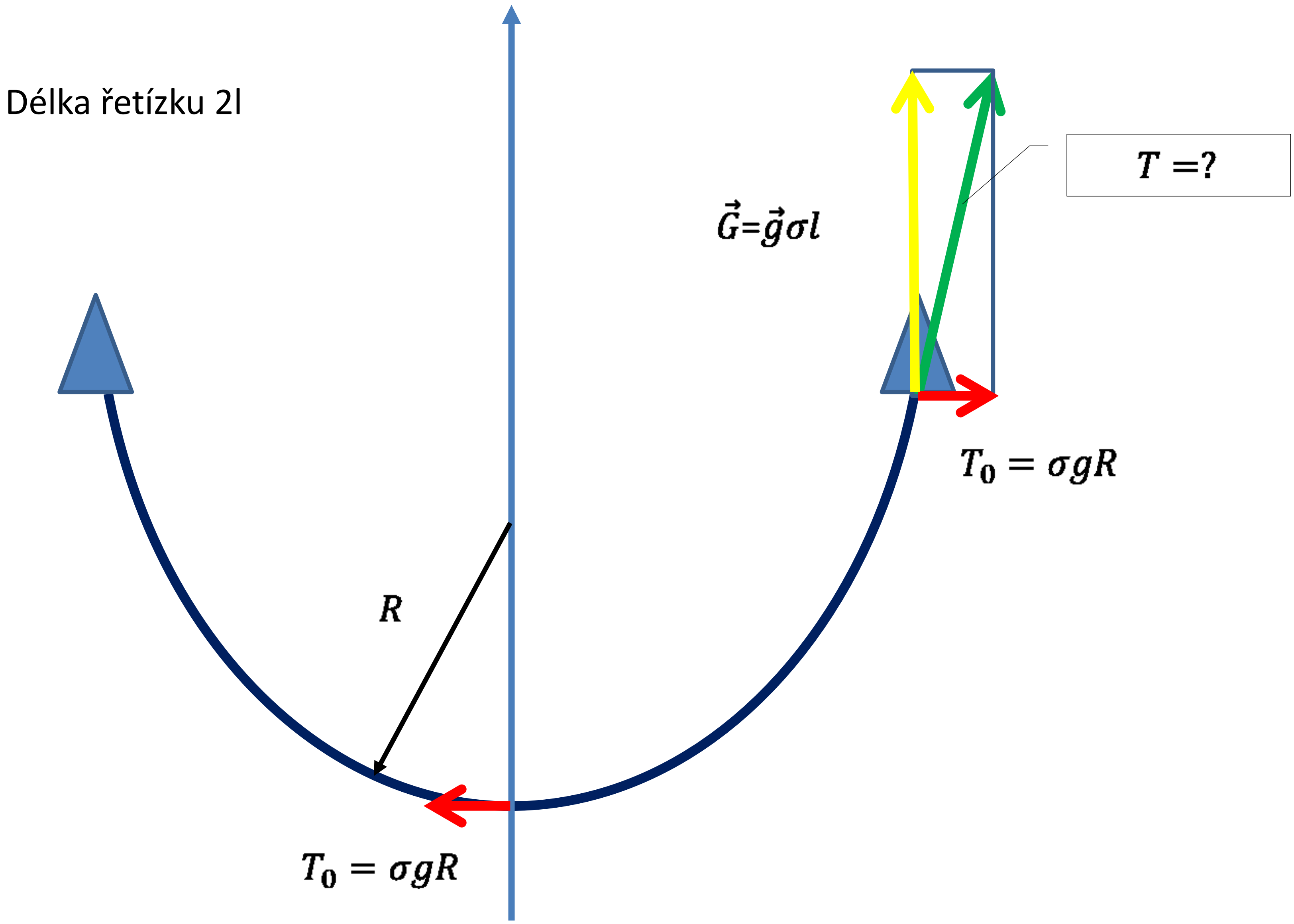
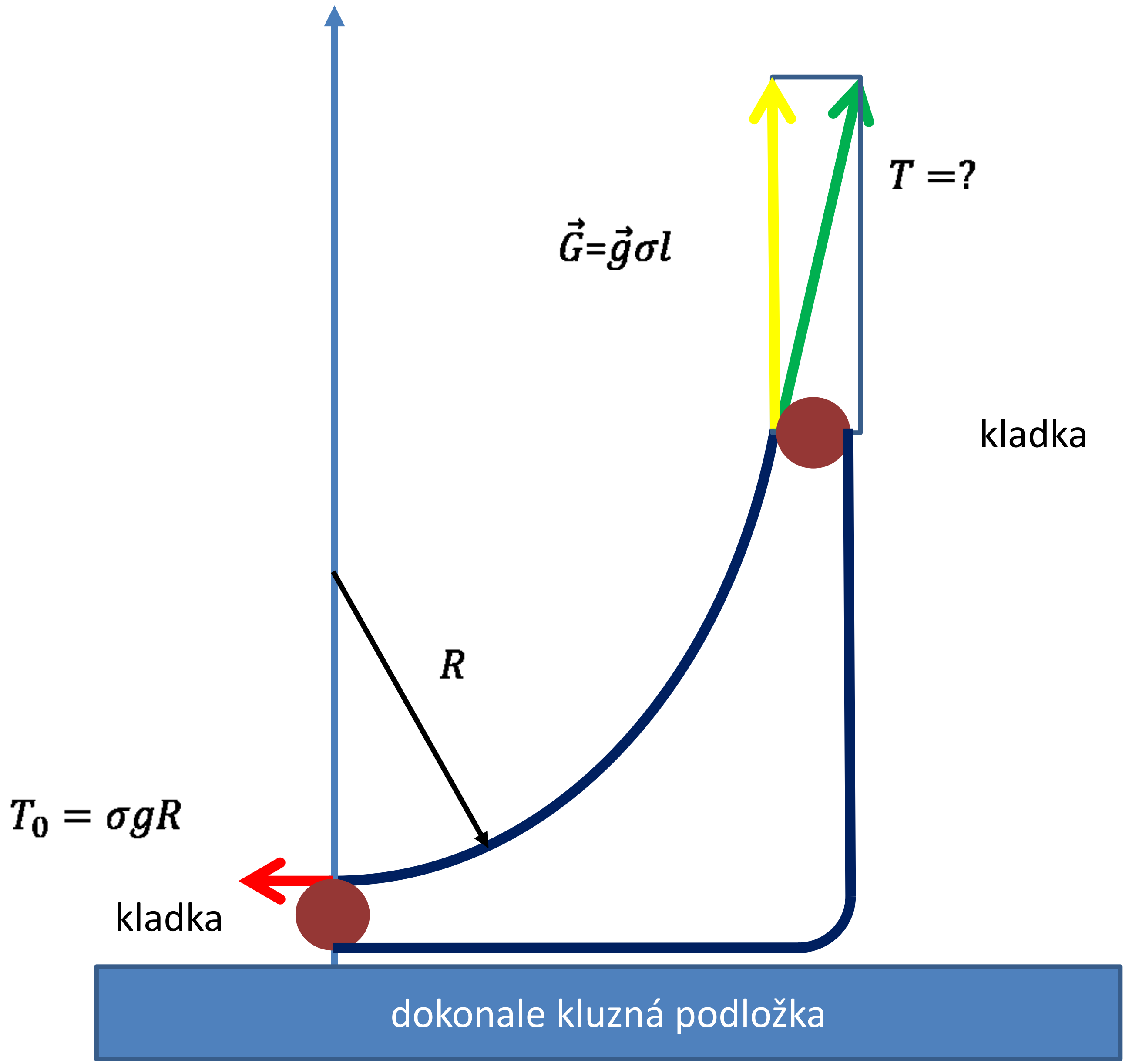
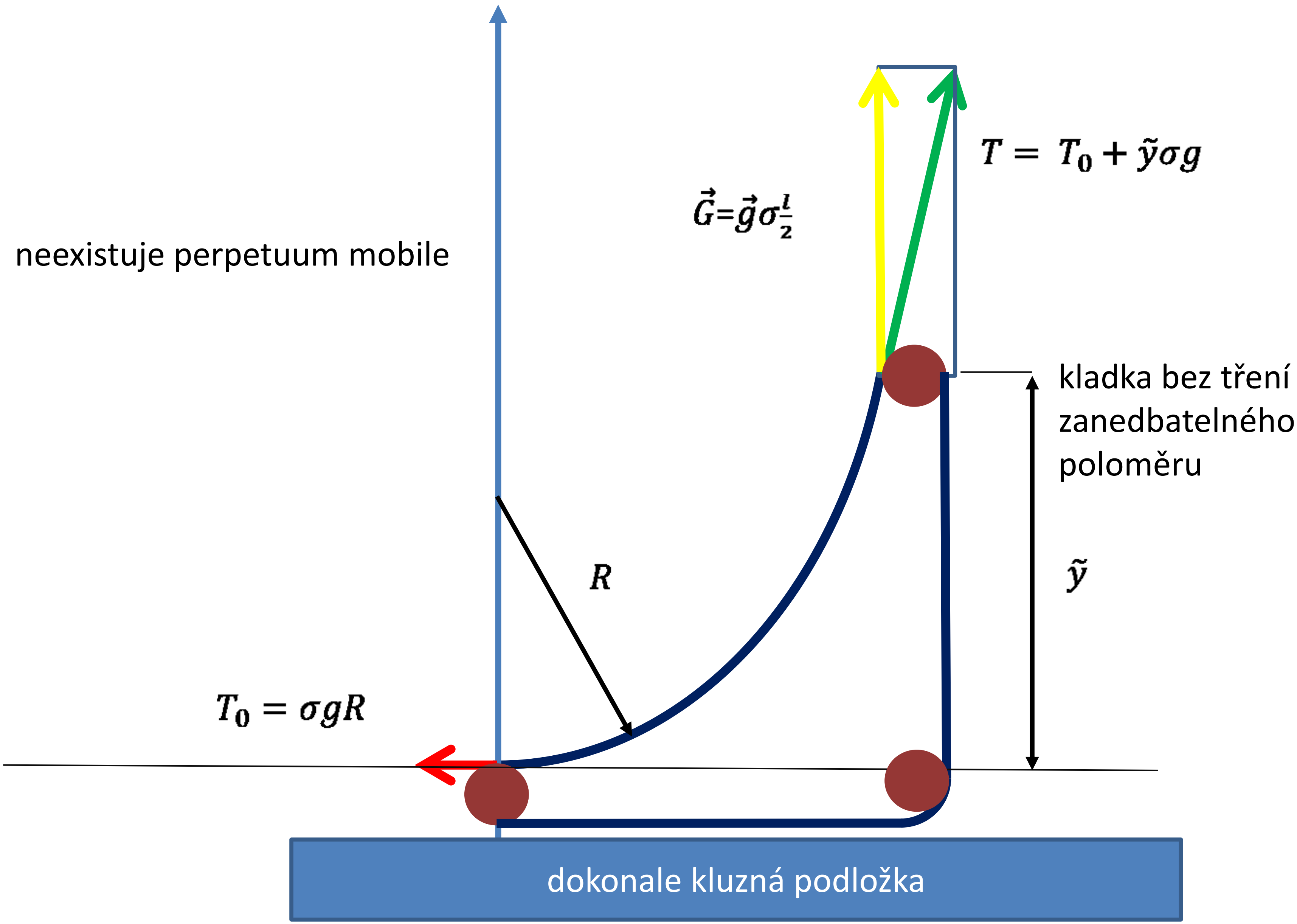
statika řetízků

