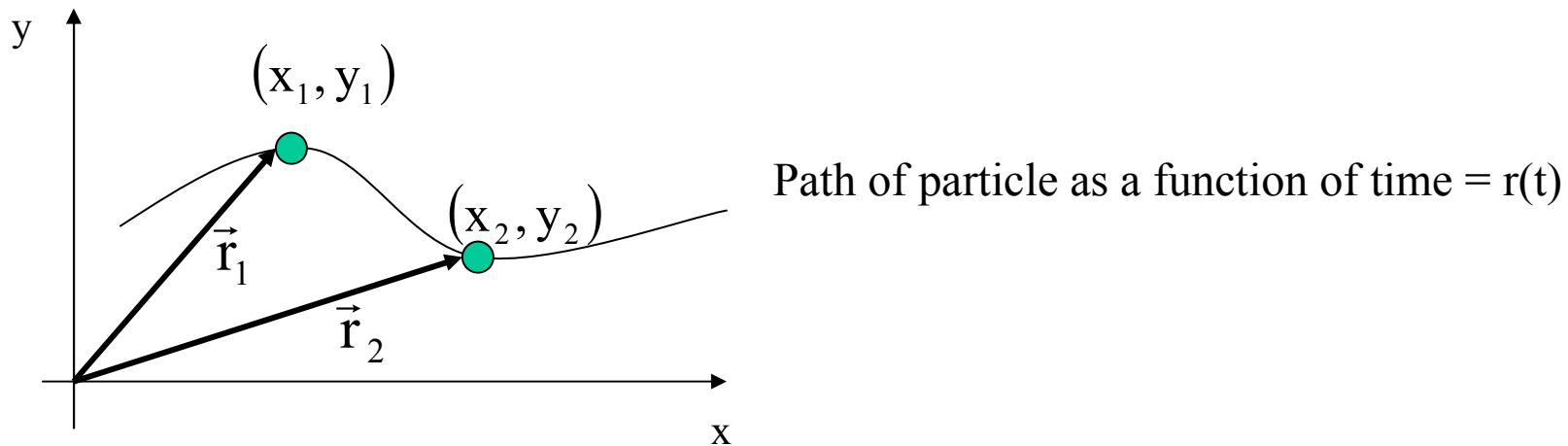


General Motion in 2 or 3 Dimensions

Consider 2-dimensions first (easy to generalize to 3-D)



The vector \mathbf{r}_1 tells you where the object is with respect to the origin ($x=0, y=0$) at time t_1 .

As the object moves, the position changes from \mathbf{r}_1 to \mathbf{r}_2

Displacement:

$$\Delta \vec{r} = \vec{r}_2 - \vec{r}_1 = (x_2 - x_1)\hat{i} + (y_2 - y_1)\hat{j}$$

or $\Delta \vec{r} = \Delta x \hat{i} + \Delta y \hat{j}$

General Motion in 2 or 3 Dimensions

Just as in 1-D, we can define an average velocity:

$$\vec{v}_{\text{avg}} = \frac{\Delta \vec{r}}{\Delta t} = \frac{\Delta x}{\Delta t} \hat{i} + \frac{\Delta y}{\Delta t} \hat{j} = v_{\text{avg},x} \hat{i} + v_{\text{avg},y} \hat{j}$$

an instantaneous velocity:

$$\vec{v}(t) = \lim_{\Delta t \rightarrow 0} \frac{\Delta \vec{r}}{\Delta t} = v_x(t) \hat{i} + v_y(t) \hat{j}$$

And acceleration:

$$\vec{a}_{\text{avg}} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\Delta v_x}{\Delta t} \hat{i} + \frac{\Delta v_y}{\Delta t} \hat{j} = a_{\text{avg},x} \hat{i} + a_{\text{avg},y} \hat{j}$$

$$\vec{a}(t) = \lim_{\Delta t \rightarrow 0} \frac{\Delta \vec{v}}{\Delta t} = a_x(t) \hat{i} + a_y(t) \hat{j}$$

Example: The position of an object with time is given by:

$$\vec{r}(t) = (45t)\hat{i} + (1.5 - 4.9t^2)\hat{j}$$

Note: The units of both quantities in () are in m. This means $45 = 45\text{m/s}$ and $4.9 = 4.9\text{m/s}^2$.

a) What is $v(t)$?

$$\vec{v}(t) = \frac{dx(t)}{dt}\hat{i} + \frac{dy(t)}{dt}\hat{j}$$

$$\vec{v}(t) = 45\hat{i} - 9.8t\hat{j}$$

Example: Continued

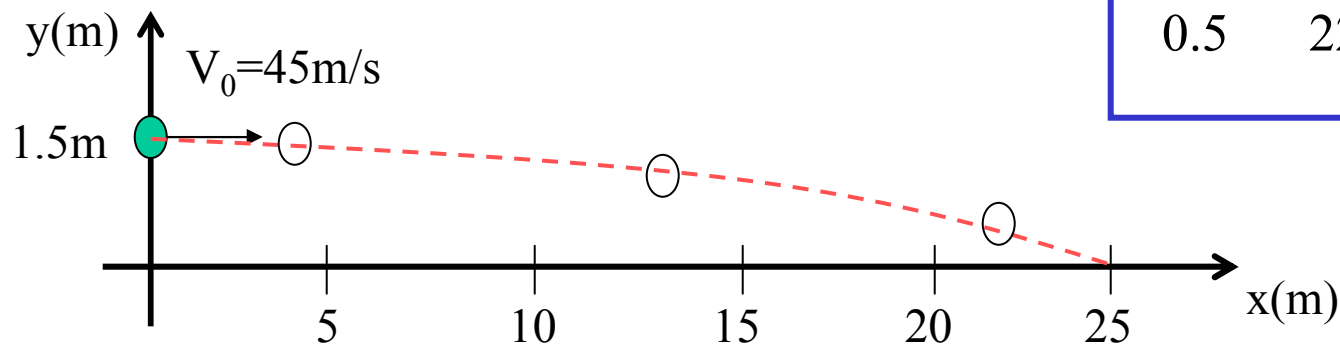
b) What is $\vec{a}(t)$?

$$\vec{a}(t) = \frac{dv_x(t)}{dt} \hat{i} + \frac{dv_y(t)}{dt} \hat{j}$$

$$\vec{a}(t) = (0) \hat{i} - 9.8 \hat{j}$$

$$\vec{a}(t) = -9.8 \hat{j}$$

c) Draw a picture of the y vs x motion from $t = 0\text{s}$ to $t = 0.5\text{s}$.



$t(\text{s})$	$r_x(\text{m})$	$r_y(\text{m})$
0.0	0.0	1.50
0.1	4.5	1.45
0.3	13.5	1.06
0.5	22.5	0.28