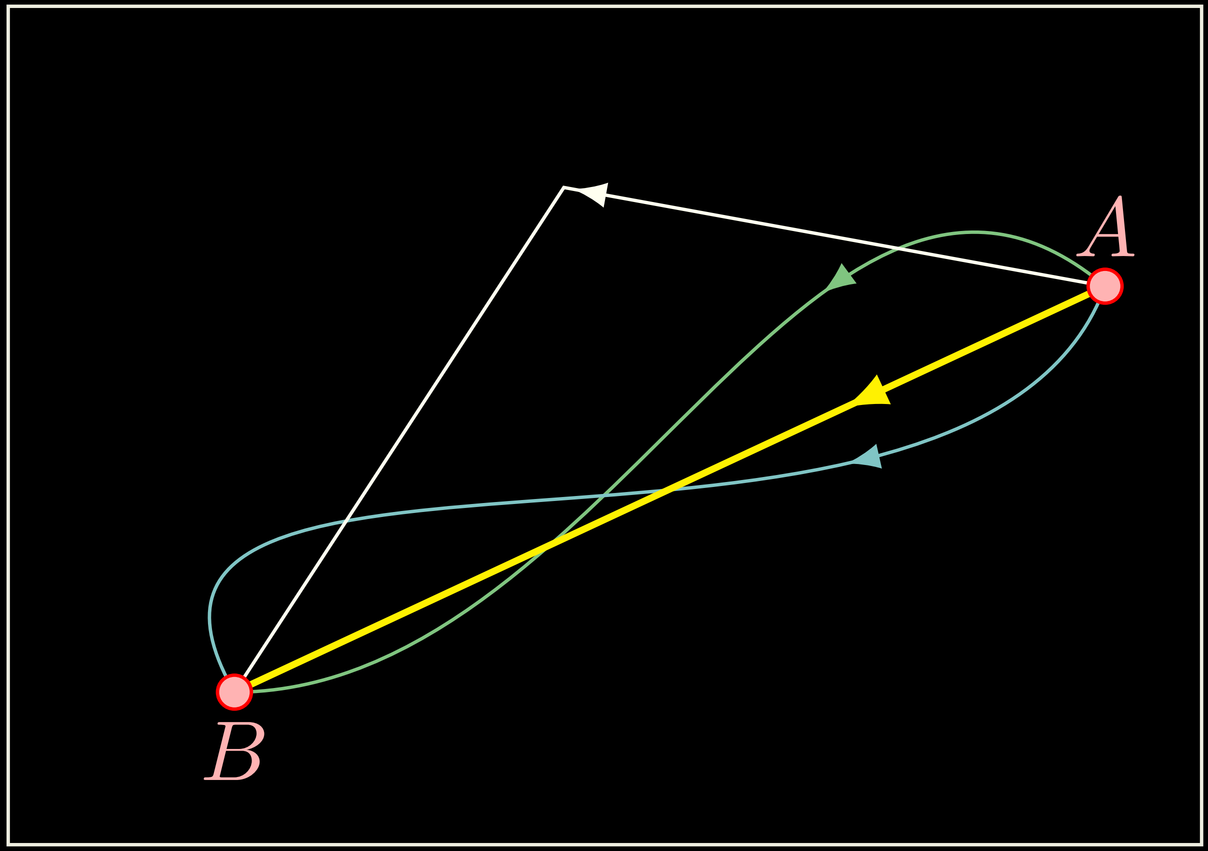
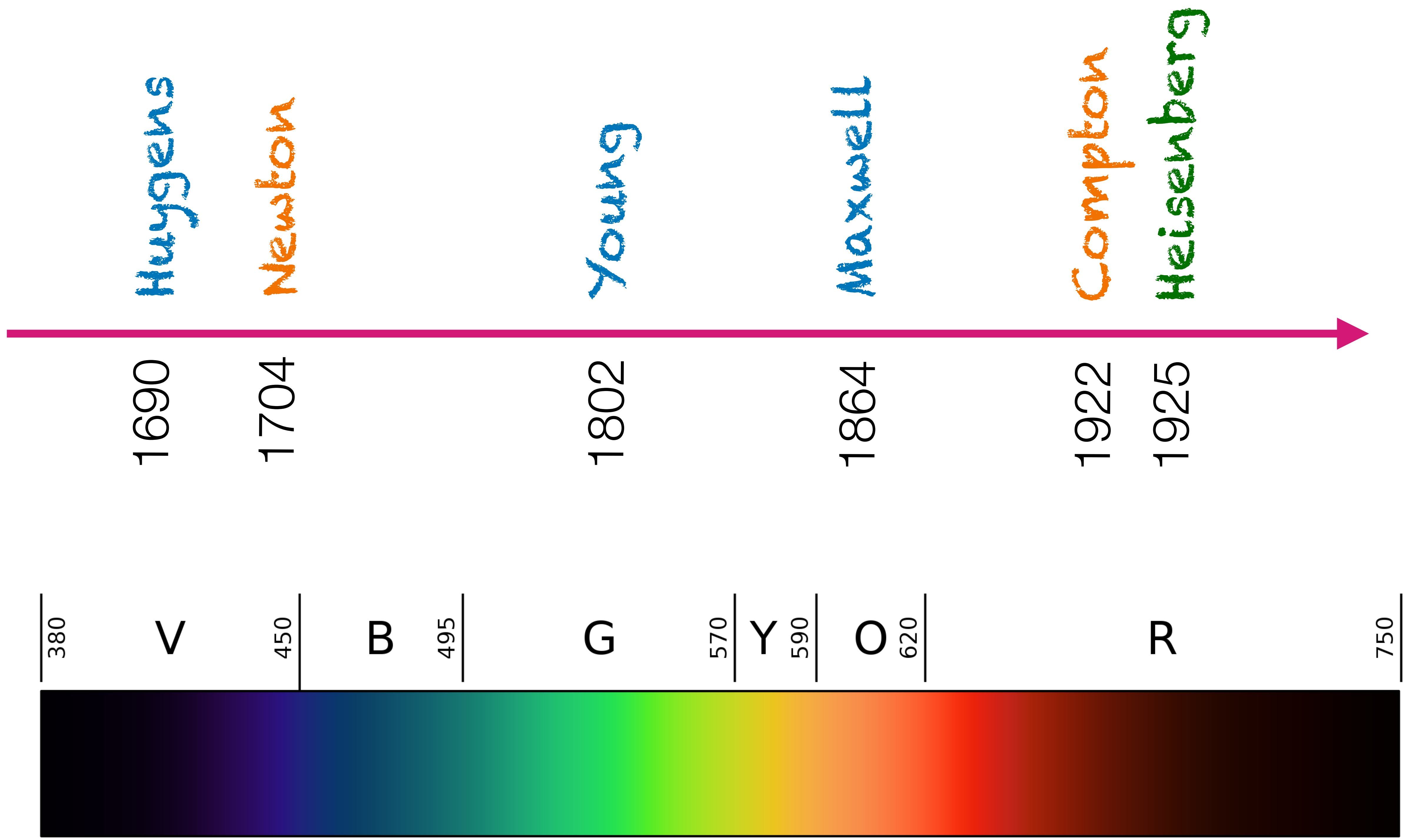


