Physics 20

## Unit C: Circular motion and energy

# Forces in circles

## A car on a curve

- A 1200 kg car holds 16.0 m/s through a horizontal curve of radius 45.0 m.
- Friction toward the centre supplies the net force that keeps changing the car’s direction.

## The inward net force has a name

- In m v squared over r, m is the mass, v is the speed, and r is the radius.
- Centripetal force is the net force toward the centre, and its size is m v squared over r.
- Banking tilts the normal force so a component points toward the centre of a curve.
- A centrifuge, a carnival circle, and a potter’s wheel each need that inward net force.

# Key terms

### centripetal force

Centripetal force is the net force toward the centre of the circle, with magnitude m v squared over r. ($F = m\,v^2/r$)

### banking

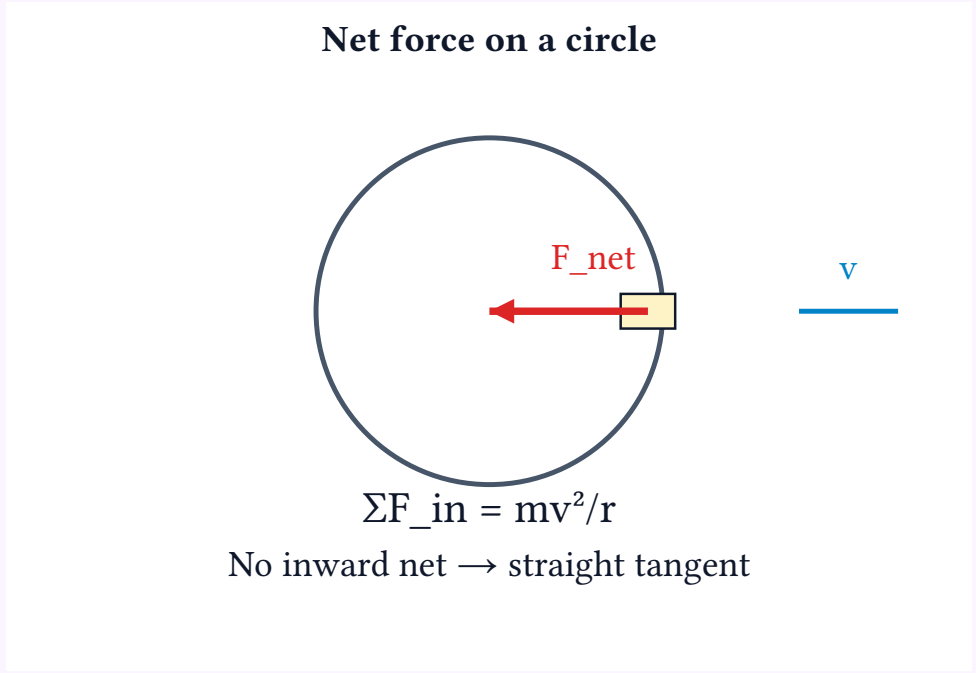
Banking tilts a roadway so the normal force has a horizontal component toward the centre of the curve.

### centrifuge

A centrifuge spins samples in a circle so a large inward net force separates materials by how they respond to that force.

# Newton’s laws on the circle

- The net force toward the centre equals m v squared over r.
- A zero inward net force leaves the velocity on a straight tangent.
- The inward force keeps changing the direction while it acts.

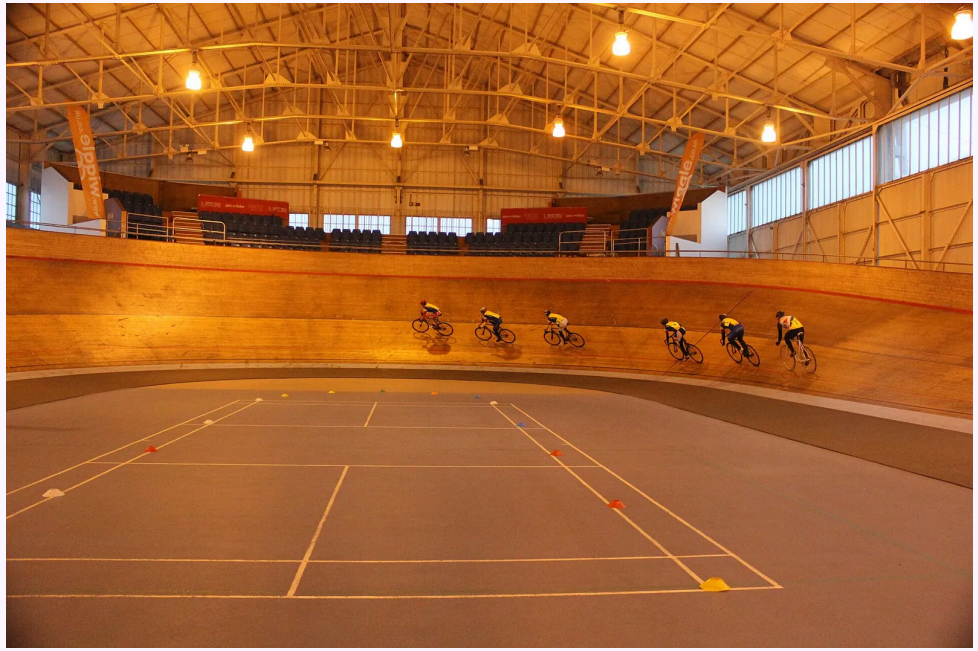


# Friction on the level curve

- The car’s mass is 1200 kg, its speed is 16.0 m/s, and the radius is 45.0 m.
- $F = (1200\ \text{kg})(16.0\ \text{m/s})^2 / 45.0\ \text{m}$.
- That force is $6.83 \times 10^3$ N toward the centre.

# Circular motion technologies

- A stopper lab relates orbital speed, radius, acceleration, and centripetal force.
- Banking uses an acute angle from the horizontal so the normal force can point partly inward.
- A centrifuge, a vertical carnival loop, and a potter’s wheel use the same inward net force.



# Top of a vertical circle

- A 0.500 kg bucket on a 0.800 m rope moves at 4.00 m/s at the top of a vertical circle.
- At the top, tension and weight both point toward the centre.
- Their sum equals m v squared over r.

# A clinical centrifuge

- A centrifuge holds a 0.00800 kg sample at radius 0.120 m and frequency 40.0 Hz.
- Find the speed and the centripetal force on the sample.
- Name the real object that supplies the inward force.

# Image credits

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