Pohybové rovnice

zákon síly

$$\vec{F} = m\vec{a} = m\frac{d^2\vec{r}}{dt^2}$$

$$a_x = \frac{F_x}{m}$$

$$a_y = \frac{F_y}{m}$$

$$a_z = \frac{F_z}{m}$$

počáteční podmínky

$$x(t=0) = x_0$$

$$y(t=0) = y_0$$

$$z(t=0) = z_0$$

$$v_x(t=0) = v_{x_0}$$

$$v_y(t=0) = v_{y_0}$$

$$v_z(t=0) = v_{z_0}$$

časová závislost souřadnic / rychlosti

$$\frac{\mathrm{d}^2x}{\mathrm{d}t^2} = \frac{F_x}{m} \qquad x(t)$$

$$\frac{\mathrm{d}^2y}{\mathrm{d}t^2} = \frac{F_y}{m} \qquad y(t)$$

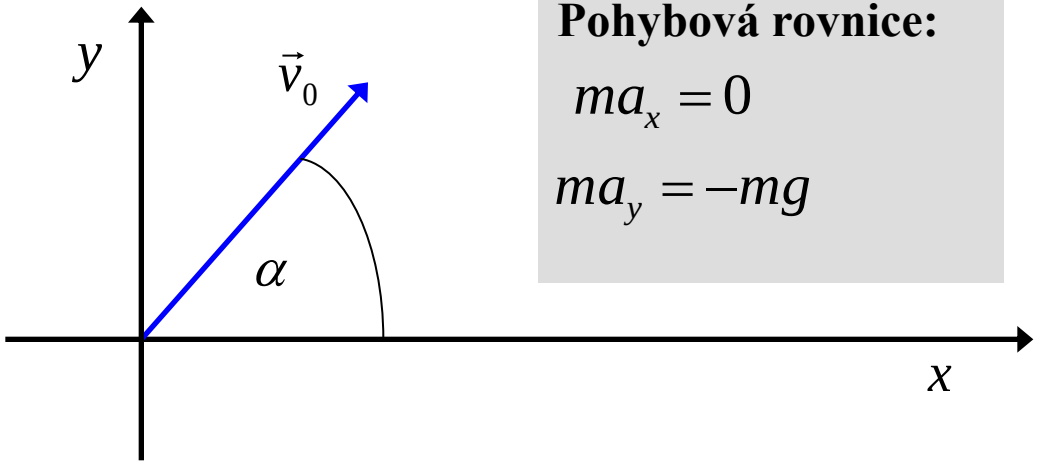
$$\frac{\mathrm{d}^2z}{\mathrm{d}t^2} = \frac{F_z}{m} \qquad z(t)$$

$$\frac{\mathrm{d}v_x}{\mathrm{d}t} = \frac{F_x}{m} \qquad v_x(t)$$

$$\frac{\mathrm{d}v_y}{\mathrm{d}t} = \frac{F_y}{m} \qquad v_y(t)$$

$$\frac{\mathrm{d}v_z}{\mathrm{d}t} = \frac{F_z}{m} \qquad v_z(t)$$

Šikmý vrh



Pohybová rovnice:

$$ma_x = 0$$

$$ma_y = -mg$$

trajektorie:

$$y = x\,\mathrm{tg}\,\alpha - \frac{1}{2} g \frac{x^2}{v_0^2 \cos^2 \alpha}$$

zrychlení:

$$a_x = 0$$

$$a_y = -g$$

počáteční podmínky:

$$x(t=0) = 0$$

$$y(t=0) = 0$$

$$v_x(t=0) = v_0 \cos(\alpha)$$

$$v_y(t=0) = v_0 \sin(\alpha)$$

rychlost:

