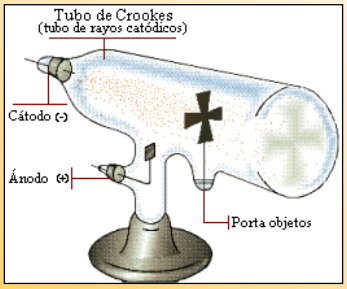
Laboratório de Física B - 4323202

Movimento de cargas em campos EM (TRC) e determinação de e/m do elétron

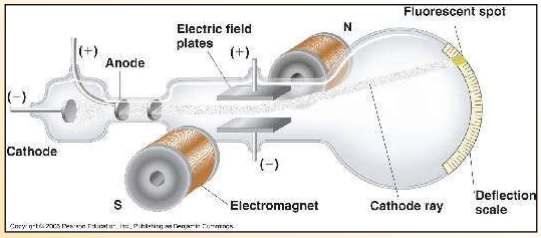
Manfredo H. Tabacniks
IFUSP 2018

Tubo de Crookes 1870

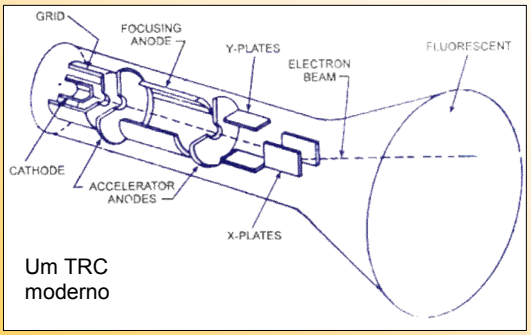


https://radiologiapatologicablog.files.wordpress.com

Campos E e B para medir e/m de elétrons



http://esa.ipb.pt/blogs/amilcar/files/2010/04/thomson_electron_experiment.jpg

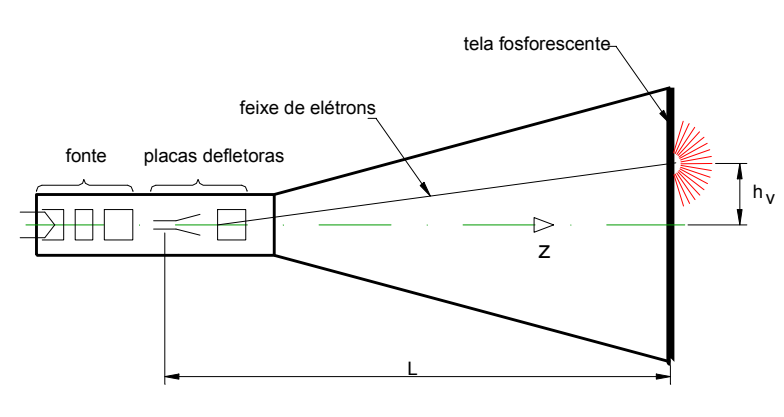


Um TRC moderno

www.daenotes.com/electronics/devices-circuits/cathod-ray-tube-crt

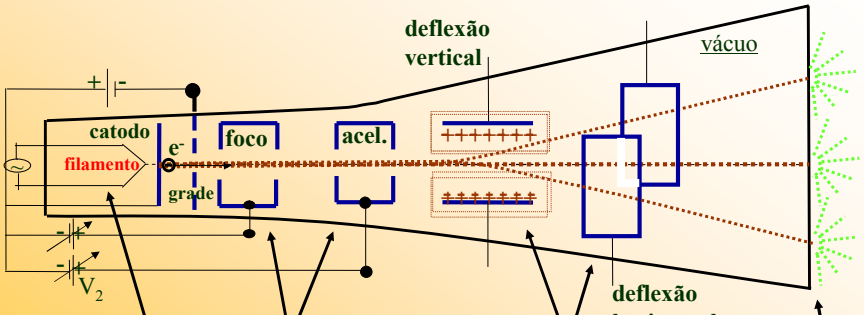
http://www.kcvs.ca/site/projects/physics_files/thompson/thomsonExp.swf

