NAME: _____ AP PHYSICS 1 DATE: _____

KINEMATICS OF CIRCULAR MOTION

Watch the word "uniform": it means constant *speed* (magnitude only) — the direction of motion changes continuously, so the velocity is not constant.

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 800 RPM into Frequency (Hz).

b. Calculate the Period (T) of the rotation.

PART 2: TANGENTIAL SPEED

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

SPEED EQUATION

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

The velocity vector is always tangent to the circle.

YOU DO **The Vinyl Record**

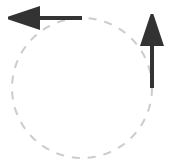
A record spins at $33\frac{1}{3}$ RPM. Radius = 0.15 m.

PART 3: CENTRIPETAL ACCELERATION

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

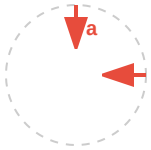
1. Velocity Turns

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 the centripetal acceleration.

b. **G-Force:** How many "g's"? (Divide by 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" ($r \to r/2$). 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 1

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.

⚠ Concept Alert: Rigid Disks
On a solid spinning object, **Frequency (f) is constant** everywhere. However, linear speed (v) changes ($v = 2\pi r f$).

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.