$$v_x = v_0 \cos(\alpha)$$

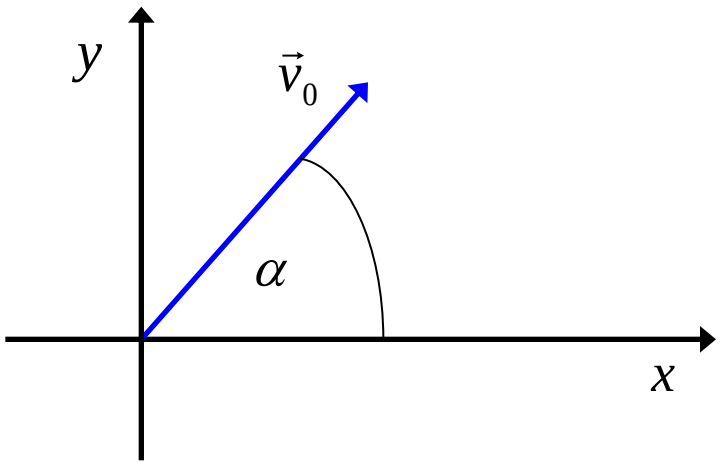
$$v_y = v_0 \sin(\alpha) - gt$$

poloha:

$$x = v_0 t \cos(\alpha)$$

$$y = v_0 t \sin(\alpha) - \frac{1}{2} g t^2$$

Šikmý vrh



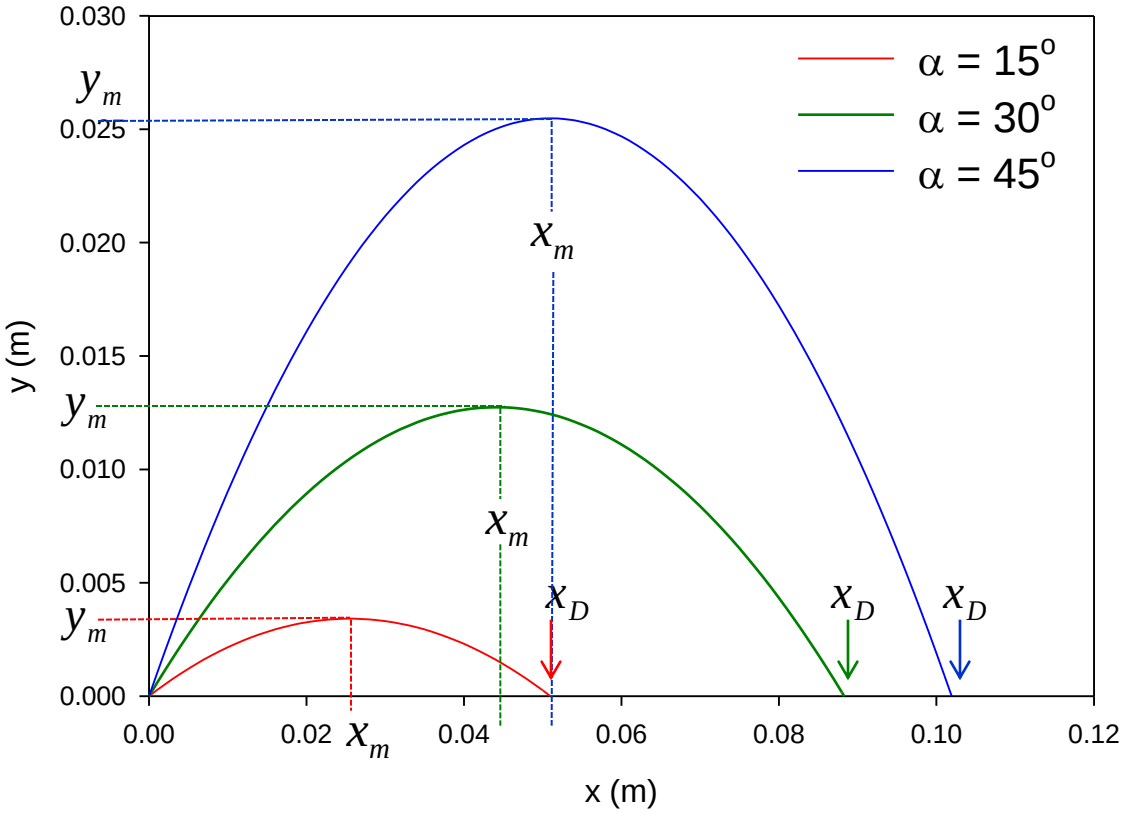
trajektorie:

