Institut Teknologi Sepuluh Nopember
Surabaya

GERAK TRANSLASI

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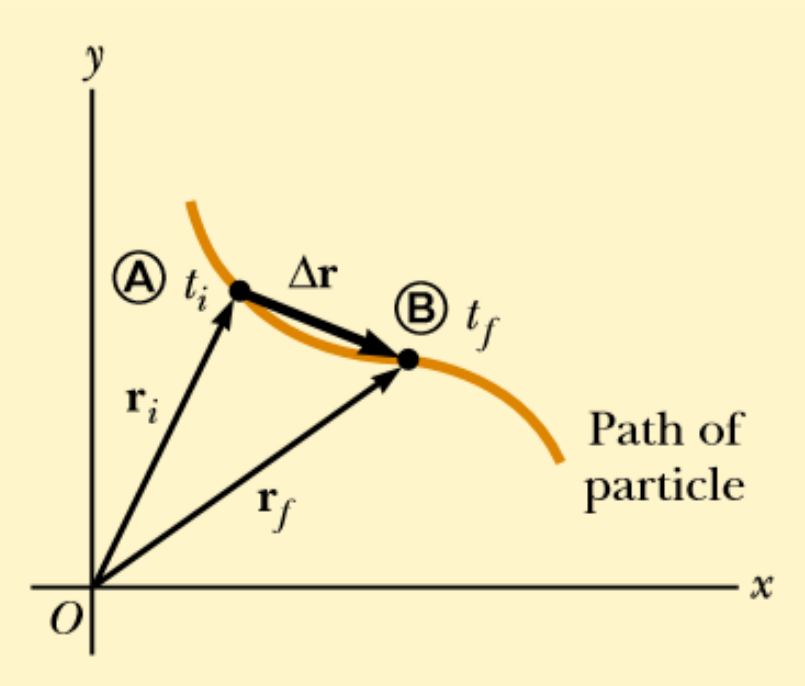
Tutug Dhanardono

Materi

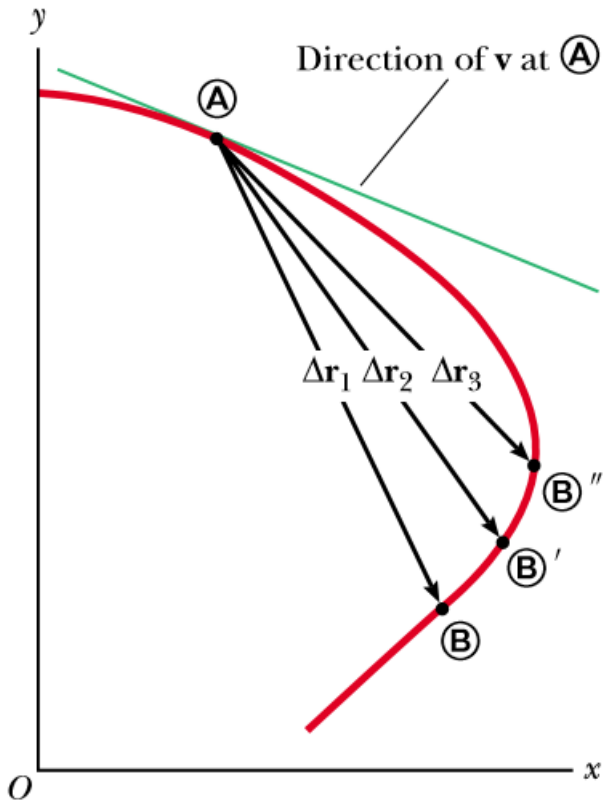
$$\Delta \mathbf{r} \equiv \mathbf{r}_f - \mathbf{r}_i$$



