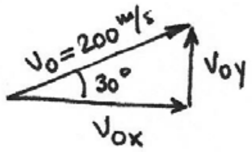
(9) The equations of the position vector and velocity are:



$$v_{oy} = 200\,\frac{m}{s} \cdot \sin 30^\circ = 100\,\frac{m}{s}$$

$$v_{ox} = 200\,\frac{m}{s} \cdot \cos 30^\circ = 173\,\frac{m}{s}$$

$$\vec{r} = 173t\,\vec{i} + (100t - 5t^2)\,\vec{j} \quad (m)$$

$$\Big\downarrow \text{ differentiation}$$

$$\vec{v} = 173\,\vec{i} + (100 - 10t)\,\vec{j} \quad (m/s)$$

(a) it hits the floor $\longrightarrow y = 0$

$$y = 100t - 5t^2 = 0 \longrightarrow t(100 - 5t) = 0 \begin{cases} t = 0 \\ 100 - 5t = 0 \\ t = \frac{100}{5} = 20\,s \end{cases}$$

$$x = 173\,t \xrightarrow{t = 20s} \boxed{x = 3460\ m}$$

(b) $\vec{v} = 173\,\vec{i} + (100 - 10t)\,\vec{j} \xrightarrow{t = 20\,s} \vec{v} = 173\,\vec{i} - 100\,\vec{j}$ (m/s)

Magnitude: $|\vec{v}| = \sqrt{173^2 + (-100)^2} = \boxed{200\,\frac{m}{s}}$

Angle: $\alpha = \tan^{-1} \dfrac{-100}{173} = \boxed{-30^\circ}$

(c) When $x = 300$ m, if $\longrightarrow$ $y < 80$ m ... it hits the obstacle

$\longrightarrow$ $y > 80$m ... it passes over the obstacle

$$x = 173\,t = 300 \longrightarrow t = \frac{300}{173} = 1.73\,s$$

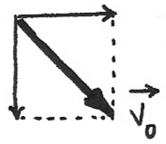
$$y = 100t - 5t^2 \xrightarrow{t = 1.73\,s} y = 100 \times 1.73 - 5 \times 1.73^2 = \boxed{158\,m} > 80m$$

It passes over the obstacle

(10) $\vec{r} = (5+t)\,\vec{i} + (1 - t - 4t^2)\,\vec{j}$ (m)

ⓐ The initial velocity

$$\vec{v}_0 = 1\,\frac{m}{s}\,\vec{i} - 1\,\frac{m}{s}\,\vec{j}$$



ⓑ The equation of the trajectory

$$\begin{cases} x = 5 + t \longrightarrow t = x - 5 \\ y = 1 - t - 4t^2 \end{cases}$$

$$y = 1 - (x-5) - 4\,(x-5)^2$$

$$y = -4x^2 + 39x - 94$$

ⓒ The equations of velocity and acceleration can be determined by differentiation

$$\vec{r} = (5+t)\,\vec{i} + (1 - t - 4t^2)\,\vec{j}$$

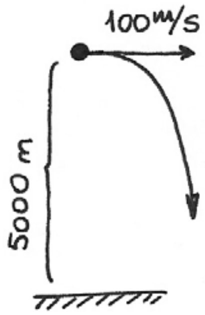
$$\downarrow$$

$$\vec{v} = \vec{i} + (-1 - 8t)\,\vec{j} \xrightarrow{t=2s} \vec{v}_{t=2} = \vec{i} - 17\,\vec{j} \ (m/s)$$

$$\downarrow$$

$$\vec{a} = -8\,\vec{j} \ (m/s^2) \xrightarrow{t=2s} \vec{a} = -8\,\vec{j} \ (m/s^2)$$

(11) $v_0 = 360 \frac{km}{h} \frac{1h}{3600 s} \frac{1000 m}{1 km} = 100 \frac{m}{s}$



ⓐ The position vector:

$\vec{r} = 100 \frac{m}{s} t \, \vec{i} + (5000 - 5t^2)\vec{j} \quad (m)$

↓ the equation of velocity (by differentiation)

$\vec{v} = 100 \frac{m}{s} \vec{i} - 10 t \vec{j} \quad (m/s)$

ⓑ The object hits the floor → $y=0$

$5000 - 5t^2 = 0 \rightarrow t = \sqrt{\frac{5000}{5}} = 31.6 \ s$

Position:

$x = 100 \frac{m}{s} \times 31.6 s = 3.160 m$

Velocity:

$\vec{v} = 100 \frac{m}{s} \vec{i} - 316 \frac{m}{s} \vec{j}$

$|\vec{v}| = \sqrt{100^2 + (-316)^2} = 331.4 \frac{m}{s}$

$\alpha = \tan^{-1} \frac{-316}{100} = -72^\circ$