$$y = x\,\mathrm{tg}\,\alpha - \frac{1}{2} g \frac{x^2}{v_0^2 \cos^2 \alpha}$$

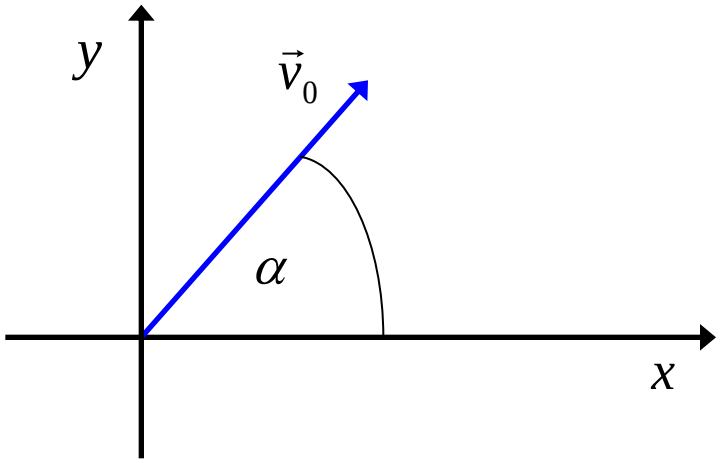
místo dopadu: $x_D = \dfrac{v_0^2 \sin 2\alpha}{g}$