Kecepatan rata-rata

$$\bar{\mathbf{v}} \equiv \frac{\Delta \mathbf{r}}{\Delta t}$$

Materi



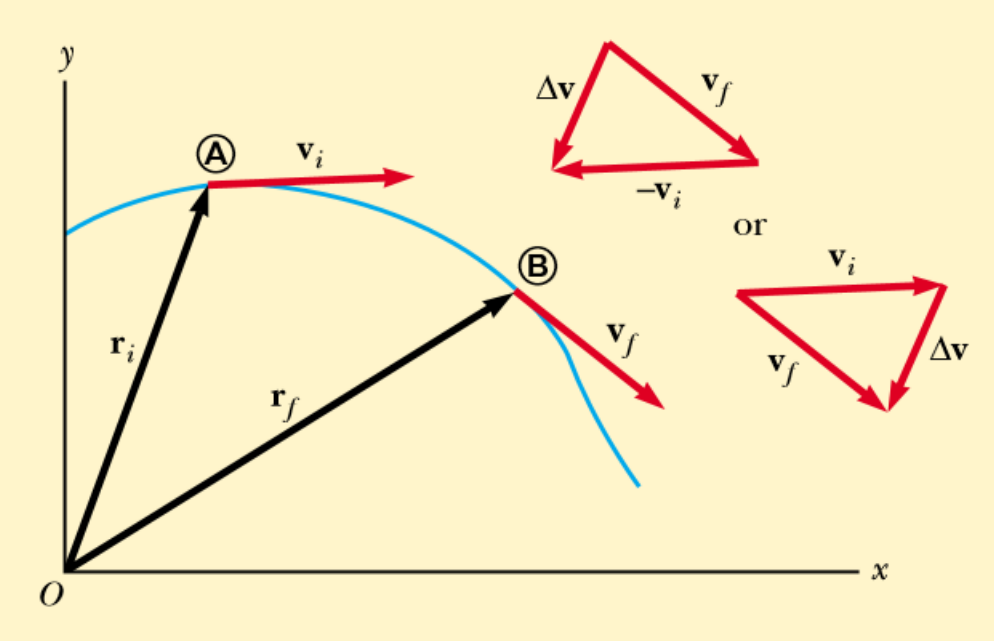
Kecepatan sesaat

$$\mathbf{v} \equiv \lim_{\Delta t \to 0} \frac{\Delta \mathbf{r}}{\Delta t} = \frac{d\mathbf{r}}{dt}$$

Percepatan rata-rata

$$\bar{\mathbf{a}} \equiv \frac{\mathbf{v}_f - \mathbf{v}_i}{t_f - t_i} = \frac{\Delta \mathbf{v}}{\Delta t}$$

Materi



Percepatan sesaat

$$\mathbf{a} \equiv \lim_{\Delta t \to 0} \frac{\Delta \mathbf{v}}{\Delta t} = \frac{d\mathbf{v}}{dt}$$

Materi

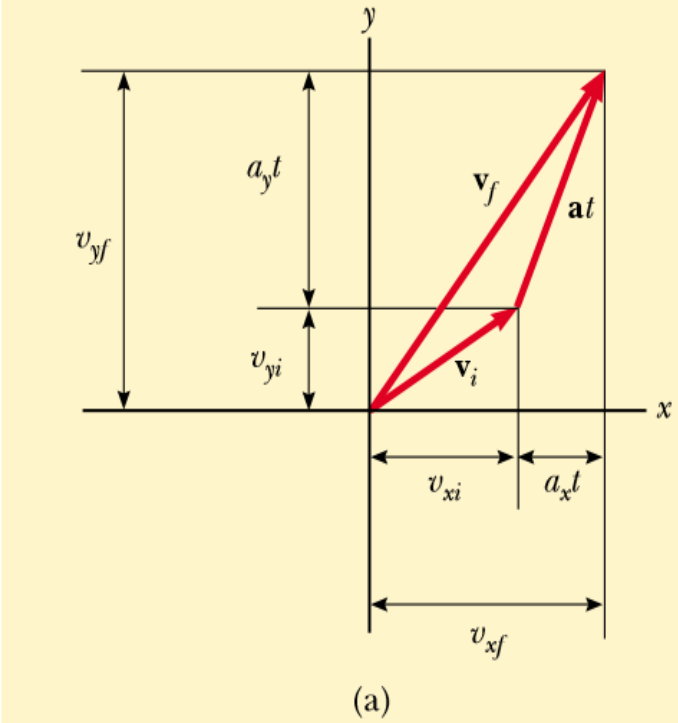
Quick Quiz 4.1 Which of the following cannot *possibly* be accelerating? (a) An object moving with a constant speed (b) An object moving with a constant velocity (c) An object moving along a curve.

