

## Circular Motion Equations Worksheet

Level: A-Level / AP Physics 1 / IB HL | Difficulty: Advanced | Topic: Mechanics

Practice uniform circular motion with 10 problems covering centripetal acceleration, centripetal force, angular velocity, and period. Full solutions included.

### Equations you will need

|                   |                                     |
|-------------------|-------------------------------------|
| $a = v^2/r$       | Centripetal acceleration            |
| $F = mv^2/r$      | Centripetal force                   |
| $\omega = v/r$    | Angular velocity                    |
| $T = 2\pi/\omega$ | Period                              |
| $v = 2\pi r/T$    | Linear speed from radius and period |

### Symbol key

| Symbol   | Quantity                 | Unit    |
|----------|--------------------------|---------|
| $a$      | centripetal acceleration | $m/s^2$ |
| $v$      | linear speed             | $m/s$   |
| $r$      | radius                   | $m$     |
| $F$      | centripetal force        | $N$     |
| $\omega$ | angular velocity         | $rad/s$ |
| $T$      | period                   | $s$     |
| $m$      | mass                     | $kg$    |

### Practice problems

1. A car travels at 10 m/s on a circular track of radius 20 m. Find centripetal acceleration.
2. Find the centripetal force on a 1500 kg car going 25 m/s around a 50 m radius curve.
3. A point on a 0.3 m diameter wheel rotates at 4 rev/s. Find linear speed.
4. Find the period of a satellite in a 7000 km orbit moving at 7500 m/s.
5. A 0.5 kg ball on a 1 m string is whirled at 3 rev/s. Find the tension.
6. A 800 kg car rounds a flat curve of radius 40 m at 15 m/s. Find required friction force.

7. Find  $\omega$  for an object completing one revolution every 4 seconds.
8. A 2 kg mass swings in a horizontal circle of radius 0.8 m at angular velocity 5 rad/s. Find centripetal force.
9. A car at 20 m/s rounds a curve where max friction force = 8000 N. Min radius if car mass is 1200 kg?
10. The Moon orbits Earth in 27.3 days at radius  $3.84 \times 10^8$  m. Find its orbital speed.

## Answer key

Full worked solutions for each problem.

1.  $a = v^2/r = 100/20 = 5 \text{ m/s}^2$
2.  $F = mv^2/r = 1500(625)/50 = 18,750 \text{ N}$
3.  $v = 2\pi r \times f = 2\pi(0.15)(4) = 3.77 \text{ m/s}$
4.  $T = 2\pi r/v = 2\pi(7 \times 10^6)/7500 = 5864 \text{ s} \approx 98 \text{ min}$
5.  $\omega = 6\pi \text{ rad/s}$ ;  $v = 6\pi \text{ m/s}$ ;  $F = mv^2/r = 0.5(6\pi)^2/1 = 177.6 \text{ N}$
6.  $F = 800(225)/40 = 4500 \text{ N}$
7.  $\omega = 2\pi/T = 2\pi/4 = 1.57 \text{ rad/s}$
8.  $v = \omega r = 4 \text{ m/s}$ ;  $F = mv^2/r = 2(16)/0.8 = 40 \text{ N}$
9.  $8000 = 1200(400)/r \rightarrow r = 60 \text{ m}$
10.  $T = 27.3 \times 86400 = 2.36 \times 10^6 \text{ s}$ ;  $v = 2\pi r/T = 1023 \text{ m/s}$