poloha maxima: $x_m = \dfrac{v_0^2 \sin 2\alpha}{2g}$

výška maxima: $y_m = \dfrac{v_0^2 \sin^2 \alpha}{2g}$

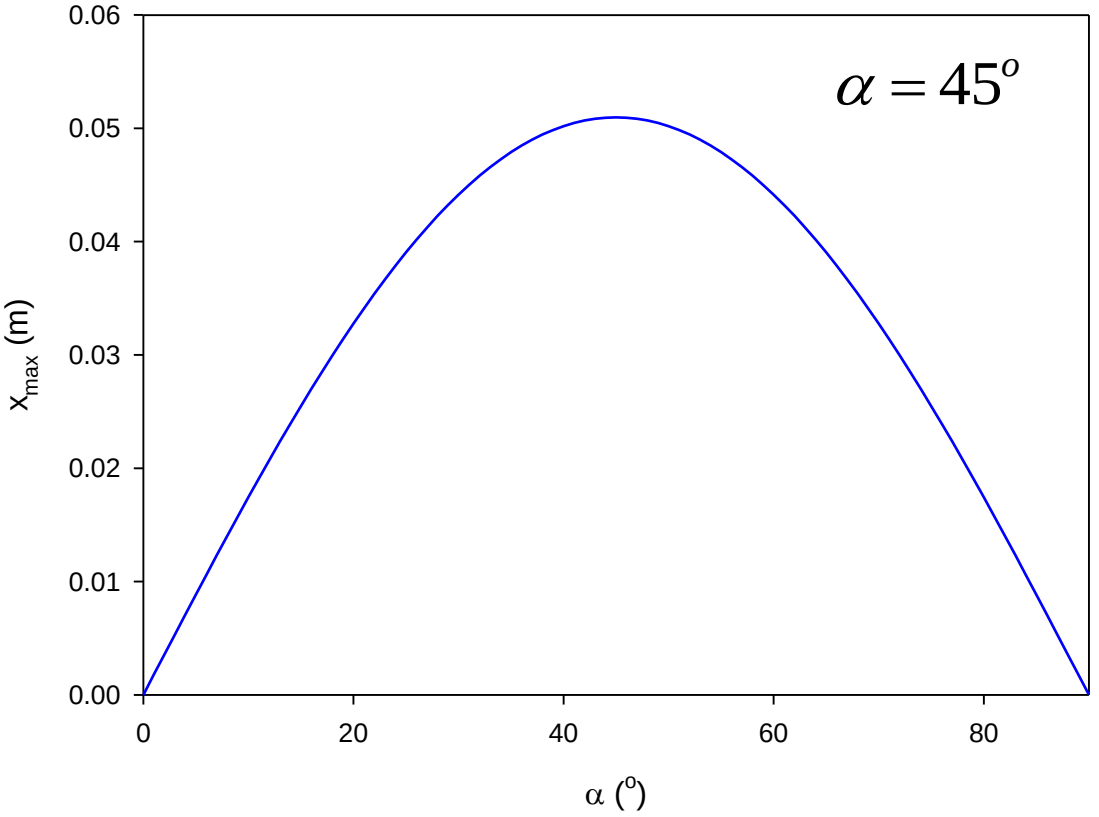


Šikmý vrh

