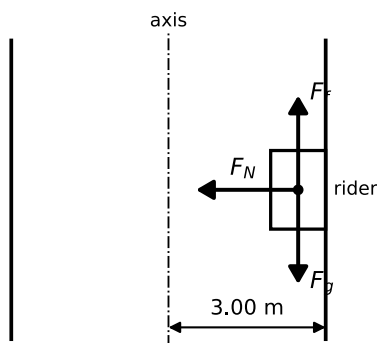
Source of F_c : static friction, so $F_f = mv^2/r$

a. Rearrange: $v = \sqrt{(F_f r / m)}$

Substitute: $v = \sqrt{((9,000 \text{ N})(60.0 \text{ m}) / 1,200 \text{ kg})} = \sqrt{(450 \text{ m}^2/\text{s}^2)}$ **Answer: $v = 21.2 \text{ m/s}$**

b. Friction cannot supply enough inward force, so the car cannot follow the curve. It slides outward off the curve, moving off along a path closer to the tangent (straight ahead), not straight outward.

5. A 50.0 kg rider stands against the wall of a rotor ride. The wall is 3.00 m from the axis, and the rider moves at 6.00 m/s. The floor drops away.



- Draw a free-body diagram for the rider on the picture.
- Find the normal force from the wall on the rider.
- How much friction must the wall supply to keep the rider from sliding down? Use $g = 9.8 \text{ m/s}^2$.

a. F_N points **toward the axis** (left). F_f points up and F_g points down, with equal lengths.

b. Source of F_c : the normal force, so $F_N = mv^2/r = (50.0 \text{ kg})(6.00 \text{ m/s})^2 / 3.00 \text{ m} = (50.0 \text{ kg})(36.0 \text{ m}^2/\text{s}^2) / 3.00 \text{ m} = \mathbf{600. \text{ N toward the axis}}$

c. Friction must balance gravity: $F_f = F_g = mg = (50.0 \text{ kg})(9.8 \text{ m/s}^2) = \mathbf{490 \text{ N upward}}$