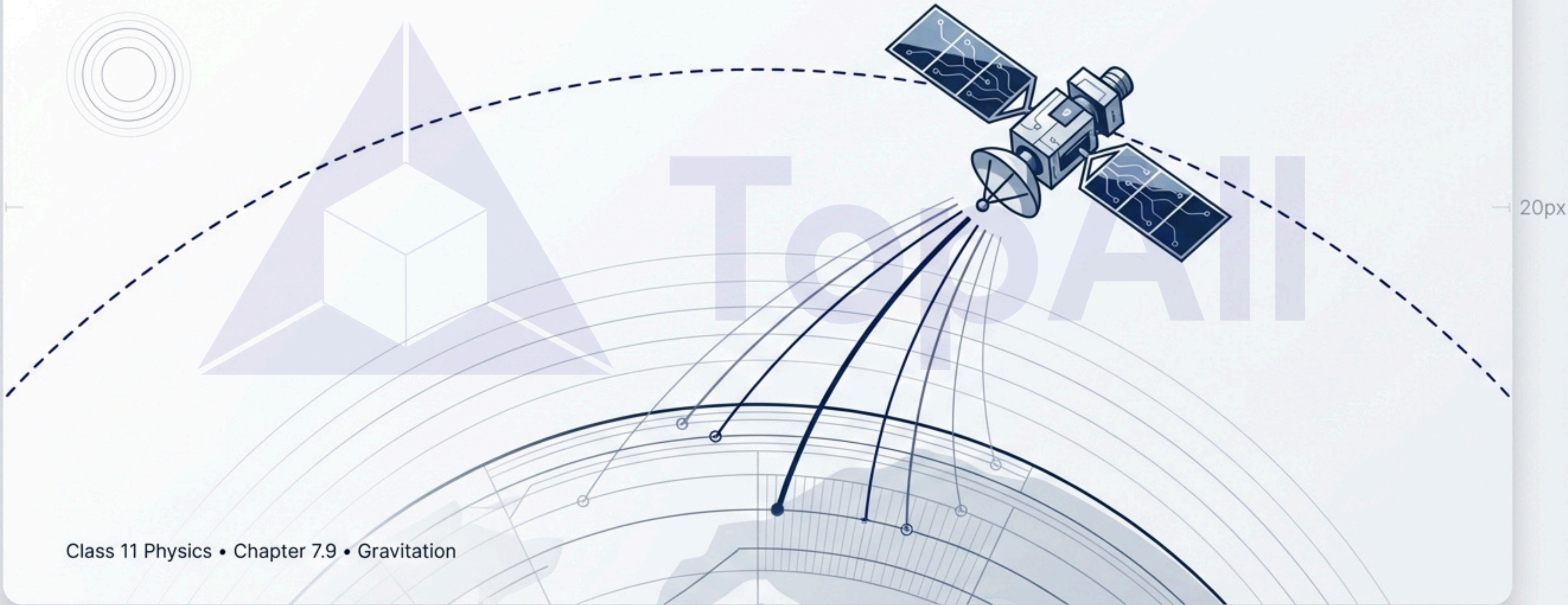


H1: Earth Satellites

H2: Why satellites keep circling Earth



Defining Earth Satellites

Any object revolving around the Earth in a stable **circular** or **elliptical orbit** is a satellite.
Their motion is completely governed by Kepler's laws of planetary motion.



Natural

Celestial bodies naturally occurring in orbit.

Example:

The Moon (Time period $\approx$ 27.3 **days**)



Artificial

Human-made machines launched into orbit for practical use.

Uses:

Telecommunication, geophysics, and meteorology

The 'Falling but Missing' Principle

A satellite does not escape Earth's gravity. Instead, gravity provides the exact centripetal force required to keep the satellite moving in a continuous circular path.



If the horizontal speed is just right, the satellite continuously falls around the Earth, rather than into it.



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$$E=mc^2$$



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Calculating Orbital Speed (V)

To find the required speed, we equate the centripetal force required for the circular orbit to the gravitational force provided by Earth.

Centripetal Force

$$F_c = \frac{m \times V^2}{R_E + h}$$

Gravitational Force

$$F_g = \frac{G \times m \times M_E}{(R_E + h)^2}$$

Equating $F_c = F_g$ and canceling the satellite's mass (m), we get the Orbital Speed formula:

$$V = \sqrt{[(G \times M_E) / (R_E + h)]}$$

Note: The mass of the satellite (m) cancels out. Orbital speed depends only on Earth's mass and the height of the orbit!

H1: Time Period of Revolution (T)

The time a satellite takes to complete one full orbit. It is the orbital circumference divided by the orbital speed.

