KINEMATICS

2D

FISIKA DASAR 1

Projectile Motion

Circular Motion

Dimensional Analysis

Adopted from MIT Course

Projectile Motion

$$x = x_o + v_{ox}t + \frac{1}{2}a_x t^2$$

$$v_x = v_{ox} + a_x t$$

$$a_x = 0$$

$$v_{0x} = v_0 \cos(\theta)$$

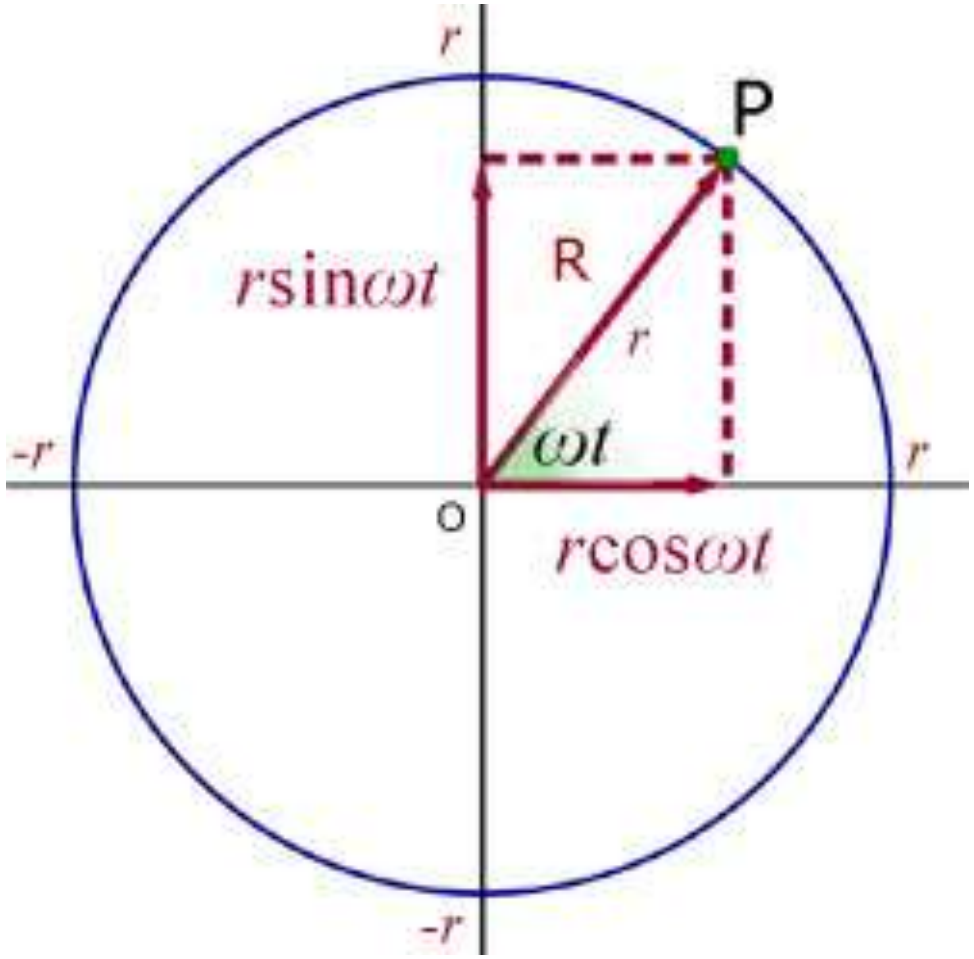
$$y = y_o + v_{oy}t + \frac{1}{2}a_y t^2$$