Quick Quiz 4.2 Consider the following controls in an automobile: gas pedal, brake, steering wheel. The controls in this list that cause an acceleration of the car are (a) all three controls (b) the gas pedal and the brake (c) only the brake (d) only the gas pedal.

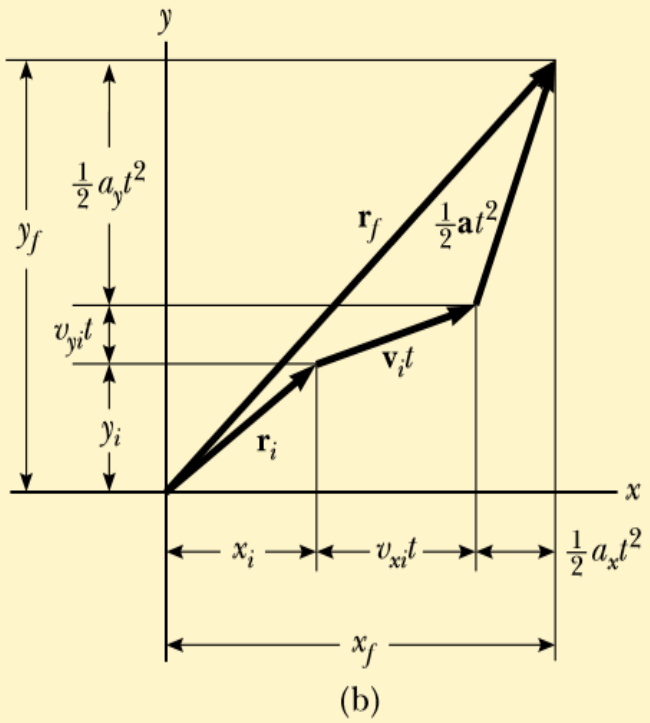
Materi

$$\mathbf{v}_f = (v_{xi} + a_x t)\hat{\mathbf{i}} + (v_{yi} + a_y t)\hat{\mathbf{j}}$$
$$= (v_{xi}\hat{\mathbf{i}} + v_{yi}\hat{\mathbf{j}}) + (a_x\hat{\mathbf{i}} + a_y\hat{\mathbf{j}})t$$
$$\mathbf{v}_f = \mathbf{v}_i + \mathbf{a}t$$

$$\mathbf{r}_f = (x_i + v_{xi}t + \tfrac{1}{2}a_x t^2)\hat{\mathbf{i}} + (y_i + v_{yi}t + \tfrac{1}{2}a_y t^2)\hat{\mathbf{j}}$$
$$= (x_i\hat{\mathbf{i}} + y_i\hat{\mathbf{j}}) + (v_{xi}\hat{\mathbf{i}} + v_{yi}\hat{\mathbf{j}})t + \tfrac{1}{2}(a_x\hat{\mathbf{i}} + a_y\hat{\mathbf{j}})t^2$$
$$\mathbf{r}_f = \mathbf{r}_i + \mathbf{v}_i t + \tfrac{1}{2}\mathbf{a}t^2$$



(a)



