

KINEMATICS OF CIRCULAR MOTION

PART 1: TIME & FREQUENCY

In circular motion, objects repeat their path. We use specific terms for repetitive motion.

THE DEFINITIONS

Period (T)

- Time for **one** full revolution.
- Units: Seconds (s)

Frequency (f)

- Revolutions per **one** second.
- Units: Hertz (Hz) or s^{-1}

$$T = \frac{1}{f} \quad \leftrightarrow \quad f = \frac{1}{T}$$

WE DO The Tachometer

A car engine idles at 800 RPM (Revolutions Per Minute).

a. Convert to Hz:

b. Find Period (T):

PART 2: TANGENTIAL SPEED

Speed is distance / time. For a circle, distance is **Circumference** ($2\pi r$).

SPEED EQUATION

$$v = \frac{2\pi r}{T} \quad \text{or} \quad v = 2\pi r f$$

The velocity vector is always tangent to the circle.

YOU DO The Vinyl Record

A record spins at $33\frac{1}{3}$ RPM. Radius = 0.15 m.

A. Find Period (T):

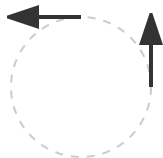
B. Find v at Edge ($r = 0.15$):

PART 3: CENTRIPETAL ACCELERATION

The Paradox: We are moving at a *constant speed*, yet we are *accelerating*. Why?

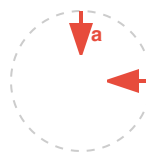
1. Velocity Turns

Velocity is a vector. Even if the length stays the same, the arrow turns.



2. Result Points Inward

The change (Δv) points to the center. This is **Centripetal**.



MAGNITUDE OF ACCELERATION

$$a_c = \frac{v^2}{r}$$

WE DO The "Gravitron"

Radius = 3.0 meters. Tangential speed = 12 m/s.

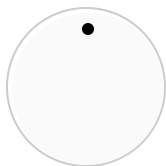
a. Calculate a_c :

b. G-Force ($\div 9.8$):

VISUAL CHECK

Object moves **Counter-Clockwise**. Draw $\vec{v}$ and $\vec{a}$.

12 o'clock



9 o'clock



CLASSWORK & PRACTICE

Work with your partners. Focus on the **relationships**.

SKILL Proportional Reasoning

Consider the equation $a_c = \frac{v^2}{r}$.

- a. If a car takes the same curve (r constant) at **double** the speed ($2v$), by what factor does a_c change?

- b. A car maintains constant speed, but the curve is **twice** as "tight" ($r \rightarrow r/2$). What happens to a_c ?

AP SKILL Ranking Task

Rank the **Magnitude of Acceleration** (Greatest to Least).

A: $r = R, v = v$

B: $r = 2R, v = 2v$

C: $r = R, v = 2v$

D: $r = 2R, v = v$

Ranking: _____ > _____ > _____ > _____

Reasoning:

CHALLENGE Real World Numbers

Moon Orbit: $T = 27.3$ days. $r = 3.84 \times 10^8$ m.

- a. Convert T to seconds.

- b. Calculate orbital speed v .

- c. Calculate centripetal acceleration.

HOMEWORK: DAY 12

1 Conceptual Check

True or False? Correct any false statements.

- [] Uniform circular motion has constant velocity.
- [] Uniform circular motion has constant speed.
- [] Acceleration and Velocity point in the same direction.

2 The Tire Problem

Tire Radius = 0.35 m. Car Speed = 25 m/s.

- a. Find Frequency (f) in Hz.

- b. Find a_c of a pebble in the tread.

- c. Find a_c of a hubcap part only 0.10 m from center.

3 Paragraph Argument

Prompt: A student claims: "Since $a_c = v^2/r$, acceleration is inversely proportional to radius. So, a point on the outside of a spinning disk (large r) accelerates LESS than a point near the center."

Is the student correct? Argue your position. (Hint: Think about what variable is constant for a rigid disk).