



KINEMATICS

more...

FISIKA DASAR 1

**More
complicated
situations**

**Special
Case**

Summary

Overview

more complicated situations

➤ More Objects

Write an additional set of equations

➤ More Dimensions

Write an additional set of equations

$$V_x = \frac{dx}{dt}$$

$$a_x = \frac{dv_x}{dt} = \frac{d^2x}{dt^2}$$

$$V_y = \frac{dy}{dt}$$

$$a_y = \frac{dv_y}{dt} = \frac{d^2y}{dt^2}$$

Vector Connections

$$\vec{v} = \frac{d\vec{r}}{dt} \quad \vec{a} = \frac{d\vec{v}}{dt} = \frac{d^2\vec{r}}{dt^2}$$

$$|\vec{v}| = \sqrt{v_x^2 + v_y^2 + v_z^2}$$

$$|\vec{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$$

Special Case of Constant Acceleration

Kinematics

Extra Special Case

$$x = x_0 + v_{0x}t + \frac{1}{2}a_xt^2$$
$$v_x = v_{0x} + a_xt$$

$$y = y_0 + v_{0y}t + \frac{1}{2}a_yt^2$$
$$v_y = v_{0y} + a_yt$$

 Initial conditions

 Physics

Trajectories with gravity near the surface of the Earth and no air resistance or other drag forces



$$a_x = 0$$

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

$$a_y = -g$$

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

Super Special Case

Range of a projectile near the surface of the Earth and no air resistance or other drag forces

$$x_0 = 0 \quad y_0 = 0 \quad y_{final} = 0 \quad x_{final} = Range$$

$$Range = \frac{v_o^2 \sin(2\theta)}{g}$$

You should immediately **forget** you ever saw this formula but **remember** the technique used to find it.

Quadratic Equations

$$ax^2 + bx + c = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Important property:

Such equations can have 0, 1, or 2 solutions depending on the value of $b^2 - 4ac$.

Negative: 0 solutions Zero: 1 solution

Positive: 2 solutions

Warning: Only one of the 2 solutions may be physical!

Example 1

The bullet is fired from point O (ground) with initial velocity $v_0 = 60\text{m/s}$ and the elevation angle from the ground is 60 degrees. $g = 10\text{m/s}^2$ Calculate:

- When will the bullet hit the ground?
- Where the bullets will fall on the ground?
- What is the velocity of the bullet when it hits the ground?

Example

Example 1

Answer

:

a. $y_{\text{final}} = 0$

$$y = v_o \sin \theta \cdot t + \frac{1}{2} (-g) t^2$$

$$0 = 60 \sin 60^\circ \cdot t - \frac{1}{2} 10 t^2$$

$$0 = 30\sqrt{3} \cdot t - 5 t^2$$

$$t = 6\sqrt{3} s$$

b. $x = v_o \cos \theta \cdot t$

$$x = 60 \sin 60^\circ \cdot 6\sqrt{3}$$

$$x = 180\sqrt{3} m$$

Bullet coordinates on the ground is $(180\sqrt{3}, 0)$

c. $v_y = v_o \sin \theta - gt$

$$v_y = 60 \sin 60^\circ - 10 \cdot 6\sqrt{3}$$

$$v_y = -30\sqrt{3} m/s$$

$$v_x = v_o \cos \theta$$

$$v_x = 60 \sin 60^\circ$$

$$v_x = 30 m/s$$

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{30^2 + (-30\sqrt{3})^2}$$

$$v = 60 m/s$$

SUMMARY

1. Study special cases (like range of a projectile) but understand the assumptions that go into all formulas
2. Position, velocity, and acceleration are ALL vectors and need to be manipulated using either arrows (qualitative) or components (quantitative)
3. Directions (or signs in 1D) of position, velocity, and acceleration can all be different

THANK YOU