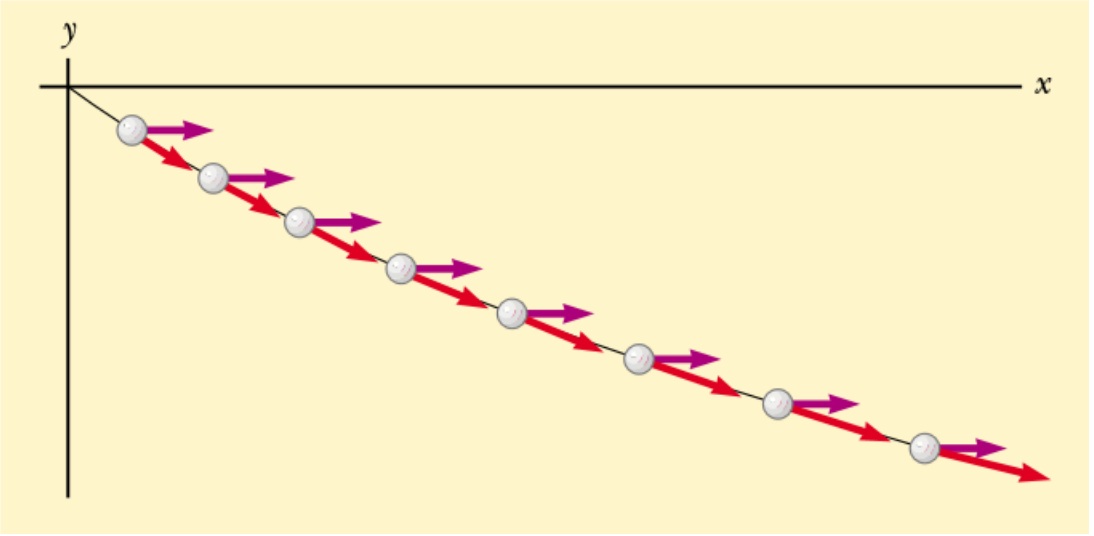
(b)

Pengantar

$$\mathbf{v}_f = \mathbf{v}_i + \mathbf{a}t \quad \begin{cases} v_{xf} = v_{xi} + a_x t \\ v_{yf} = v_{yi} + a_y t \end{cases}$$

$$\mathbf{r}_f = \mathbf{r}_i + \mathbf{v}_i t + \tfrac{1}{2}\mathbf{a}t^2 \quad \begin{cases} x_f = x_i + v_{xi} t + \tfrac{1}{2} a_x t^2 \\ y_f = y_i + v_{yi} t + \tfrac{1}{2} a_y t^2 \end{cases}$$