Esquema de um Tubo de Raios Catódicos



Profa. Eloisa Szanto

Tubo de raios catódicos e carga/massa do elétron

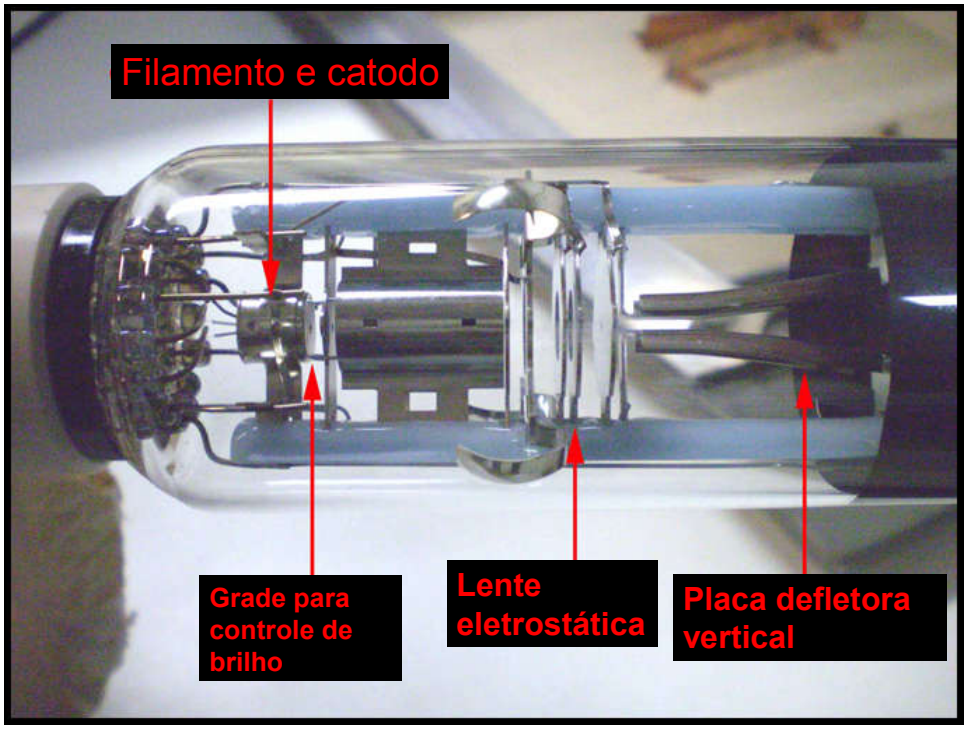


O filamento aquece o catodo, que por efeito termoiônico, **cria uma nuvem de** elétrons**.**

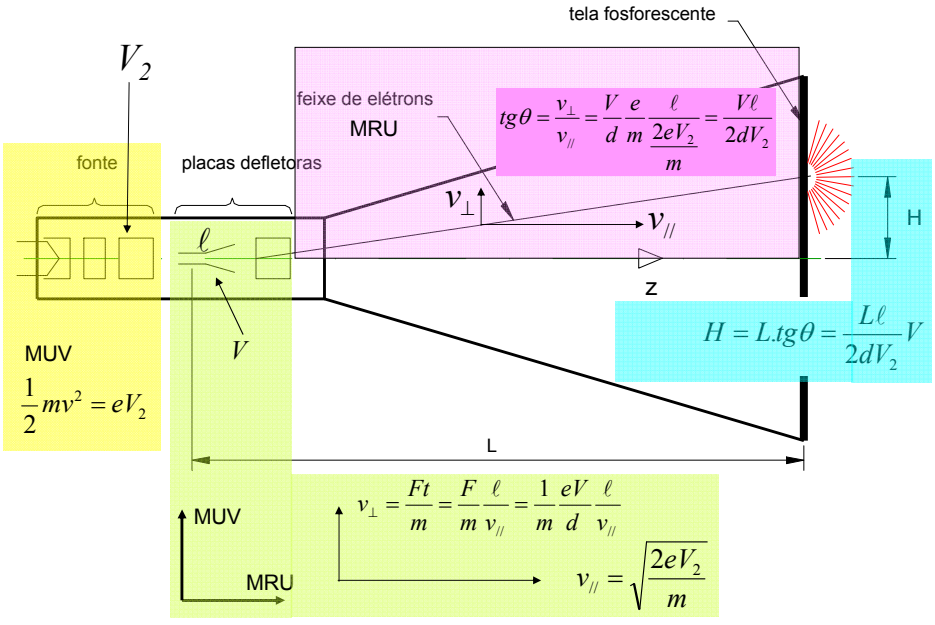
Elétrons são acelerados por uma diferença de potencial **no anodo acelerador e focados numa lente eletrostática.** O feixe corre para a tela fosforescente.