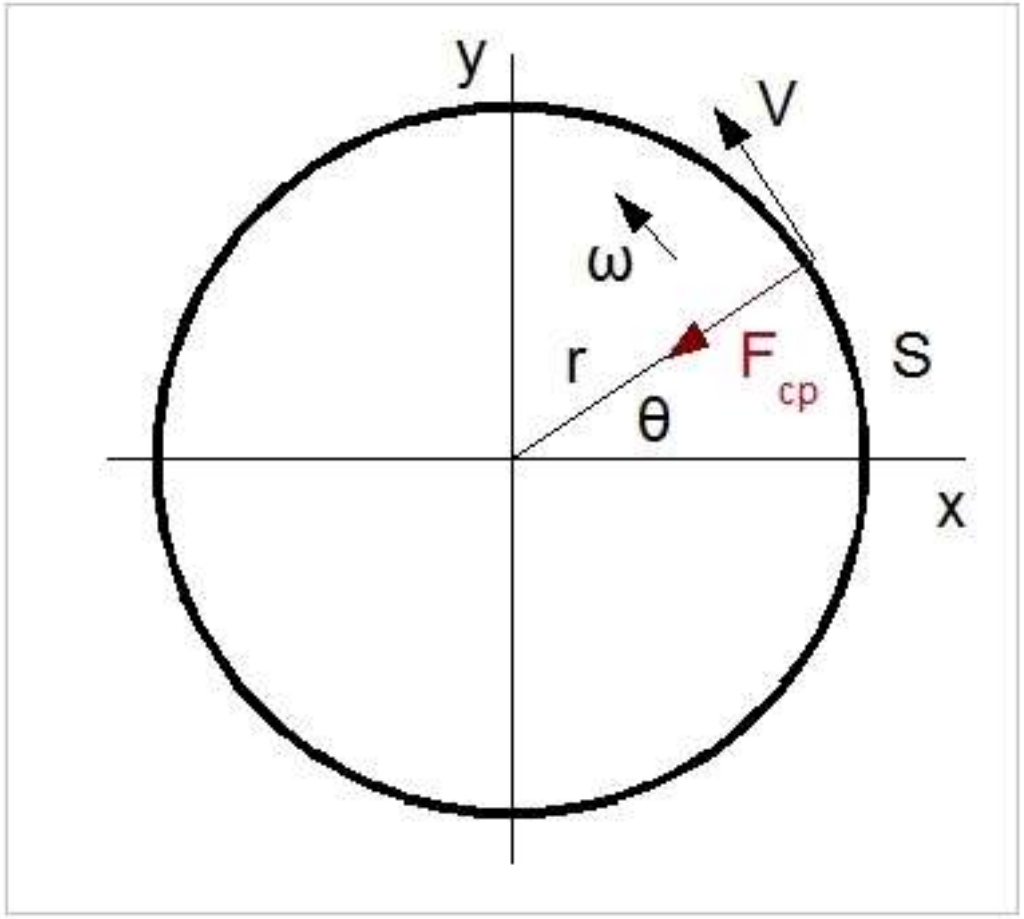
$$v_y = v_{oy} + a_y t$$

$$a_y = -g$$

$$v_{0y} = v_0 \sin(\theta)$$

Circular Motion





Circular Motion Equations

Kinematics

Circular Motion Summary

$$x = R\cos(\omega t) \qquad y = R\sin(\omega t)$$

$$v_x = -R\omega\sin(\omega t) \qquad v_y = R\omega\cos(\omega t)$$

$$a_x = -R\omega^2\cos(\omega t) \qquad a_y = -R\omega^2\sin(\omega t)$$

$$a_x = -\omega^2 x \qquad a_y = -\omega^2 y$$

$$|\vec{r}| = R \qquad |\vec{a}| = R\omega^2 = \frac{|\vec{v}|^2}{R}$$

$$|\vec{v}| = R\omega \qquad \vec{a} = -\omega^2\vec{r}$$

1. Trajectories with gravity near the surface of the Earth and no air resistance or other drag forces.
2. The velocity is constant in magnitude but changes direction. It points tangentially.
3. The acceleration is constant in magnitude but changes direction. It points radially inward.
4. The magnitude of the acceleration is given by: $|\vec{a}| = \frac{v^2}{R}$

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Example

Example 1

The moon revolves around the earth for 28 days. The distance between the earth and the moon is $38{,}4x10^4 km$.

Find:

a. *Linier Speed*
b. *Angular Velocity*
c. *centripetal acceleration*

Solution:

a. $s = 2\pi R = 2\pi\ 38{,}4x10^4 = 24{,}13x10^8 m$

$t = 28x24x3600 = 24{,}19x10^5 s$

$v = 24{,}13x10^8 x\ 24{,}19x10^5 = \mathbf{99 m/s}$

b. $\omega = v/R$

$$\omega = \frac{99}{38{,}4x10^4}$$

$$= \mathbf{3{,}58x10^{-7} rad/s}$$

c. $a = v^2/R$

$$a = \frac{99^2}{38{,}4x10^4}$$

$$= \mathbf{26x10^{-6} m/s^2}$$

Dimensional Analysis

Kinematics 2D

1. Name for a technique of checking the dimensions (or units) of an answer to check for careless mistakes in the formulas or algebra.
2. Example:

$$|\vec{a}| = \frac{v^2}{R}$$

$$\frac{m}{s^2} \stackrel{?}{=} \frac{\left(m/s\right)^2}{m} = \frac{\left(m^2/s^2\right)}{m} = \frac{m^2}{s^2 m} = \frac{m}{s^2}$$

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SUMMARY

1. Position, velocity, and acceleration are ALL vectors and need to be manipulated using either arrows (qualitative) or components (quantitative)
2. A vector can change by changing its magnitude (speed) or direction or both. All three changes imply the presence of an acceleration
3. Checking the units or dimensions of an answer will help to guard against simple careless mistakes

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THANK YOU