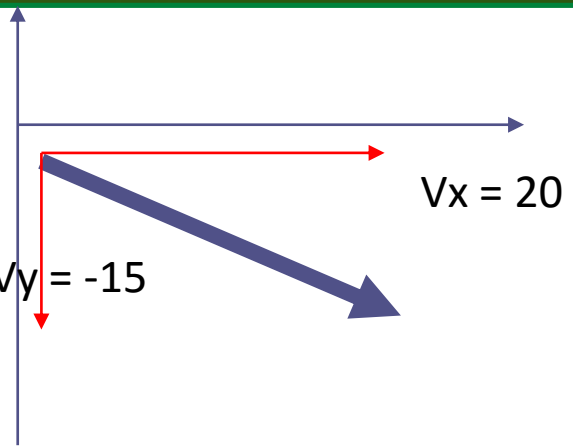
Gerakan dalam 2 dimensi

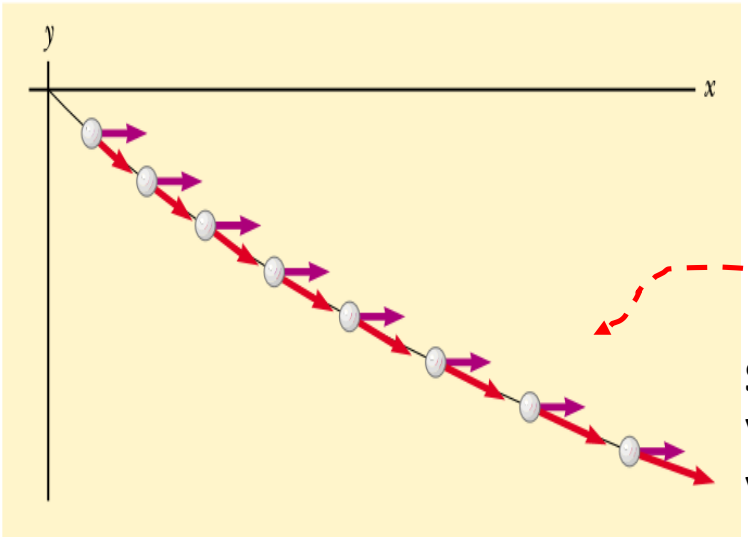


Contoh soal

A particle starts from the origin at $t = 0$ with an initial velocity having an x component of 20 m/s and a y component of -15 m/s. The particle moves in the xy plane with an x component of acceleration only, given by $a_x = 4.0\ \text{m/s}^2$.

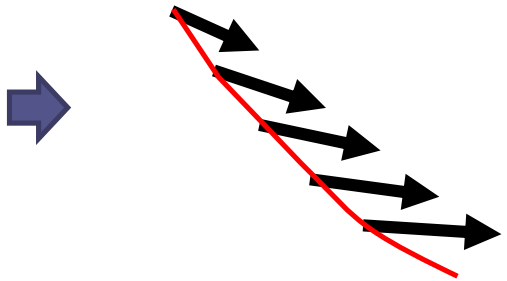
(A) Determine the components of the velocity vector at any time and the total velocity vector at any time.





Dengan percepatan konstan (arah x) → akan menyebabkan kenaikan kecepatan arah x
Dan kecepatan arah y konstan

Setiap saat
Vx membesar
Vy tetap



Contoh soal

Besar kecepatan arah x dan y, untuk setiap saat

(1) $v_{xf} = v_{xi} + a_x t = (20 + 4.0t)\ \text{m/s}$

(2) $v_{yf} = v_{yi} + a_y t = -15\ \text{m/s} + 0 = -15\ \text{m/s}$

$$\mathbf{v}_f = v_{xi}\hat{\mathbf{i}} + v_{yi}\hat{\mathbf{j}} = [(20 + 4.0t)\hat{\mathbf{i}} - 15\hat{\mathbf{j}}]\ \text{m/s}$$

(B) Calculate the velocity and speed of the particle at $t = 5.0$ s.

Solution With $t = 5.0$ s, the result from part (A) gives

$$\mathbf{v}_f = [(20 + 4.0(5.0))\hat{\mathbf{i}} - 15\hat{\mathbf{j}}]\ \text{m/s} = (40\hat{\mathbf{i}} - 15\hat{\mathbf{j}})\ \text{m/s}$$

Sudut yang dibentuk oleh vektor kecepatan Vx dengan Vy

$$\theta = \tan^{-1}\left(\frac{v_{yf}}{v_{xf}}\right) = \tan^{-1}\left(\frac{-15\ \text{m/s}}{40\ \text{m/s}}\right)$$

$$= -21°$$

Besar kecepatan saat t = 5 dt

$$v_f = |\mathbf{v}_f| = \sqrt{{v_{xf}}^2 + {v_{yf}}^2} = \sqrt{(40)^2 + (-15)^2}\ \text{m/s}$$

$$= 43\ \text{m/s}$$

Contoh soal

(C) Determine the x and y coordinates of the particle at any time t and the position vector at this time.