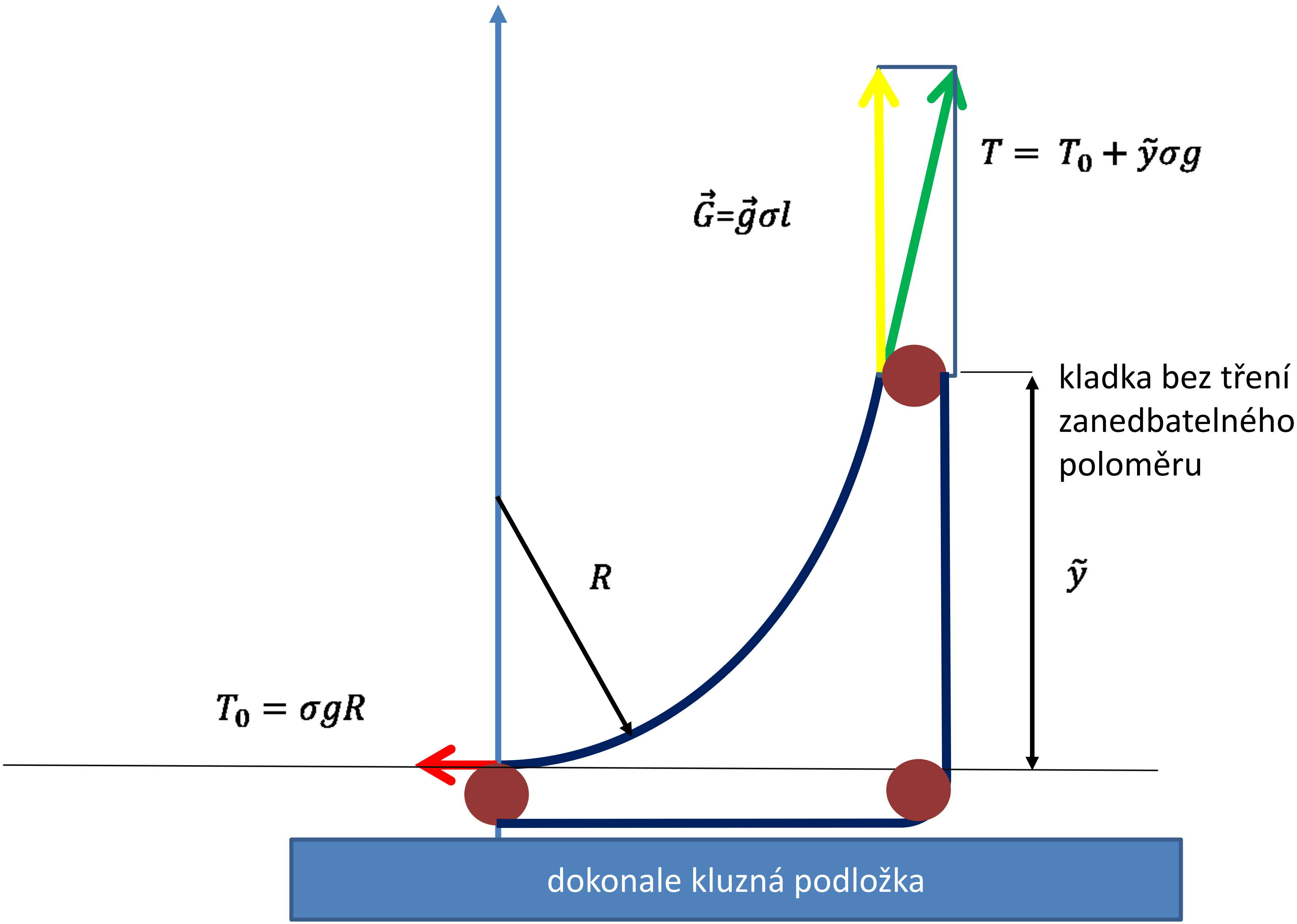

Délka řetízku 2l
$\vec{G}=\vec{g}\sigma l$
$T = ?$
$T_0 = \sigma g R$
R
$T_0 = \sigma g R$

