

Centripetal Force

Newton's Second Law

$$F = ma$$
$$F_c = \frac{mv^2}{r} = mr\omega^2$$

Some other _____ creates _____ force

- Swinging something from a string → _____
- Satellite in orbit → _____
- Car going around curve → _____

A 1.25-kg toy airplane is attached to a string and swung in a circle with radius = 0.50 m. What was the centripetal force for a speed of 20 m/s? What provides the F_c ?

What affects F_c more: a change in mass, a change in radius, or a change in speed?

Why do objects seem to fly away from circular motion?

How does the spin cycle in a washing machine work?

Practice Work

1. A bug lands on a windshield wiper. Explain why the bug is more likely to be dislodged when the wipers are turned on at the high rather than the low setting.
2. A penny is placed on a rotating turntable. Where on the turntable does the penny require the largest centripetal force to remain in place? Explain.
3. Define centripetal force. Can any type of force (for example, tension, gravitational force, friction, and so on) be a centripetal force? Can any combination of forces be a centripetal force?
4. If centripetal force is directed toward the center, why do you feel that you are 'thrown' away from the center as a car goes around a curve? Explain.

5. A 0.015-kg ball is shot from the plunger of a pinball machine. Because of a centripetal force of 0.028 N, the ball follows a circular arc whose radius is 0.25 m. What is the speed of the ball? (Cutnell 5.11) **0.68 m/s**
6. In a skating stunt known as "crack-the-whip," a number of skaters hold hands and form a straight line. They try to skate so that the line rotates about the skater at one end, who acts as the pivot. The skater farthest out has a mass of 80.0 kg and is 6.10 m from the pivot. He is skating at a speed of 6.80 m/s. Determine the magnitude of the centripetal force that acts on him. (Cutnell 5.12) **606 N**
7. At an amusement park there is a ride in which cylindrically shaped chambers spin around a central axis. People sit in seats facing the axis, their backs against the outer wall. At one instant the outer wall moves at a speed of 3.2 m/s, and an 83-kg person feels a 560-N force pressing against his back. what is the radius of a chamber? (Cutnell 5.14) **1.5 m**
8. (a) A 22.0 kg child is riding a playground merry-go-round that is rotating at 40.0 rev/min. What centripetal force must she exert to stay on if she is 1.25 m from its center? (b) What centripetal force does she need to stay on an amusement park merry-go-round that rotates at 3.00 rev/min if she is 8.00 m from its center? (OpenStax 6.23) **483 N, 17.4 N**
9. Calculate the centripetal force on the end of a 100 m (radius) wind turbine blade that is rotating at 0.5 rev/s. Assume the mass is 4 kg. (OpenStax 6.24) **4×10^3 N**
10. The Earth with mass 5.98×10^{24} kg orbits the sun in an approximately circular orbit with radius 147 billion meters. (a) What provides the centripetal force? (b) What is the centripetal force required to keep the Earth in its orbit? (Hint: find the angular velocity in rad/s first. It takes 1 year for the Earth to orbit the sun.) (RW) **(b) 3.48×10^{22} N**
11. A baseball pitcher throws a ball at 90 mph (40.2 m/s). Right before the ball is thrown, it is traveling in a circular arc by the pitcher's arm. If the mass of the baseball is 0.145 kg and the pitcher's arm is 63.5 cm, what centripetal force on the baseball? (RW) **369 N**
12. A Chevy Corvette Z06 will slide on a corner if the centripetal force is greater than 2.00×10^4 N (1.19 *g*). If the mass of the car is 1710 kg and is traveling at 1.00×10^2 m/s, what is the smallest radius of an unbanked corner it can go around without slipping? (RW) **855 m**