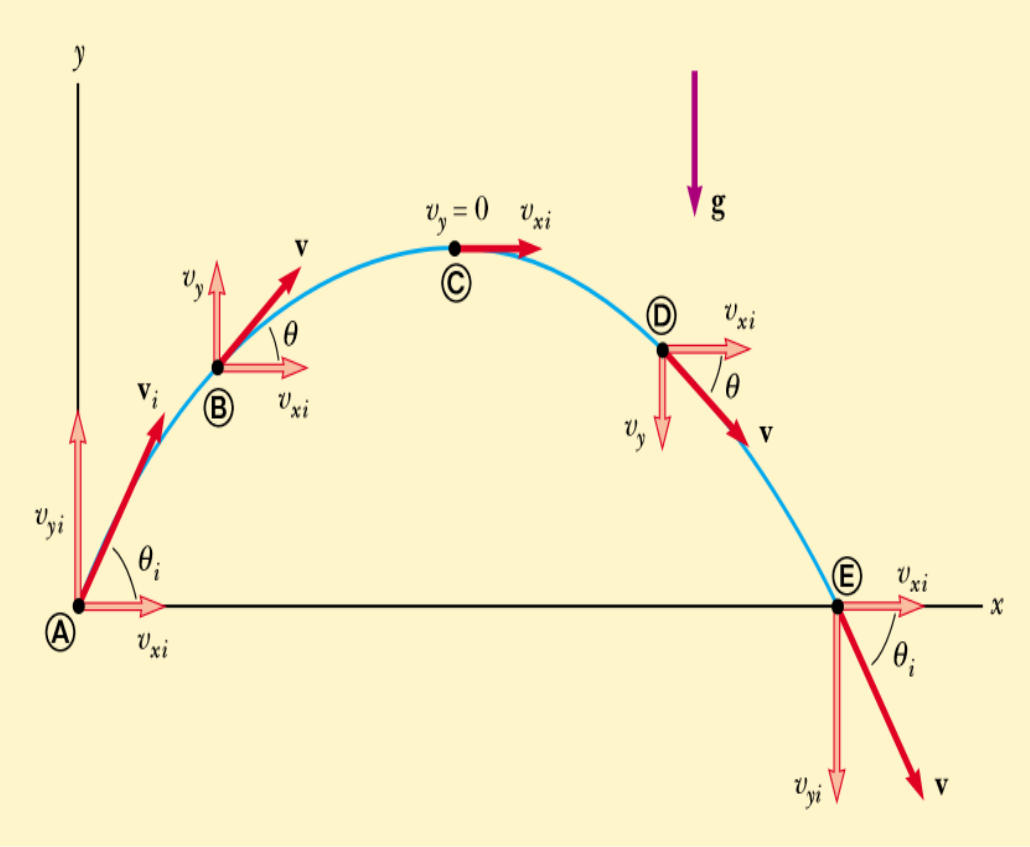
Solution Because $x_i = y_i = 0$ at $t = 0$, Equation 4.9a gives

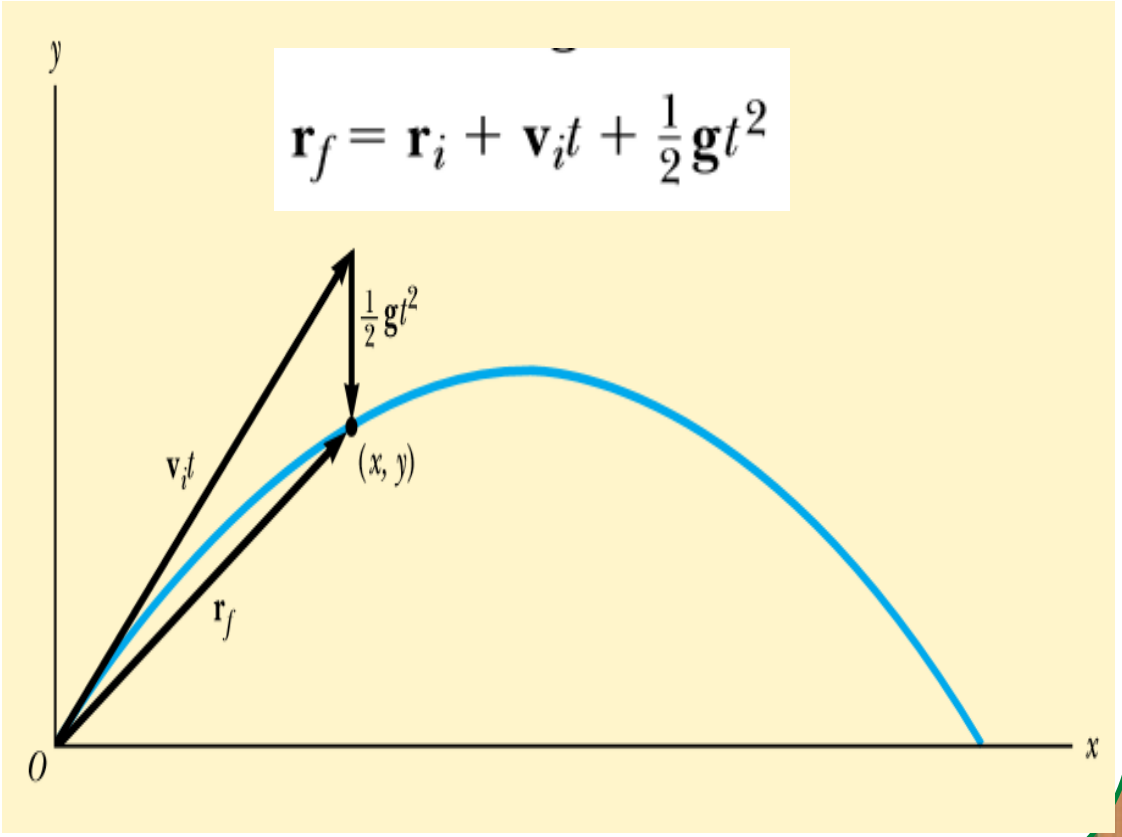
$$x_f = v_{xi}t + \frac{1}{2}a_x t^2 = (20t + 2.0t^2)\ \text{m}$$