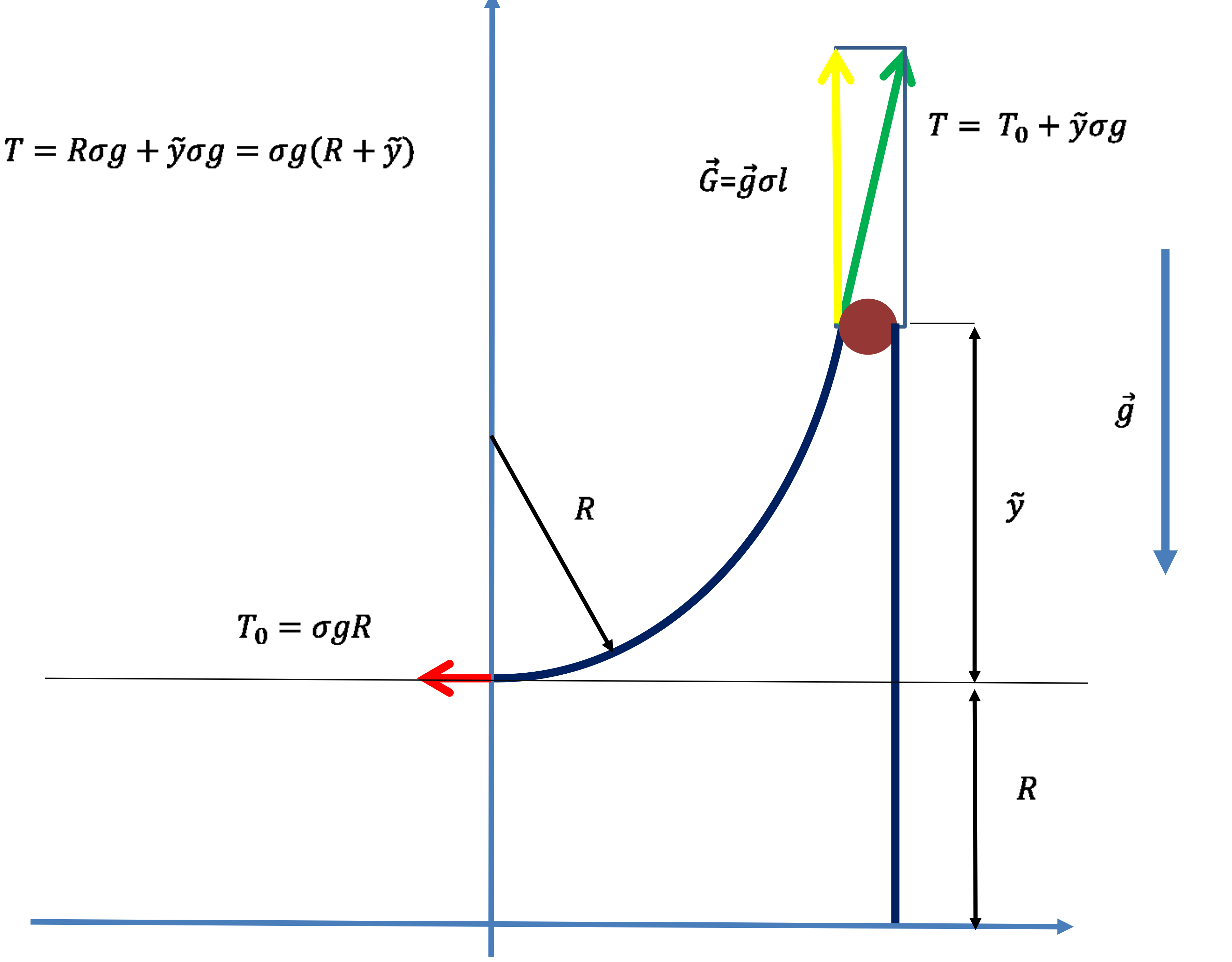


$T = ?$
$\vec{G} = \vec{g}\sigma l$
kladka
R
$T_0 = \sigma g R$
kladka
dokonale kluzná podložka

