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

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

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

Vector Connections

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

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

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

Special Case of Constant Acceleration

Kinematics

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

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

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

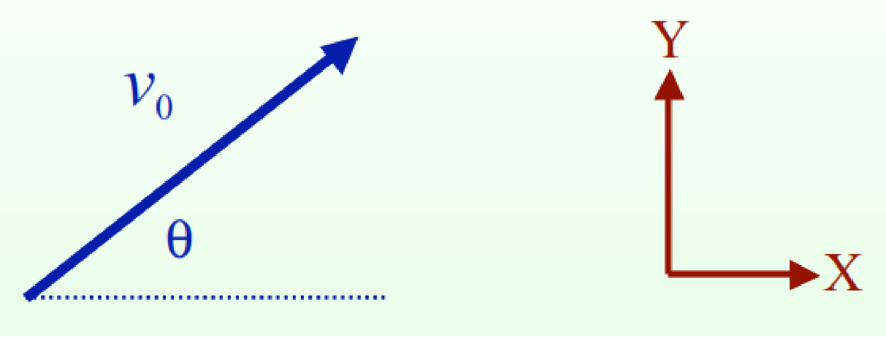
$$v_y = v_{oy} + a_y t$$

Initial conditions

Physics

Extra Special Case

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



$$a_x = 0$$

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

$$a_y = -g$$

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

Adopted from MIT Course

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

Example 1

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

a. When will the bullet hit the ground?
b. Where the bullets will fall on the ground?
c. What is the velocity of the bullet when it hits the ground?

Example

Example 1

Answer:

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

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

$$0 = 60Sin60^o . t - \frac{1}{2}10t^2$$

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

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

b.

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

$$x = 60Sin60^o . 6\sqrt{3}$$

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

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

C.

$$v_y = v_o Sin\theta - gt$$

$$v_y = 60Sin60^o - 10.6\sqrt{3}$$

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

$$v_x = v_o cos\theta$$

$$v_x = 60Sin60^o$$

$$\boldsymbol{v_x = 30m/s}$$

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

$$\boldsymbol{v = 60m/s}$$

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