Chapter 8 – Dynamics in 2D

- Uniform/Nonuniform Circular Motion
- Centrifugal (fictitious) force

General Principles

Newton's Second Law

Expressed in x- and y-component form:

$$(F_{\text{net}})_x = \sum F_x = ma_x$$

$$(F_{\text{net}})_y = \sum F_y = ma_y$$

Expressed in rtz-component form:

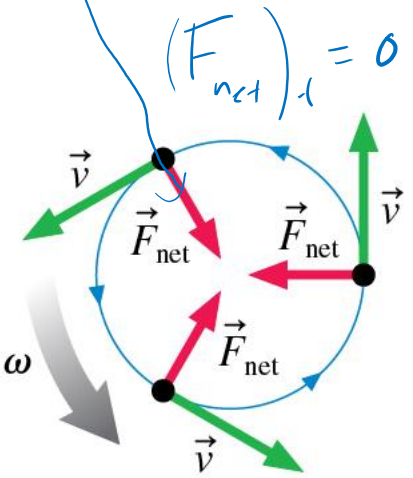
$$(F_{\text{net}})_r = \sum F_r = ma_r = \frac{mv_t^2}{r} = m\omega^2 r$$

$$(F_{\text{net}})_t = \sum F_t = \begin{cases} 0 & \text{uniform circular motion} \\ ma_t & \text{nonuniform circular motion} \end{cases}$$

$$(F_{\text{net}})_z = \sum F_z = 0$$

Uniform Circular Motion

- Speed is constant.
- $\vec{F}_{\text{net}}$ points toward the center of the circle.
- The **centripetal acceleration** $\vec{a}$ points toward the center of the circle. It changes the particle's direction but not its speed.



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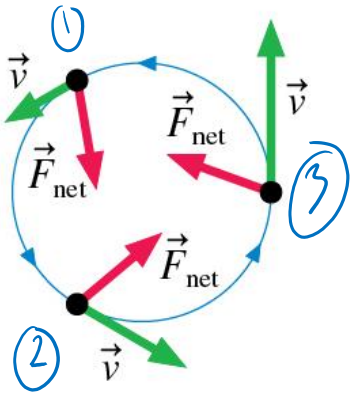
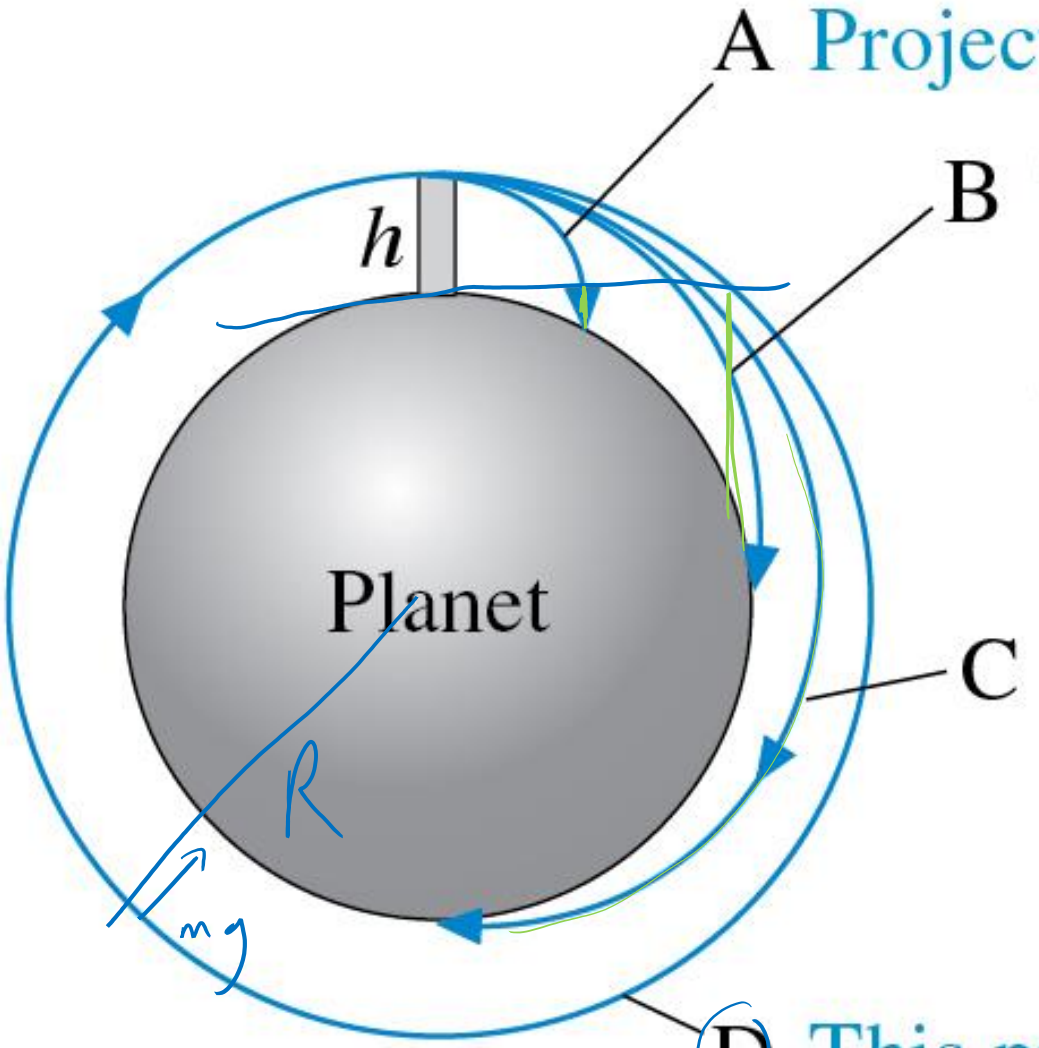
Nonuniform Circular Motion

- Speed changes.
- $\vec{F}_{\text{net}}$ and $\vec{a}$ have both radial and tangential components.
- The radial component changes the particle's direction.
- The tangential component changes the particle's speed.