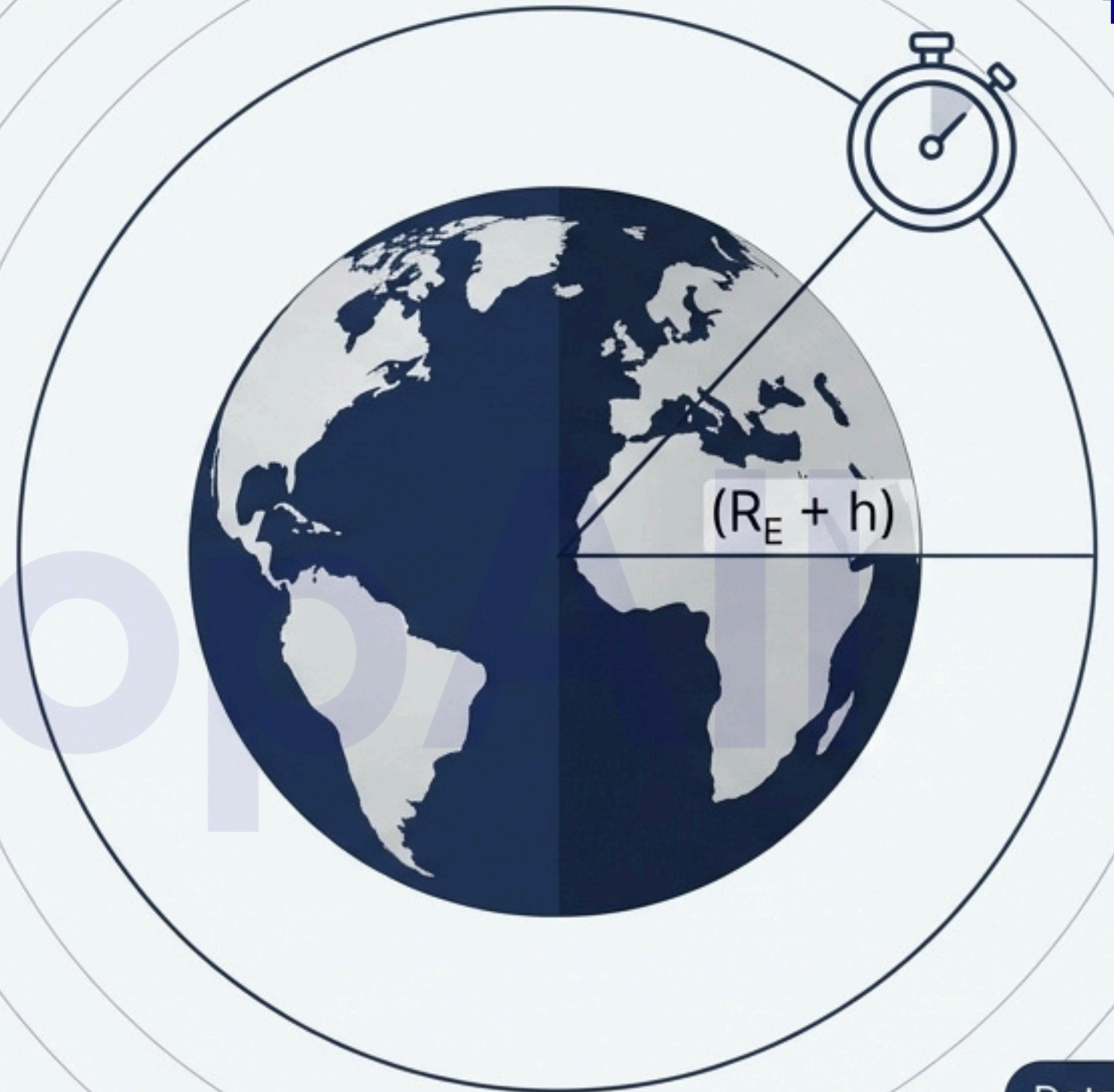
$$T = \frac{2\pi(R_E + h)}{V}$$

Substituting V, we get:

$$T = 2\pi\sqrt{\frac{(R_E + h)^3}{G * M_E}}$$

Squaring both sides yields $T^2 \propto (R_E + h)^3$. This perfectly aligns with Kepler's Law of Periods.

TOP



Data Pill

For a satellite very close to Earth's surface ($h \approx 0$), $T_0 = 2\pi\sqrt{(R_E / g)} \approx 85$ minutes.

H1: How Altitude Affects Orbit

Stacked Orbit Comparison

Higher Altitude = Slower Speed

Because $V \propto \frac{1}{\sqrt{R_E + h}}$, satellites further from Earth travel at slower speeds. The gravitational pull is weaker, requiring less centripetal force.

Satellite A:
Low Orbit

Satellite B:
High Orbit

V_A

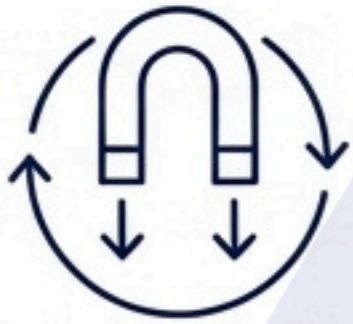
Short T_A

V_B
Long T_B

Higher Altitude = Longer Period

Because $T \propto (R_E + h)^{3/2}$, satellites further from Earth have a vastly longer journey and travel slower, dramatically increasing the time required for one orbit.

H1: Chapter Summary: Earth Satellites



H3: Gravity Drives Orbit

Earth's gravitational pull provides the exact centripetal force required to keep a satellite in circular, continuous freefall.



H3: Speed vs. Radius

Orbital speed (**v**) is completely independent of the satellite's mass, but it decreases as the orbit radius (**$R_E + h$**) increases.



H3: Time Period

The time period (**T**) increases dramatically with orbit size, adhering to Kepler's Law of Periods where **$T^2 \propto R^3$** .



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