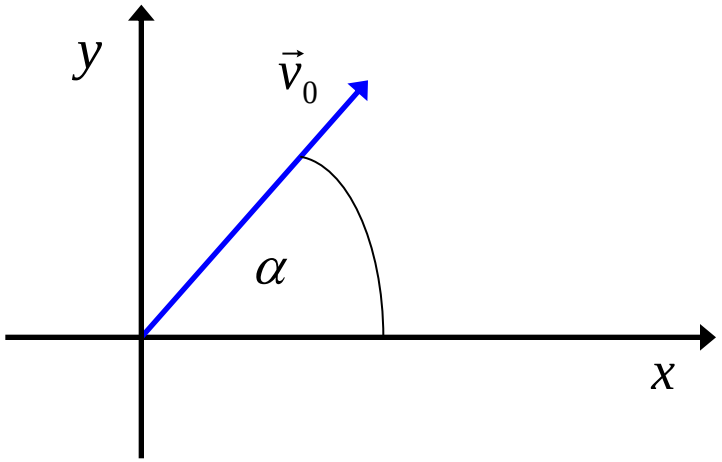


$$x_{\max} = \frac{v_0^2 \sin(2\alpha)}{2g}$$

$v_0 = 1\,\mathrm{ms}^{-1}$

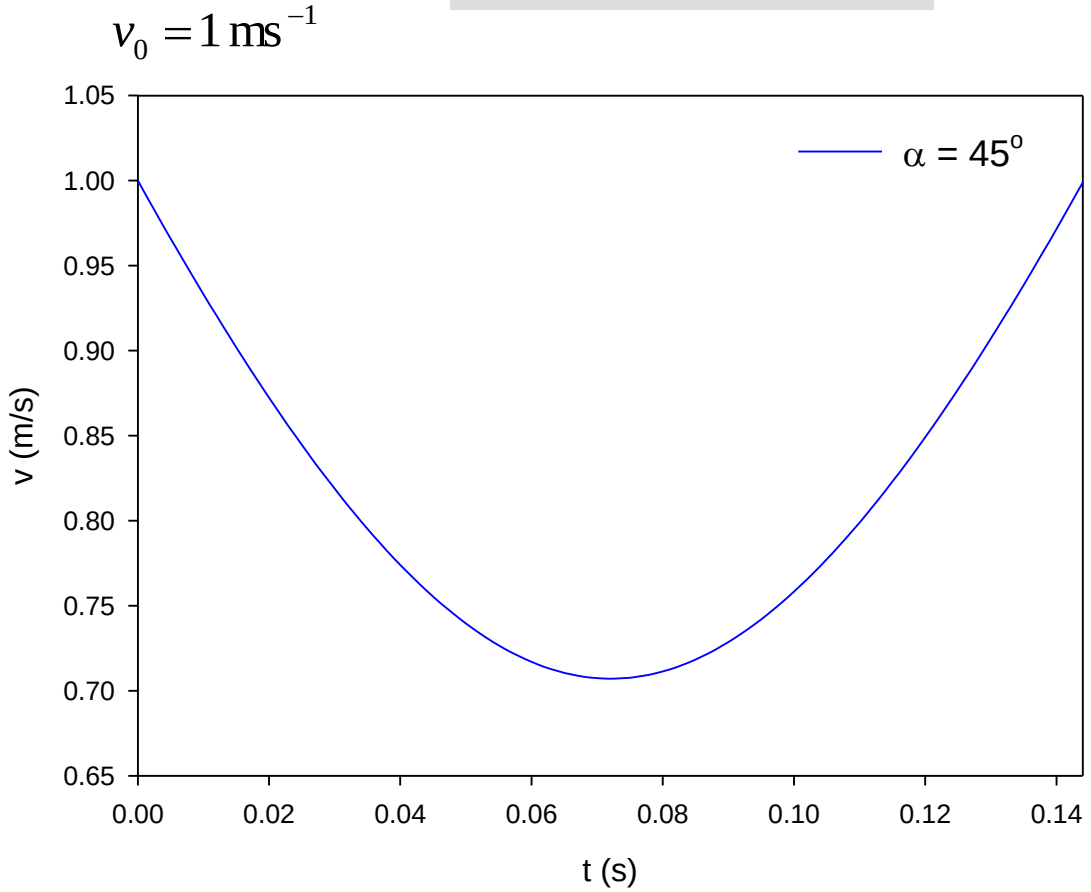


Šikmý vrh



Velikost rychlosti:

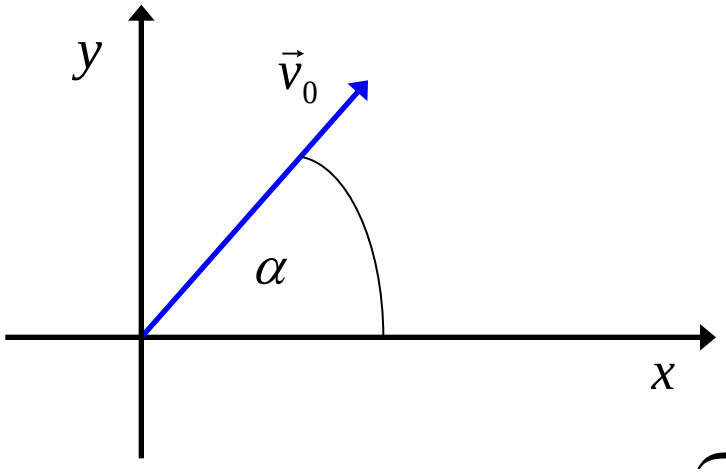
$$v = \sqrt{v_x^2 + v_y^2}$$



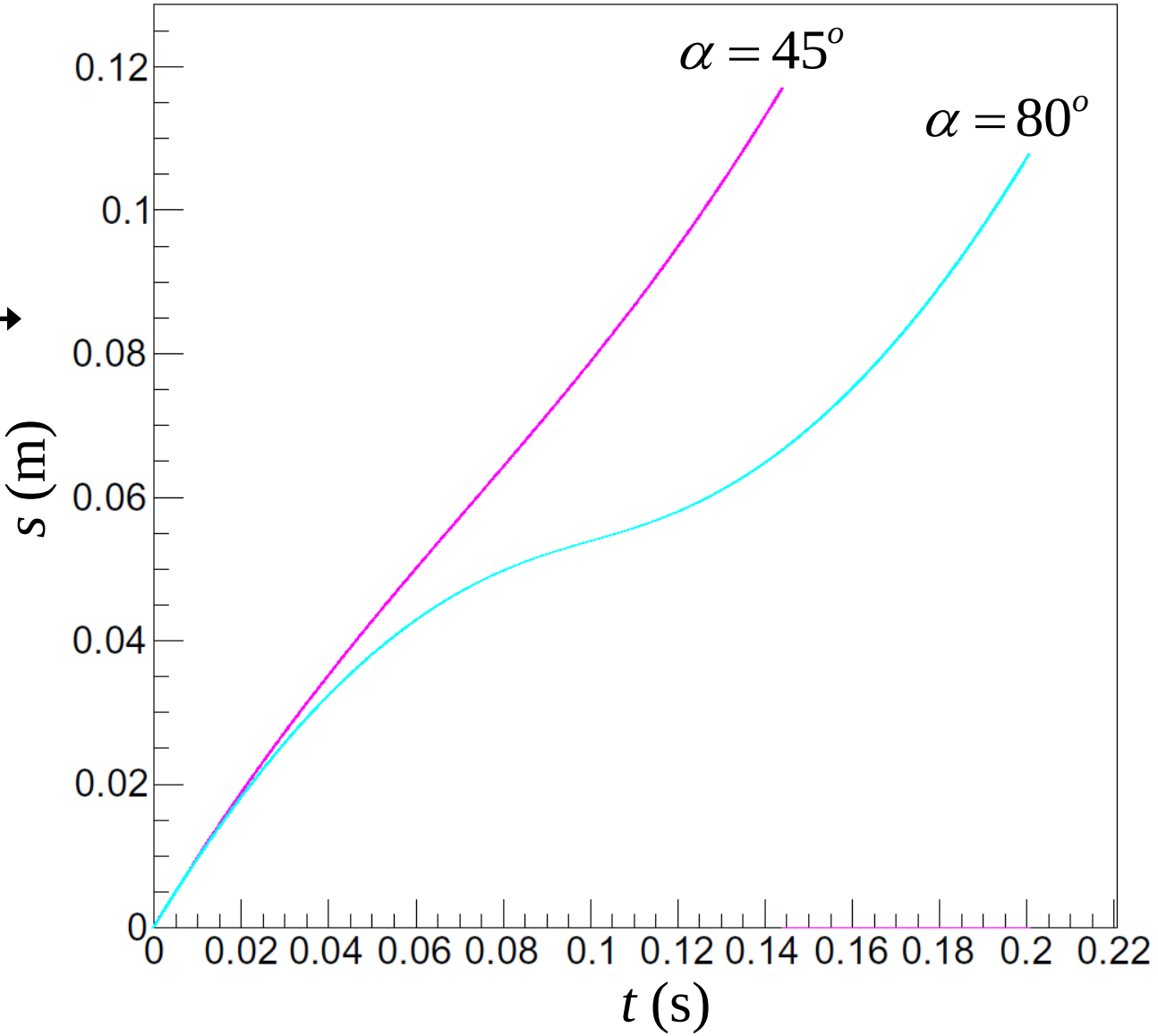
Numerický výpočet rychlosti a dráhy

```
v0=1; //velikost rychlosti v case t=0
dt=0.001;
t[0]=0.0;
x[0]=0.0;
y[0]=0.0;
vx[0]=v0*cos(alfa);
vy[0]=-g*dt/2.0+v0*sin(alfa);
v[0]=v0;
s=0.0;
i=0;
while(y[i]>=0 && i<n)     //cyklus dokud teleso nespadne na zem
{
 i++;
 t[i]=t[i-1]+dt;
 x[i]=x[i-1]+vx[i-1]*dt;
 y[i]=y[i-1]+vy[i-1]*dt;
 vx[i]=vx[i-1];
 vy[i]=vy[i-1]-g*dt;
 v[i]=sqrt(vx[i]*vx[i]+vy[i]*vy[i]); //velikost rychlosti
 s=s+(v[i]+v[i-1])/2*dt;             //urazena draha
}
```