$|v_1| < |v_2| < |v_3|$

$(\vec{F}_{\text{net}})_t$ same as $\vec{v}$



A Projectile motion

B The ground is curving away from the projectile.

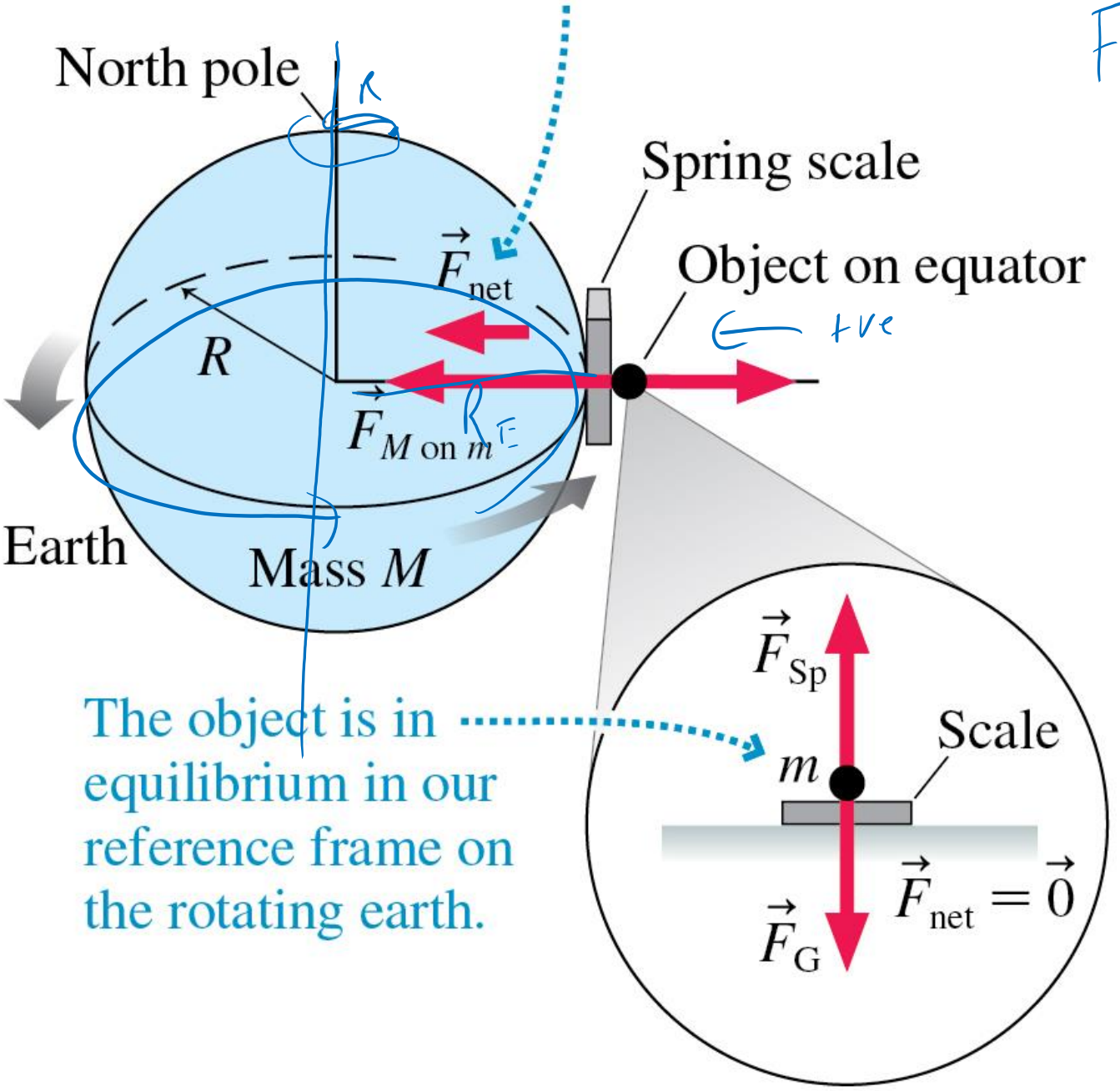
D This projectile "falls" all the way around the planet because the curvature of its trajectory matches the planet's curvature.

$\frac{mv^2}{R} = mg$

$v^2 = gR$

$v \sim 8 \frac{km}{s}$

The object is in circular motion on a rotating earth, so there is a net force toward the center.



$\rightarrow 0.03\ m/s^2$

$F_{net} = mg - n = m\omega^2 R_E$

$n = mg - m\omega^2 R_E$

ma or centrifugal force