A trajetória é modificada por **placas defletoras.**

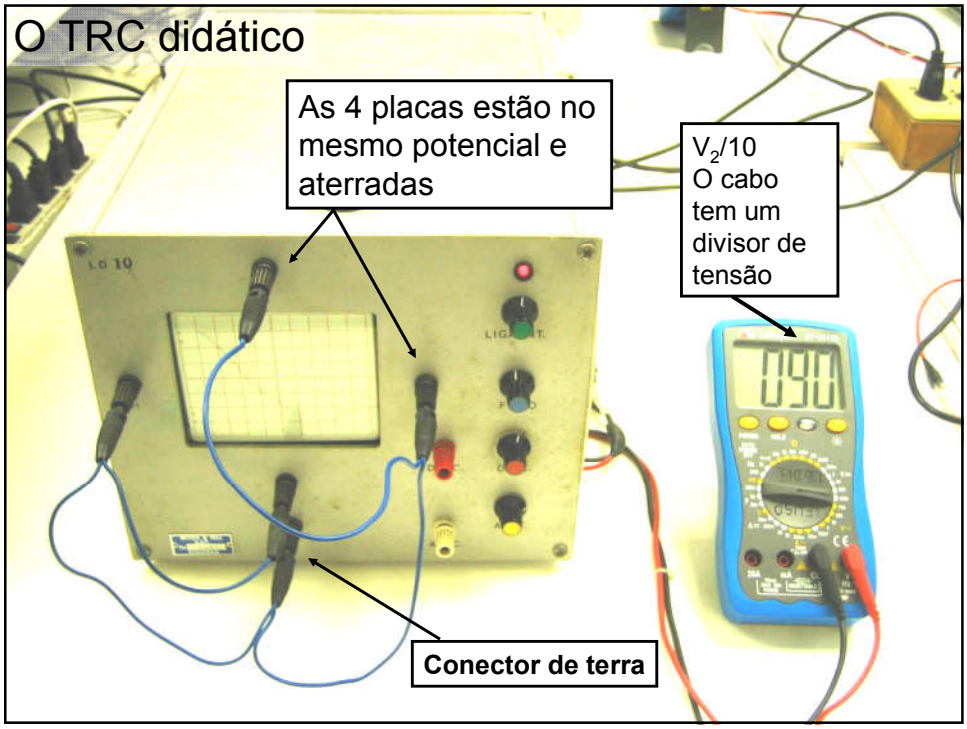
A tela fosforescente **ilumina** o ponto em que os elétrons incidem.