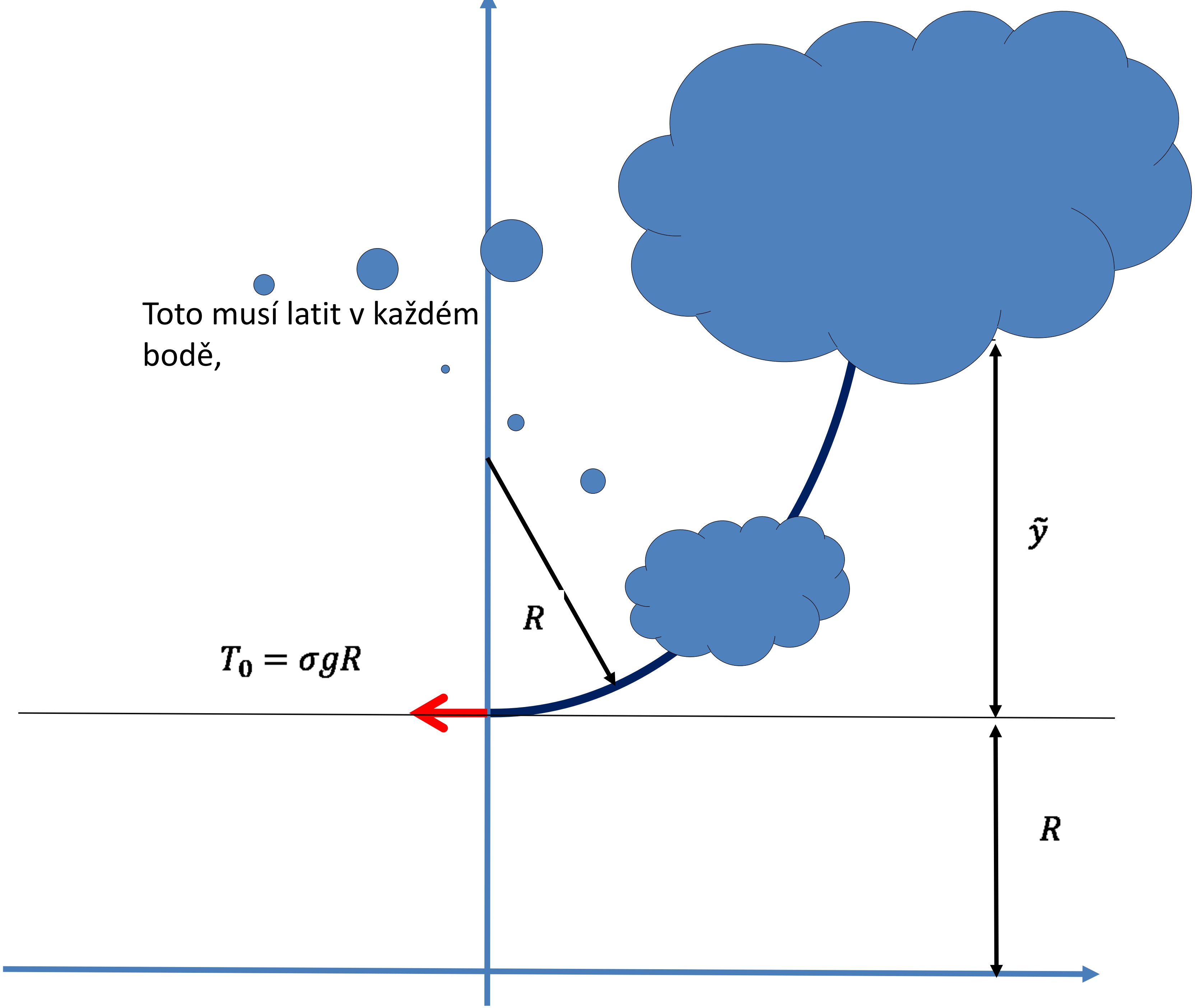
neexistuje perpetuum mobile

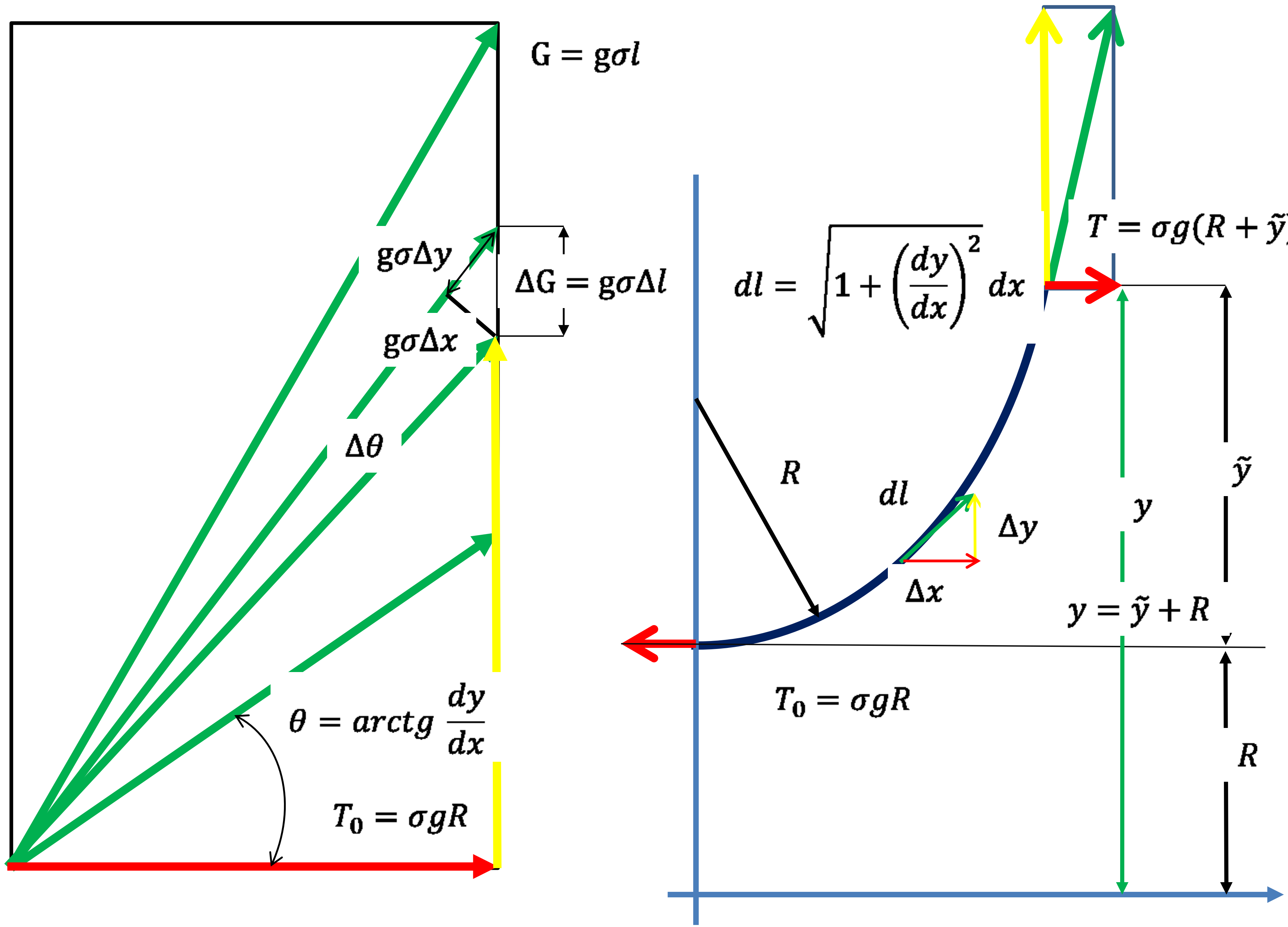



$T = T_0 + \tilde{y}\sigma g$
$\vec{G} = \vec{g}\sigma l$
kladka bez tření zanedbatelného poloměru
R
$\tilde{y}$
$T_0 = \sigma g R$
dokonale kluzná podložka

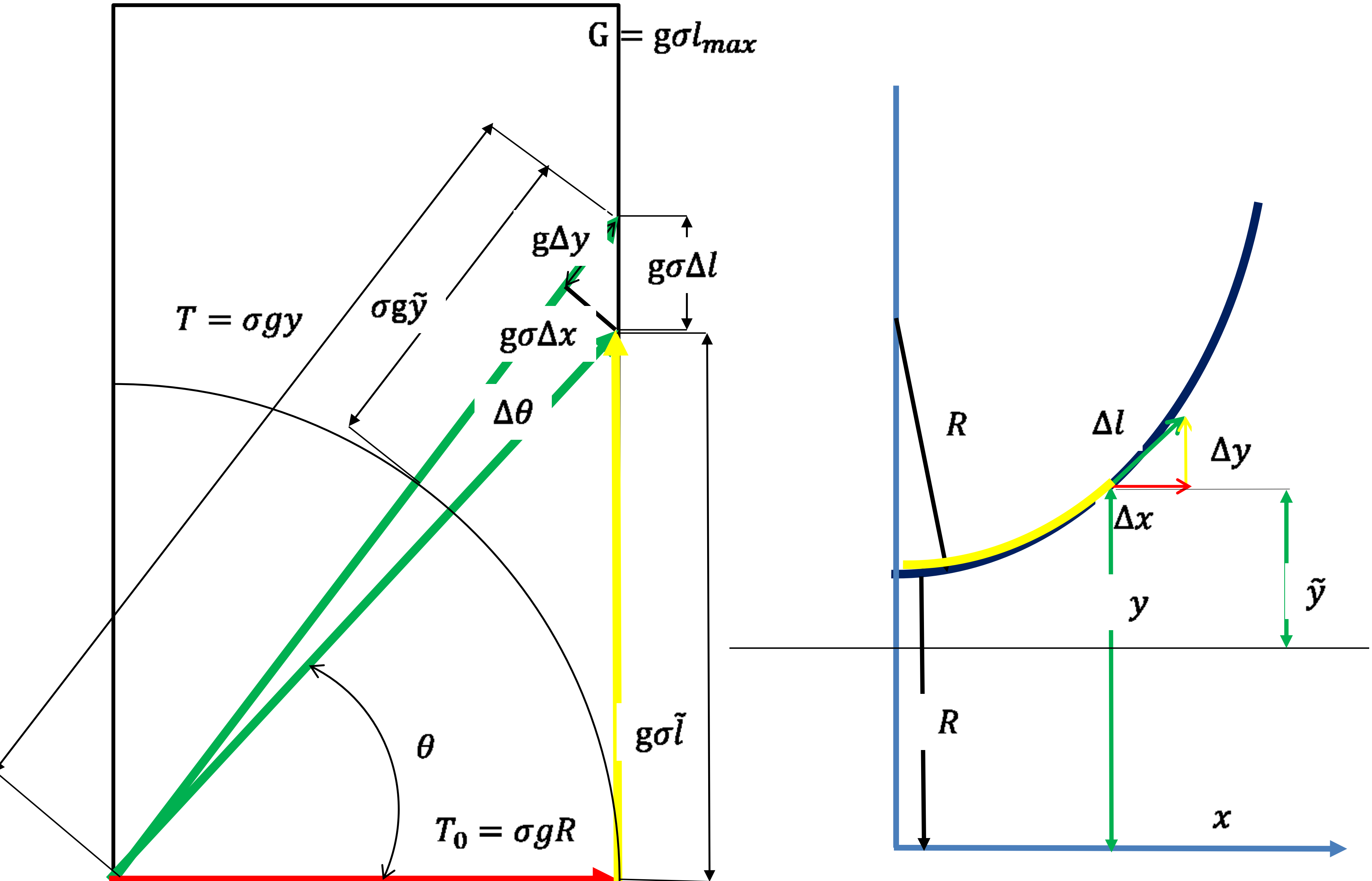


$T = R\sigma g + \tilde{y}\sigma g = \sigma g(R + \tilde{y})$
$T = T_0 + \tilde{y}\sigma g$
$\vec{G} = \vec{g}\sigma l$
$\vec{g}$
R
$\tilde{y}$
$T_0 = \sigma g R$
R


Toto musí latit v každém bodě,
$T_0 = \sigma g R$
R
$\tilde{y}$
R



$G = g\sigma l$
$g\sigma\Delta y$
$\Delta G = g\sigma\Delta l$
$g\sigma\Delta x$
$\Delta\theta$
$\theta = arctg\,\frac{dy}{dx}$
$T_0 = \sigma g R$
$dl = \sqrt{1 + \left(\frac{dy}{dx}\right)^2}\,dx$
$T = \sigma g(R + \tilde{y}$
R
dl
Δy
Δx
$\tilde{y}$
y
$y = \tilde{y} + R$
$T_0 = \sigma g R$
R