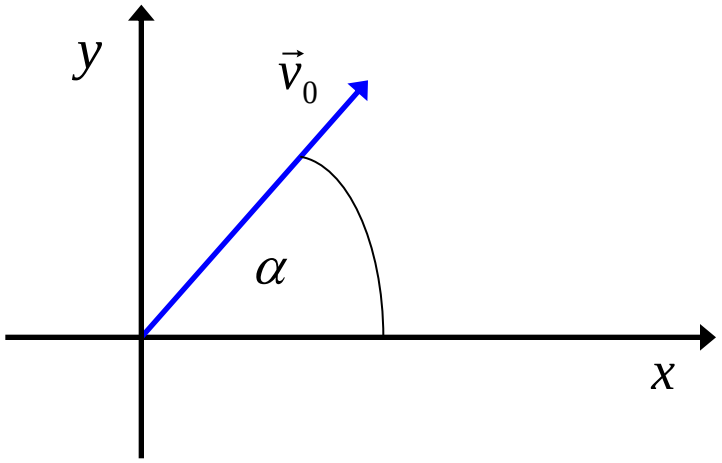
Šikmý vrh



$$s \equiv \int v(t)\,\mathrm{d}t$$

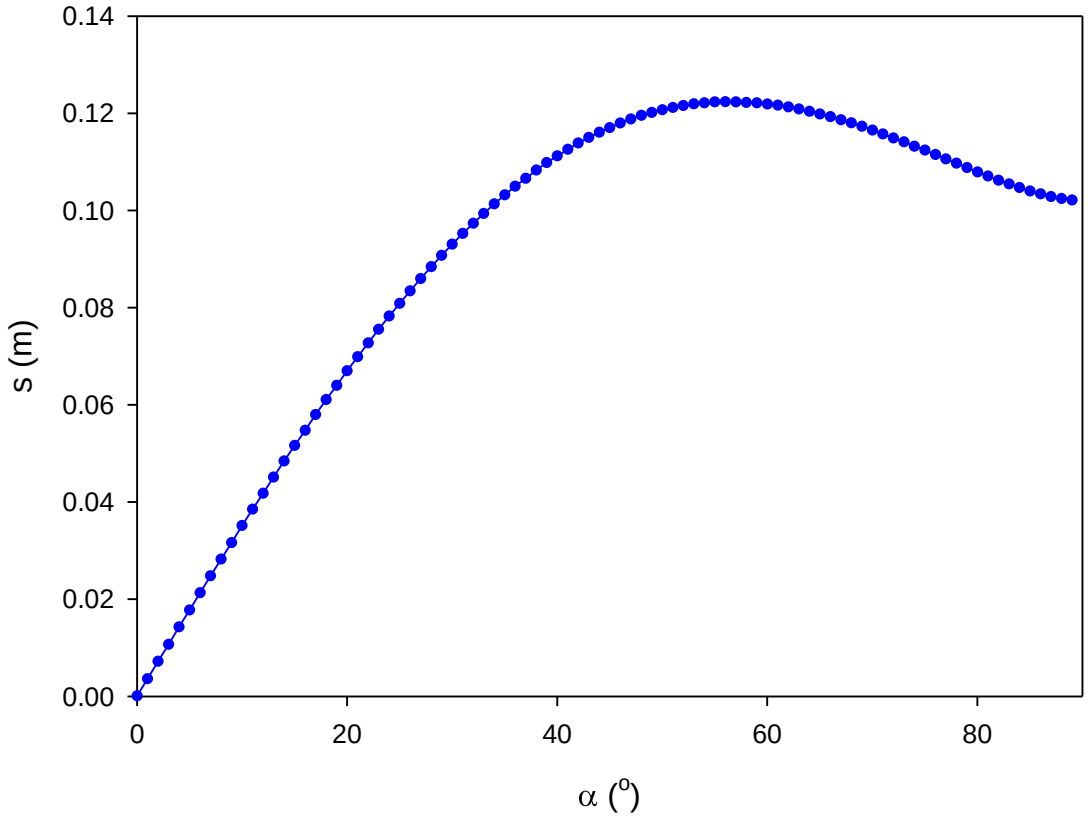


Šikmý vrh

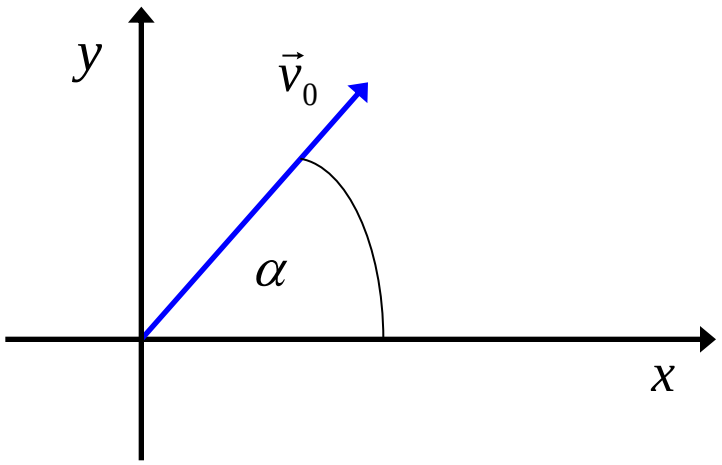


$$s \equiv \int v(t)\,\mathrm{d}t$$

$$s = \int_0^{\frac{2v_0 \sin\alpha}{g}} \sqrt{v_0^2 \cos^2\alpha + \left(v_0 \sin\alpha - gt\right)^2}\ \mathrm{d}t$$



Šikmý vrh



$$s = \frac{v_0^2}{g}\left(\sin\alpha + \cos^2\alpha \ln\frac{1+\sin\alpha}{\cos\alpha}\right)$$

$$s \equiv \int v(t)\,\mathrm{d}t$$