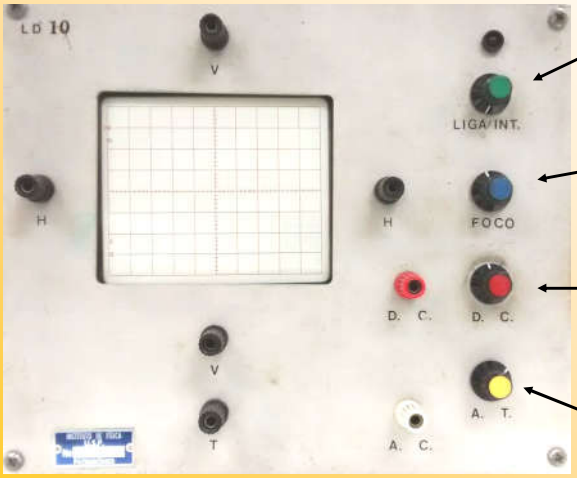
Movimento dos elétrons num TRC



O TRC didático



Controles



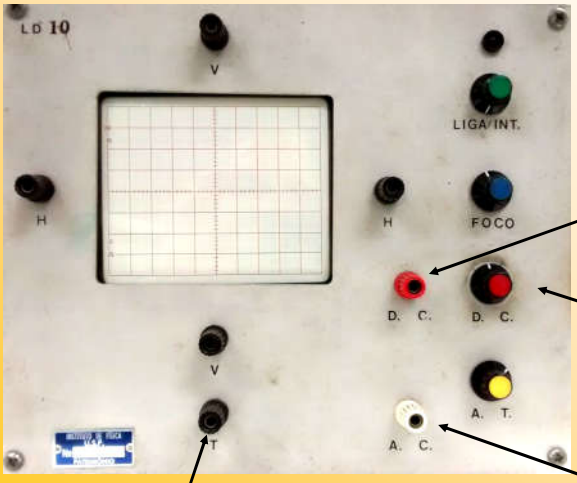
Liga/Desliga e Intensidade

Foco

Fonte DC variável

Controle de Alta Tensão

Fontes de tensão



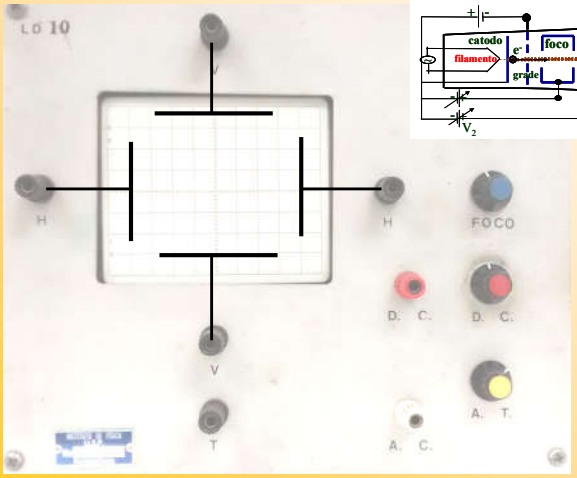
Terminal com tensão DC variável

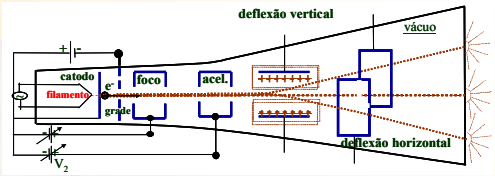
Fonte DC variável

Terminal com tensão alternada fixa

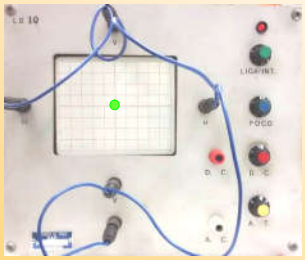
Terra (V=0)

Acesso às placas defletoras do TRC

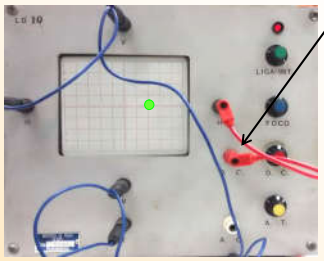




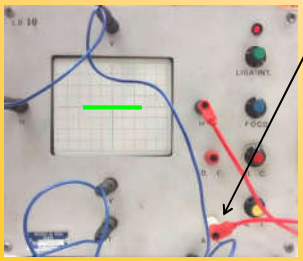
4 placas aterradas (V=0)



1 placa ligada na fonte DC
as outras aterradas

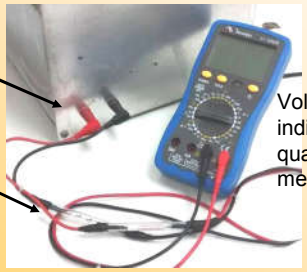


1 placa ligada na fonte AC
as outras aterradas



Monitor de
alta tensão

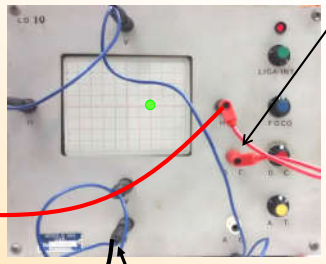
Divisor 10:1
para medir
alta tensão



Voltímetro
indica 80V
quando
mede 800V

Medindo tensão DC

1 placa ligada na fonte DC
as outras aterradas

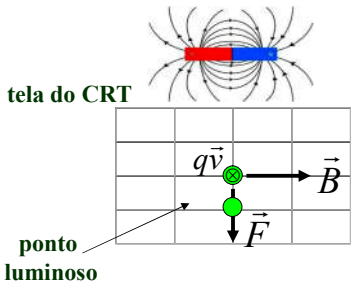


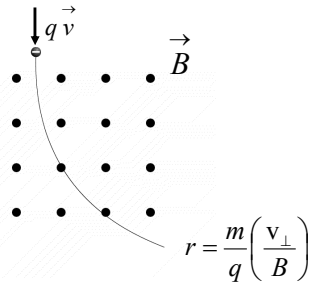
Terra (V=0)

EXPERIÊNCIA:

1. **Identificação de componentes, controles e terminais do TRC.**
2. **Identificação dos elementos do painel (terminal & controle).**
3. **Ligar o TRC, regular e centrar o ponto luminoso.**
4. **Interação do feixe eletrônico com o campo magnético de um imã.**
5. **Medir a sensibilidade do TRC (deflexão vertical).**
6. **Determinar a razão carga/massa do elétron (necessita de um campo magnético).**