$G = g\sigma l_{max}$
$g\Delta y$
$g\sigma\Delta l$
$\sigma g\tilde{y}$
$T = \sigma g y$
$g\sigma\Delta x$
$\Delta\theta$
$g\sigma\tilde{l}$
θ
$T_0 = \sigma g R$
R
Δl
Δy
Δx
y
$\tilde{y}$
R
x

$$y = \sqrt{R^2 + l^2}$$

$$y = R\sqrt{1 + \left(\frac{l}{R}\right)^2} \qquad y = \frac{R}{\cos(\theta)}$$

$$\eta = \sqrt{1 + \xi^2}$$

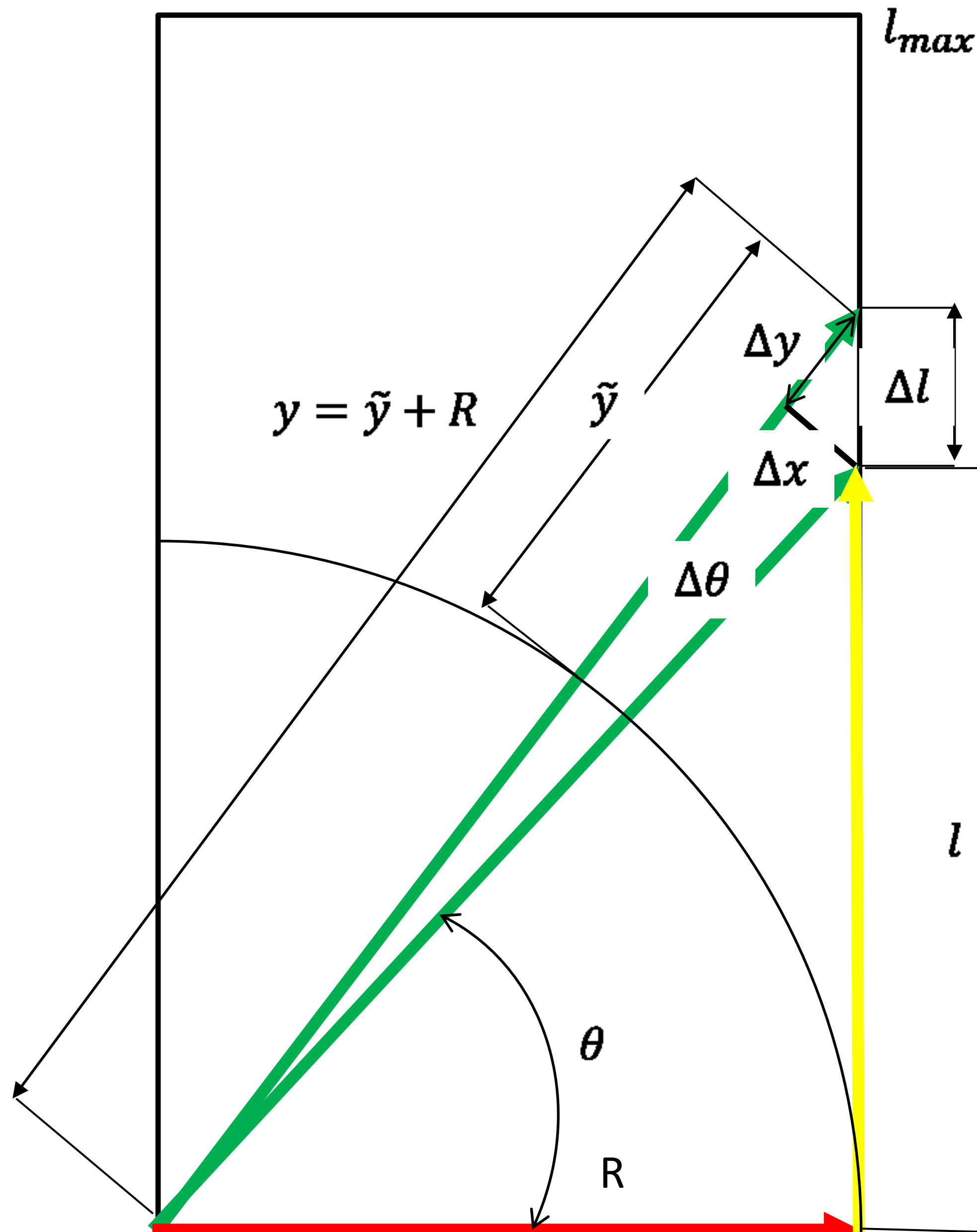
$$dx = dl\cos(\theta)$$

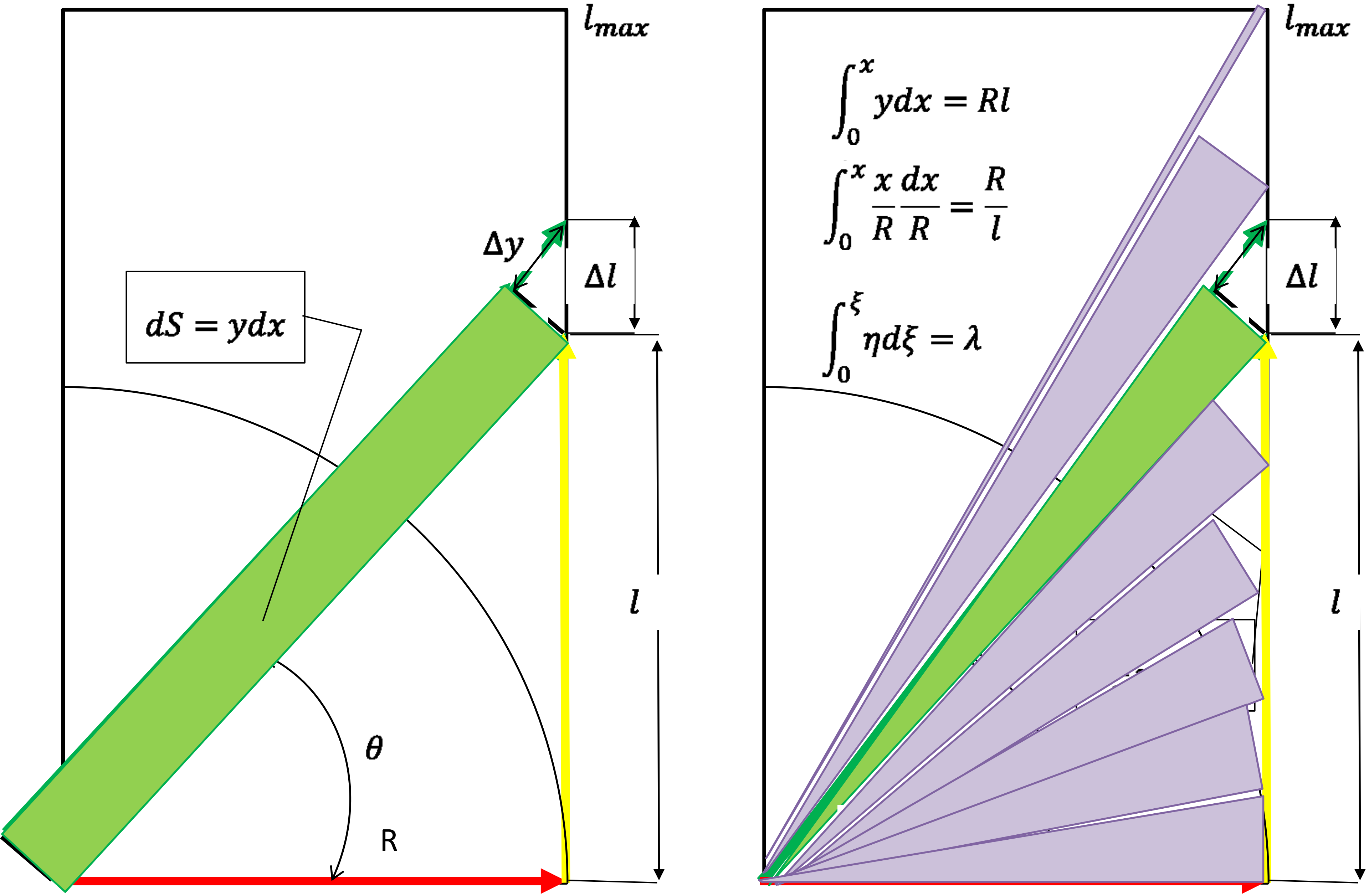
$$dx = dl\,\frac{R}{y} = \frac{dl}{\sqrt{1 + \left(\frac{l}{R}\right)^2}}$$

$$d\xi = \frac{d\lambda}{\sqrt{1 + \lambda^2}}$$

$$d\xi = \mathrm{d}(\operatorname{arcsinh}(\lambda))$$

$$\lambda = \sinh(\xi)$$





l_{max}
Δy
Δl
$dS = ydx$
l
θ
R
l_{max}
$\int_0^x ydx = Rl$
$\int_0^x \frac{x}{R}\frac{dx}{R} = \frac{R}{l}$
$\int_0^\xi \eta d\xi = \lambda$
Δl
l