$$y_f = v_{yi}t = (-15t)\ \text{m}$$

Materi

Gerakan proyektile





Materi

Setiap saat besarnya kecepatan arah x dan y

$$v_{xi} = v_i \cos \theta_i \qquad v_{yi} = v_i \sin \theta_i$$

Dan besarnya lintasan (arah x dan arah y) setiap saat

$$x_f = v_{xi} t = (v_i \cos \theta_i)\, t$$

$$y_f = v_{yi} t + \tfrac{1}{2} a_y t^2 = (v_i \sin \theta_i)\, t - \tfrac{1}{2} g t^2$$

$$y = (\tan \theta_i)\, x - \left(\frac{g}{2 v_i^2 \cos^2 \theta_i} \right) x^2$$

Persamaan kuadrat dalam x
Menunjukkkan bentuk grafik (lintasan) parabola

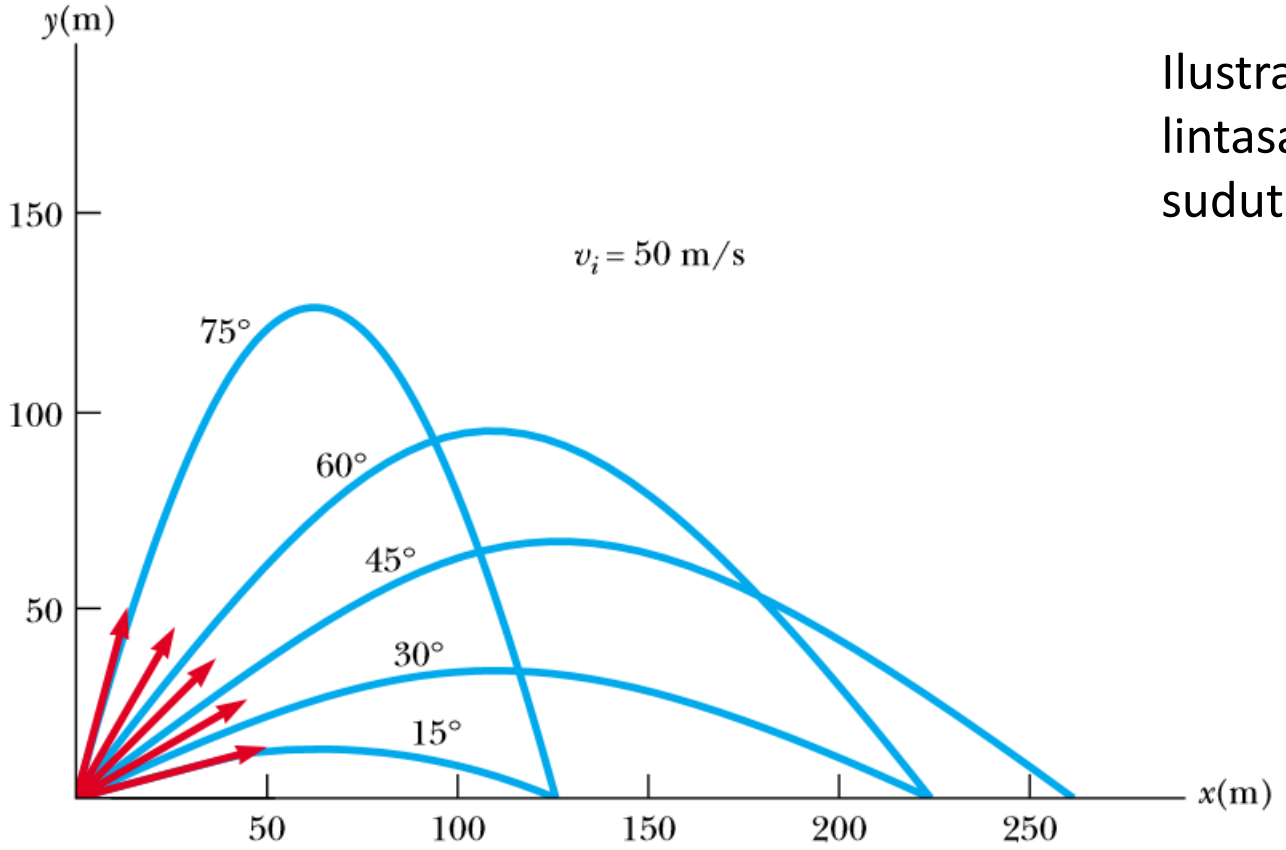
$Y = a X + b X^2$

Quick Quiz 4.3 Suppose you are running at constant velocity and you wish to throw a ball such that you will catch it as it comes back down. In what direction should you throw the ball relative to you? (a) straight up (b) at an angle to the ground that depends on your running speed (c) in the forward direction.

Quick Quiz 4.4 As a projectile thrown upward moves in its parabolic path (such as in Figure 4.8), at what point along its path are the velocity and acceleration vectors for the projectile perpendicular to each other? (a) nowhere (b) the highest point (c) the launch point.

Quick Quiz 4.5 As the projectile in Quick Quiz 4.4 moves along its path, at what point are the velocity and acceleration vectors for the projectile parallel to each other? (a) nowhere (b) the highest point (c) the launch point.