Movimento de uma carga elétrica num campo magnético

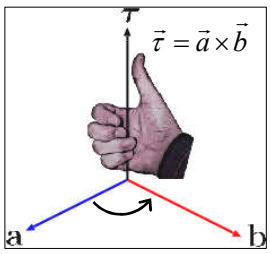


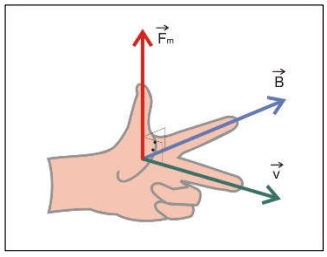


$$\vec{F} = q\vec{v} \times \vec{B}$$

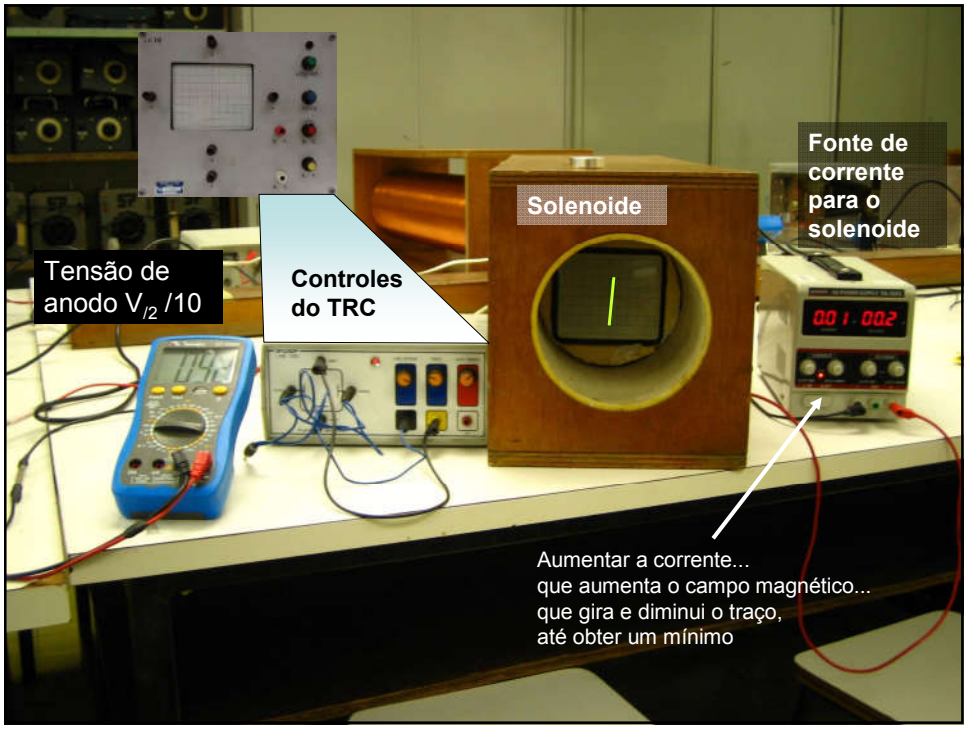
$$\vec{F} = -e\vec{v} \times \vec{B}$$

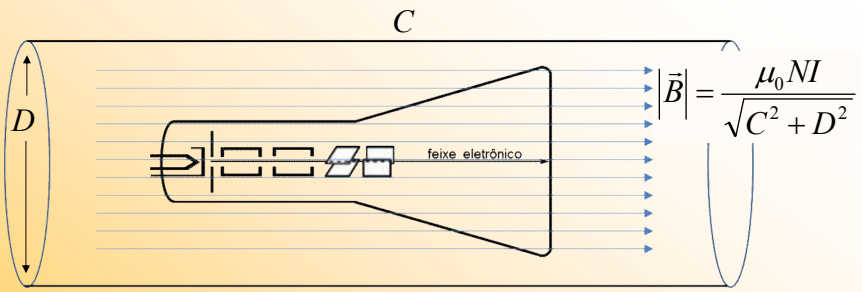
$q = -e$ (negativa)