$$\int_0^{\xi} \eta d\xi = \lambda$$

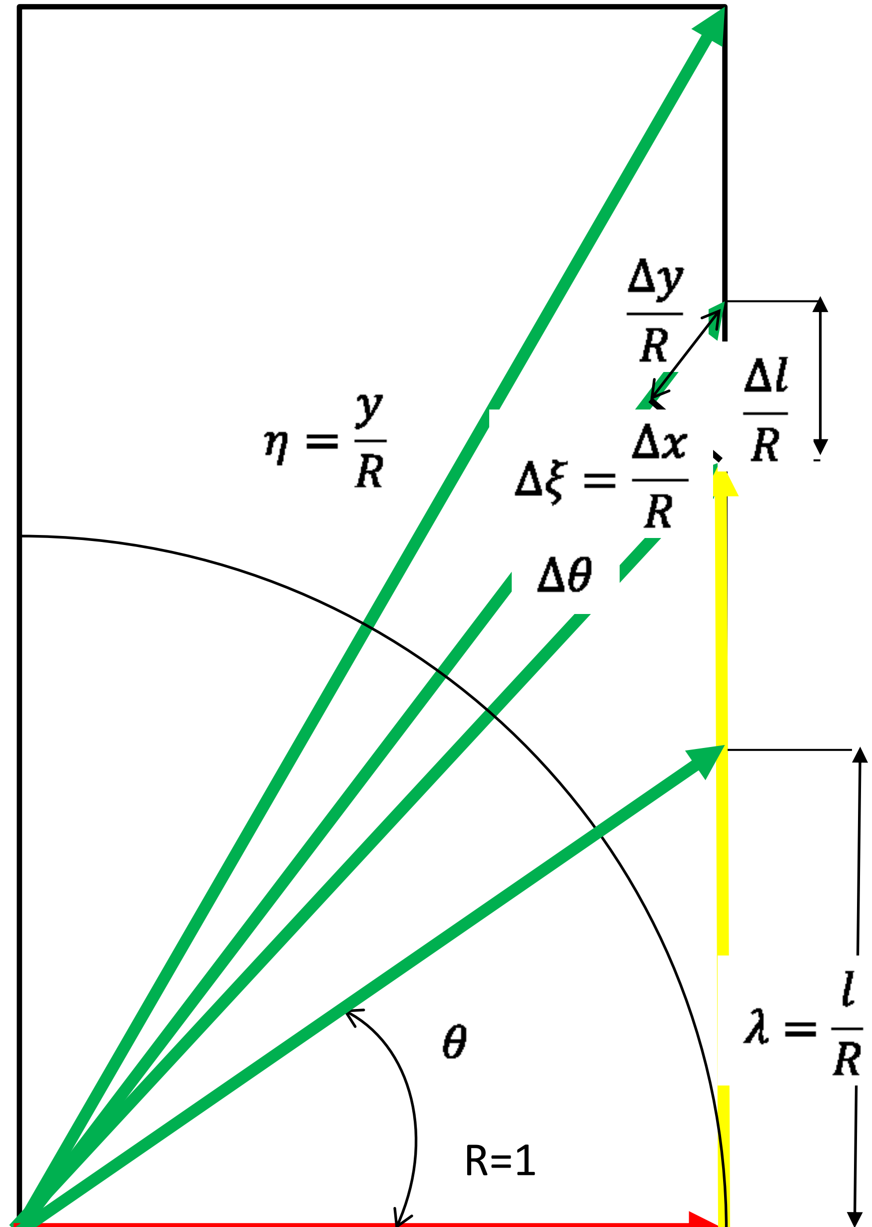
$$\eta d\xi = d\lambda$$

$$d\xi = \frac{d\lambda}{\sqrt{1+\lambda^2}}$$

$$\eta = \cosh \xi$$

$$y = R * \cosh \frac{x}{R}$$

$$d\lambda = \sqrt{1 + \left(\frac{d\eta}{d\xi}\right)^2}\, d\xi = \cosh\xi\, d\xi = d\Sigma$$



- Závislost na délkové hustotě
- Závislost na tíhovém zrychlení
- Kotvení lodí

Doba šíření signálu od závěsu k závěsu

$$dt = \frac{dl}{v}$$

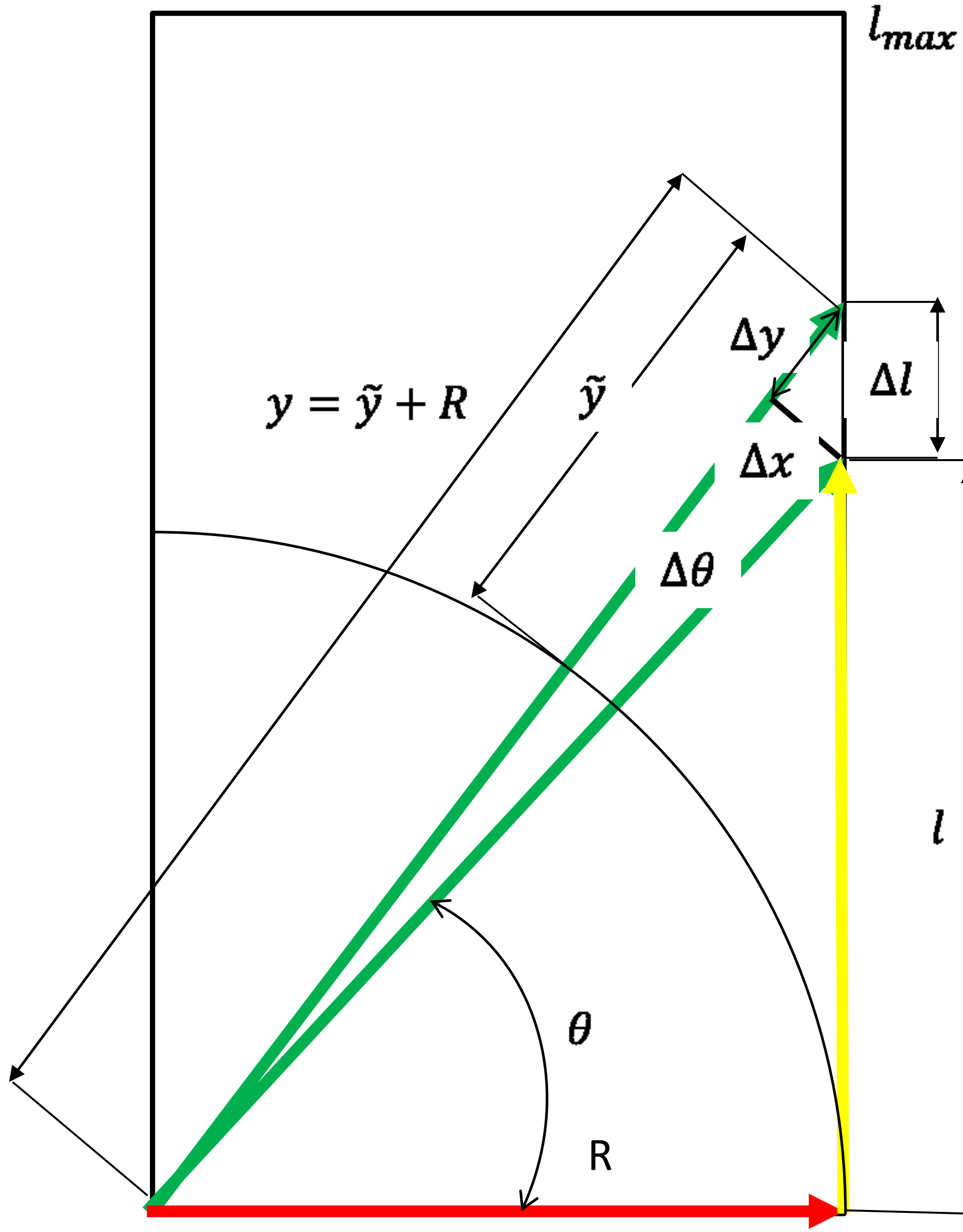
$$dt = \frac{dl}{v}$$

$$v = \sqrt{\frac{\tau}{\sigma}}$$

$$dt = \frac{\cosh\frac{x}{R}}{\sqrt{\frac{\sigma g R \cosh\frac{x}{R}}{\sigma}}} dx$$

$$dt = \frac{R * \cosh\frac{x}{R}}{\sqrt{\frac{\sigma g R \cosh\frac{x}{R}}{\sigma}}} d\frac{x}{R}$$

$$t = \sqrt{\frac{R}{g}} \int_0^{\xi} \sqrt{\cosh\xi}\, d\xi$$



Určení délky řetězovky vážením „grafu“

Konkrétní příklad

$l = 67.5\ cm$

$x_0 = 41.8$ cm

$\frac{l}{x} = 1.615$

R =23,54 cm

$\frac{l}{R} = 2.867$

$y = 23.54 * \cosh(1.776) = 71.5\ cm$

$sinh\xi = 1.615\xi$

https://www.wolframalpha.com/

$\xi = 1.776$

$\xi = \frac{x_0}{R}$

https://www.wolframalpha.com/input/?i=solve(sinh(x)%3D1.615*x)

solve(sinh(x)=1.615*x)