Materi



Ilustrasi berbagai pola lintasan dari variasi sudut awal proyektile

Materi

7. A fish swimming in a horizontal plane has velocity $\mathbf{v}_i = (4.00\hat{\mathbf{i}} + 1.00\hat{\mathbf{j}})$ m/s at a point in the ocean where the position relative to a certain rock is $\mathbf{r}_i = (10.0\hat{\mathbf{i}} - 4.00\hat{\mathbf{j}})$ m. After the fish swims with constant acceleration for 20.0 s, its velocity is $\mathbf{v} = (20.0\hat{\mathbf{i}} - 5.00\hat{\mathbf{j}})$ m/s. (a) What are the components of the acceleration? (b) What is the direction of the acceleration with respect to unit vector $\hat{\mathbf{i}}$? (c) If the fish maintains constant acceleration, where is it at $t = 25.0$ s, and in what direction is it moving?

8. A particle initially located at the origin has an acceleration of $\mathbf{a} = 3.00\hat{\mathbf{j}}$ m/s^2 and an initial velocity of $\mathbf{v}_i = 500\hat{\mathbf{i}}$ m/s. Find (a) the vector position and velocity at any time t and (b) the coordinates and speed of the particle at $t = 2.00$ s.

20. A firefighter, a distance d from a burning building, directs a stream of water from a fire hose at angle θ_i above the horizontal as in Figure P4.20. If the initial speed of the stream is v_i, at what height h does the water strike the building?