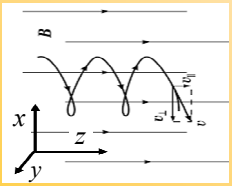


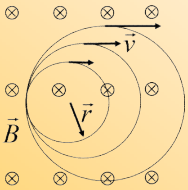
escolha a regra que mais te agradar





$$|\vec{B}| = \frac{\mu_0 NI}{\sqrt{C^2 + D^2}}$$





$$r = \frac{m}{q}\left(\frac{v_\perp}{B}\right)$$

$$T = \frac{m}{q}\left(\frac{2\pi}{B}\right)$$

$$V = V_0 \cos \omega t$$

$$v_{//} = \sqrt{\frac{2eV_2}{m}}$$

$$v_r = \frac{Ft}{m} = \frac{F}{m}\frac{\ell}{v_{//}} = \frac{1}{m}\frac{eV}{d}\frac{\ell}{v_{//}}$$

$$v_r = \frac{e}{m}\frac{V_0 \cos \omega t}{d}\ell\sqrt{\frac{m}{2eV_2}}$$

$$v_r = \sqrt{\frac{e}{m}}\frac{V_0 \ell}{d\sqrt{2V_2}}\cos \omega t$$

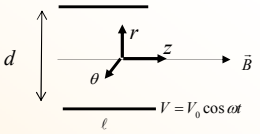
$$r = \frac{m}{q}\left(\frac{v_\perp}{B}\right)$$

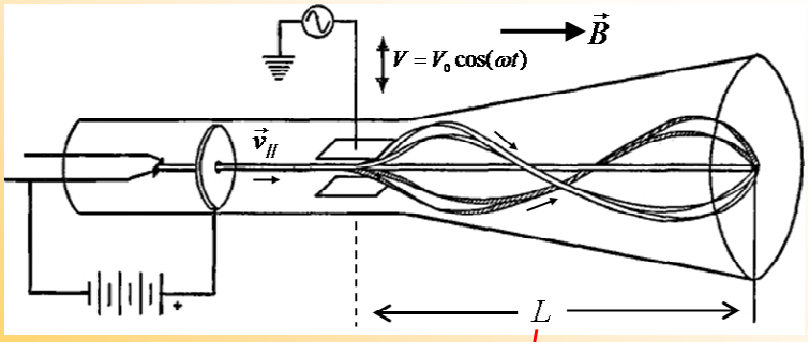
$$\left|\vec{B}\right| = \frac{\mu_0 NI}{\sqrt{C^2 + D^2}}$$

$$\vec{F} = q\vec{v} \times \vec{B} = m\ddot{\vec{v}}$$

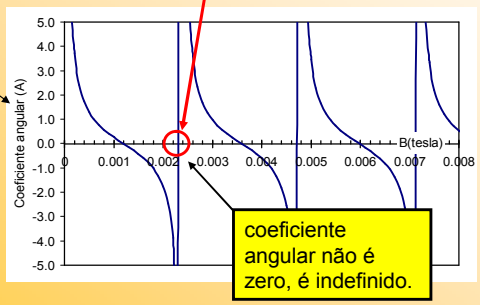
$$\vec{B} = 0\hat{r} + 0\hat{\theta} + B\hat{z}$$

$$\vec{v} = v_r\hat{r} + v_\perp\hat{\theta} + v_{//}\hat{z}$$





$$\frac{y}{x} = \frac{\left[\frac{mv_\perp}{eB}\mathrm{sen}\left(\frac{eBz}{mv_{//}}\right)\right]}{\frac{mv_\perp}{eB}\left[\cos\left(\frac{eBz}{mv_{//}}\right) - 1\right]} = \frac{\left[\mathrm{sen}\left(\frac{eBz}{mv_{//}}\right)\right]}{\left[\cos\left(\frac{eBz}{mv_{//}}\right) - 1\right]} = A$$



coeficiente angular não é zero, é indefinido.

$$\frac{e}{m} = \frac{8\pi^2 V_2}{L^2 B^2}$$

Quadro 2.1. RESUMO DE FÓRMULAS PARA PROPAGAÇÃO DE INCERTEZAS

w = w (x, y, ...)	Expressões para σ_w
w = x ± y **soma e subtração**	$\sigma_w^2 = \sigma_x^2 + \sigma_y^2$
w = axy **multiplicação**	$\left(\frac{\sigma_w}{w}\right)^2 = \left(\frac{\sigma_x}{x}\right)^2 + \left(\frac{\sigma_y}{y}\right)^2$
w = a (y / x) **divisão**	$\left(\frac{\sigma_w}{w}\right)^2 = \left(\frac{\sigma_x}{x}\right)^2 + \left(\frac{\sigma_y}{y}\right)^2$
w = x^m **potência simples**	$\left\|\frac{\sigma_w}{w}\right\| = \left\|m\frac{\sigma_x}{x}\right\|$
w = ax **multiplicação por constante**	$\left\|\frac{\sigma_w}{w}\right\| = \left\|\frac{\sigma_x}{x}\right\|$ **ou** $\sigma_w = \|a\|\sigma_x$