Browse Examples   Surprise Me

Input interpretation:

solve	$\sinh(x) = 1.615\,x$

$\sinh(x)$ is the hyperbolic sine function

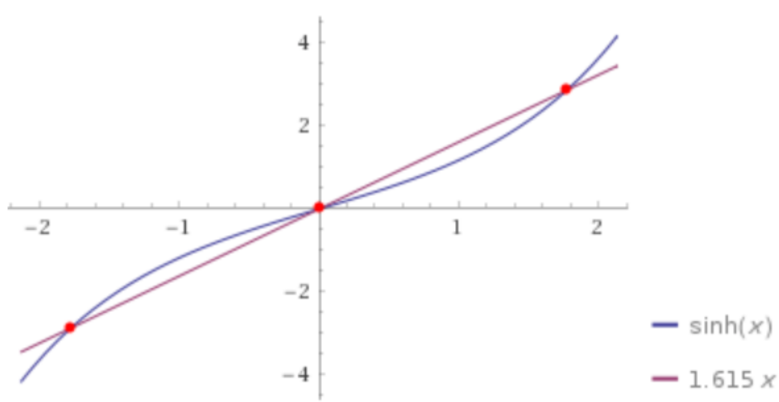
Solution over the reals: Exact forms   More digits

$x \approx -1.77586$

$x = 0$

$x \approx 1.77586$

Plot:



Open code

15:26 13.12.2018

měření

Hmotnost čtverce o straně R m= 12.4 g

Hmotnost čtverce o straně R m= 12.4 g

Hmotnost papíru pod křivkou m= 32.27 g

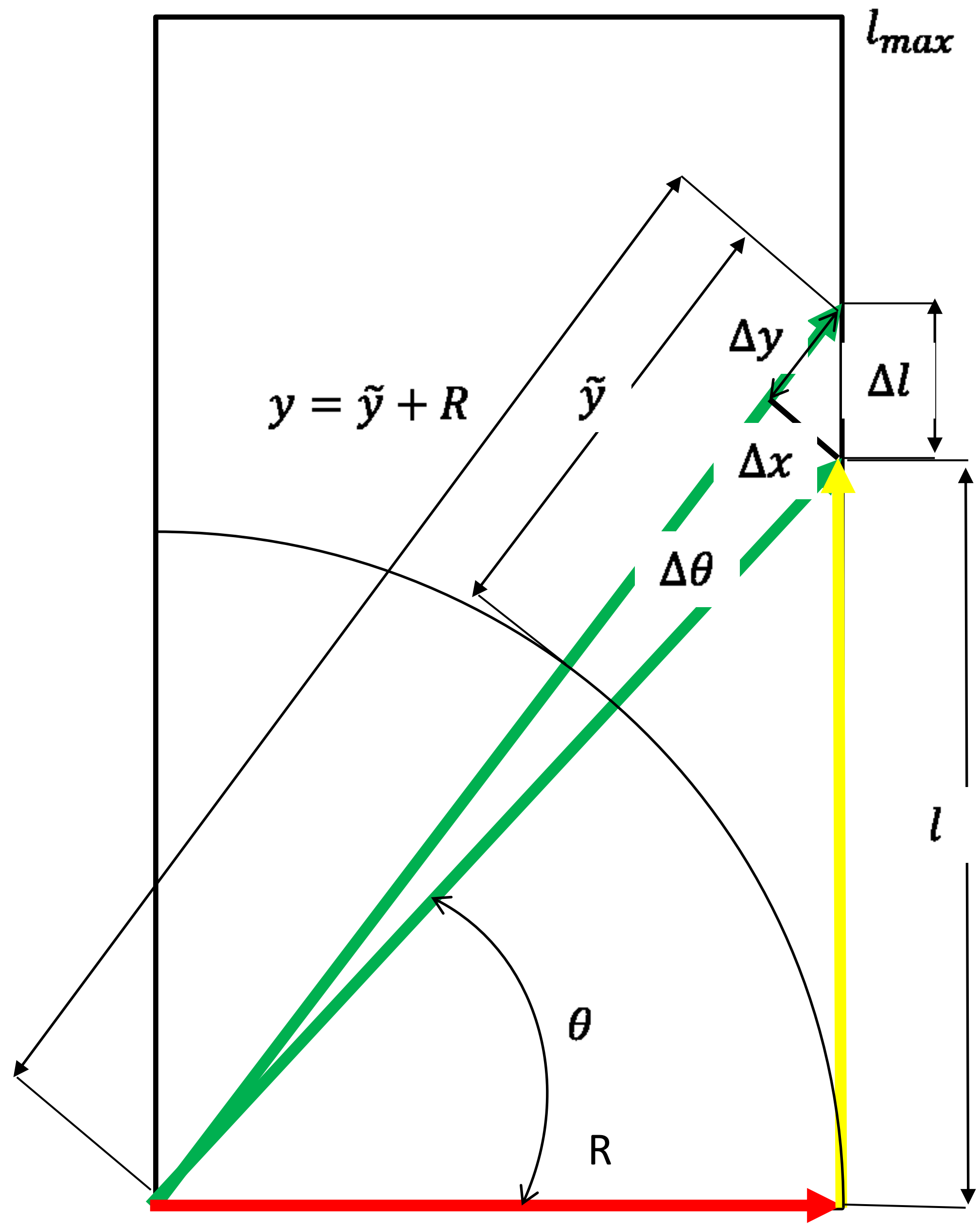
Poměr hmotností tj. Bezrozměrná délka křivky 2.831

Bezrozměrná délka křivky určená výpočtem 2.867

Doba šíření signálu od závěsu k závěsu

$$t = \sqrt{\frac{R}{g}}\int_0^{\xi}\sqrt{cosh\xi}\,d\xi$$

$$\Delta t_n = \frac{\Delta l}{\sqrt{\frac{\sigma g\sqrt{(R^2+n^{\wedge}2*\Delta l^2)}}{\sigma}}}$$



Konkrétní příklad

$2 * l = 292.2\ cm$

$m = 53.5\ g$

$x_0 = 81.5$ cm

$\frac{l}{x} = 1.793$

R =41.18 cm

t =0.531 s

$sinh\xi = 1.793\xi$

https://www.wolframalpha.com/

$\xi = 1.979$

$\xi = \frac{x_0}{R}$

Výpočet pomocí tabulkového procesoru pro 20 dílků t= 0.521 s https://www.wolframalpha.com/input/?i=solve+(sinh(x)%3D1.793*x,x)

solve (sinh(x)=1.793*x,x)

Browse Examples | Surprise Me

Input interpretation:

solve	$\sinh(x) = 1.793\,x$	for	x

Open code

$\sinh(x)$ is the hyperbolic sine function

Solution over the reals:

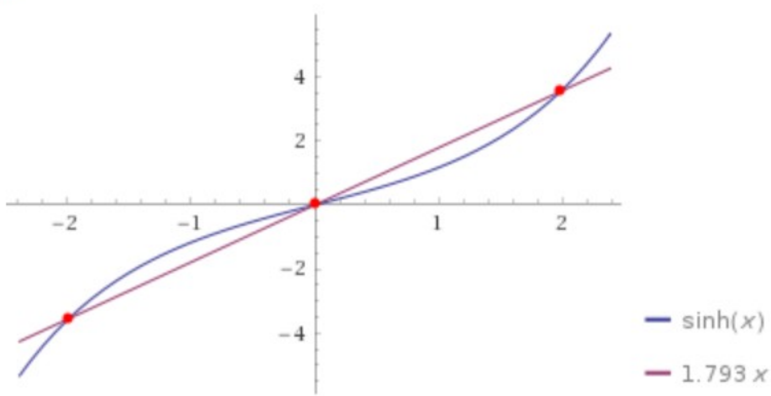
Exact forms | More digits

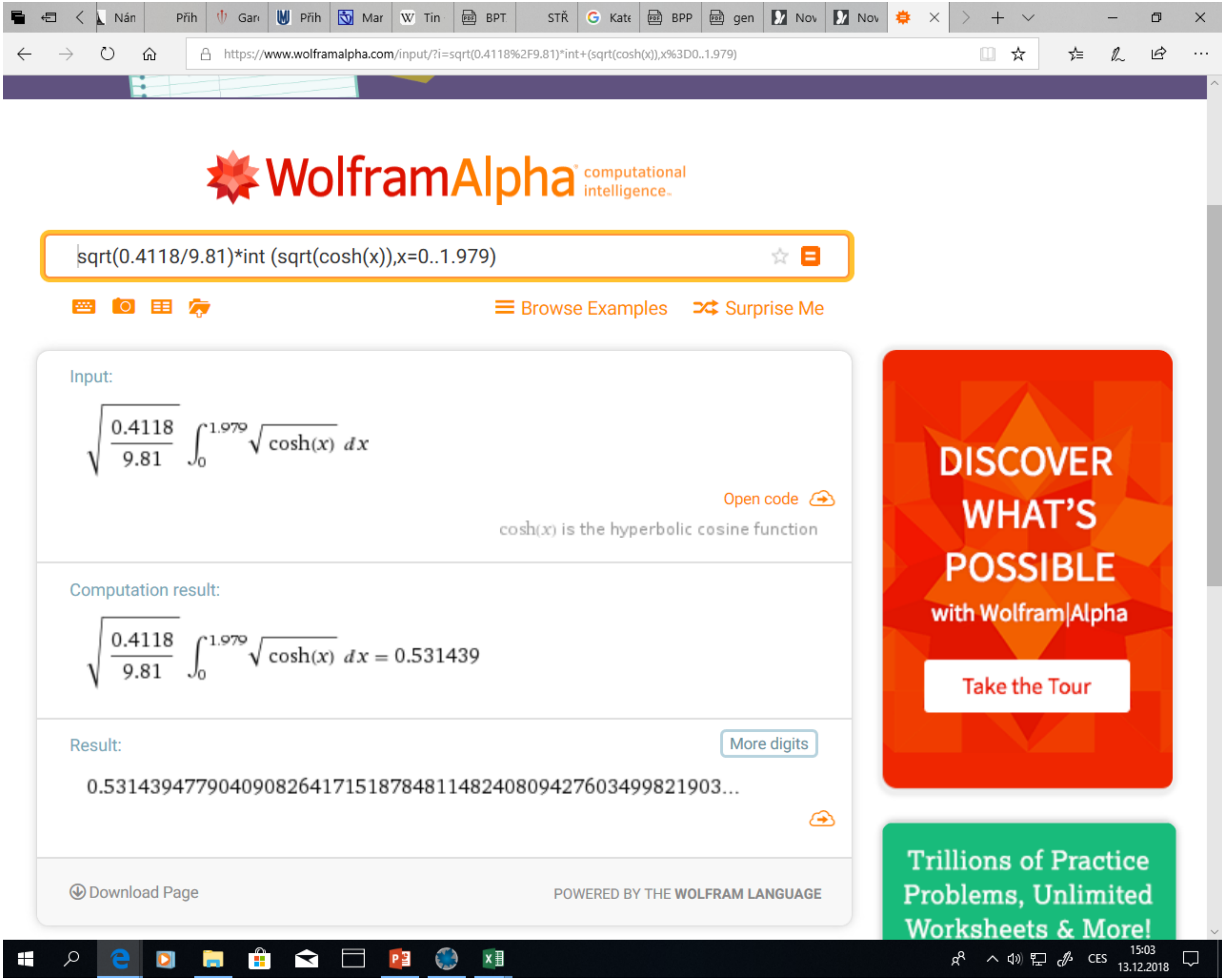
$x \approx -1.97884$

$x = 0$

$x \approx 1.97884$

Plot:




https://www.wolframalpha.com/input/?i=sqrt(0.4118%2F9.81)*int+(sqrt(cosh(x)),x%3D0..1.979)
WolframAlpha computational intelligence.
sqrt(0.4118/9.81)*int (sqrt(cosh(x)),x=0..1.979)
Browse Examples
Surprise Me
Input:
$\sqrt{\frac{0.4118}{9.81}} \int_0^{1.979} \sqrt{\cosh(x)}\, dx$
Open code
cosh(x) is the hyperbolic cosine function
Computation result:
$\sqrt{\frac{0.4118}{9.81}} \int_0^{1.979} \sqrt{\cosh(x)}\, dx = 0.531439$
Result:
More digits
0.53143947790409082641715187848114824080942760349982190 3...
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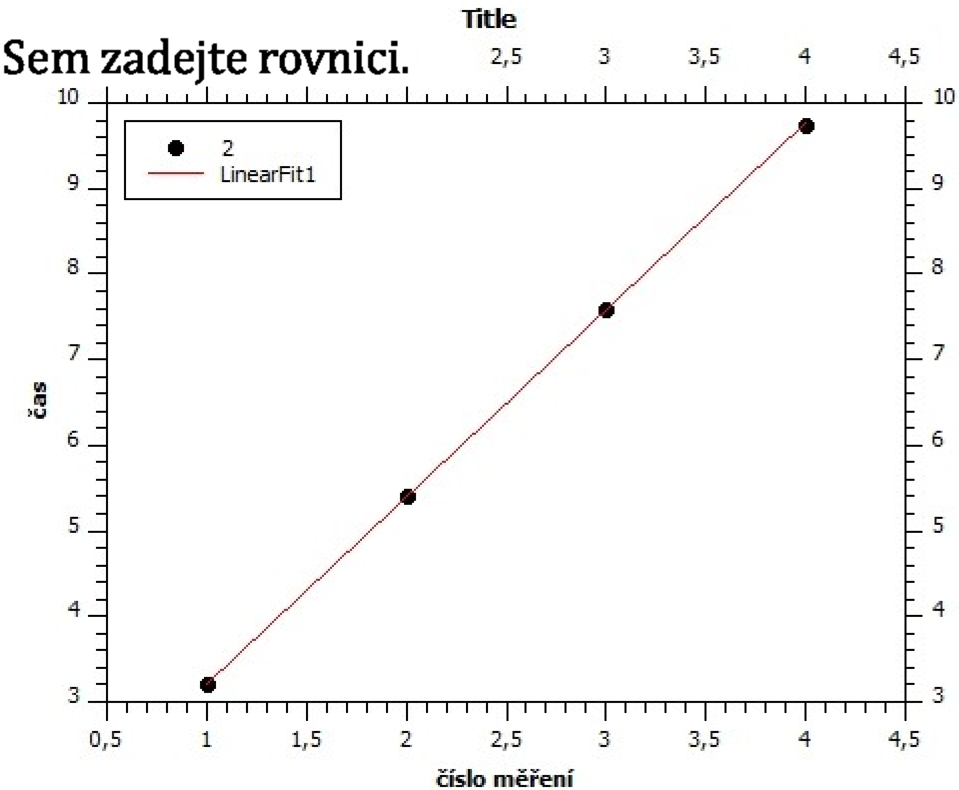
Měření

	čas
1	3.216
2	5.405
3	7.582
4	9.750

Sem zadejte rovnici.



$$t_{měř} = 2.179 \mp 0.003\ s$$

Srovnání

$t_{měř}$ je čas šíření tam i zpět, t výpočet je čas šíření od půlky do konce

$$4 * t_{výp} = 2.124\ s$$