Física IV

19 outubro 2020

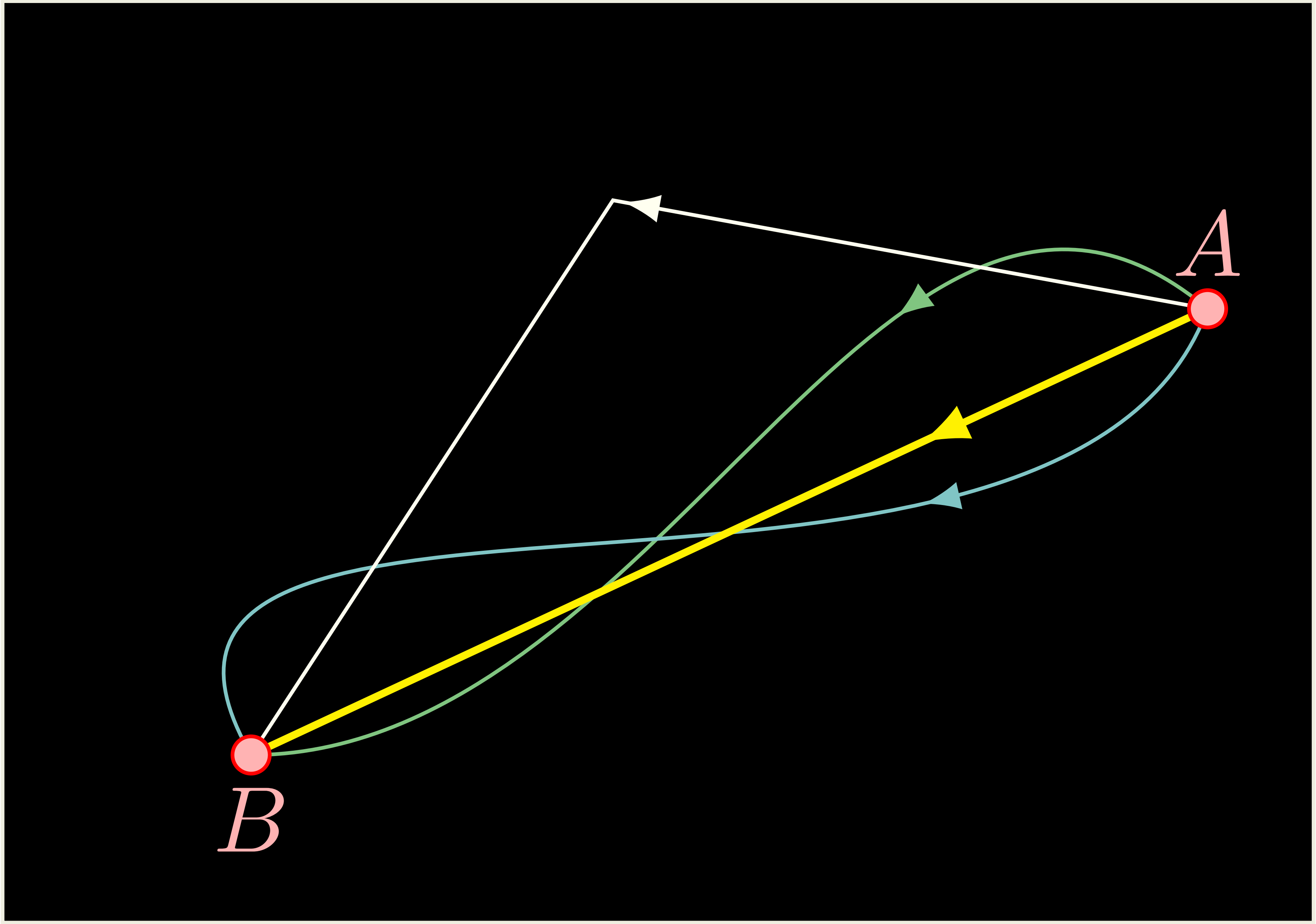
Ótica geométrica

Luz



Huygens
Newton
Young
Maxwell
Compton
Heisenberg
1690
1704
1802
1864
1922
1925
380
V
450
B
495
G
570
Y
590
O
620
R
750

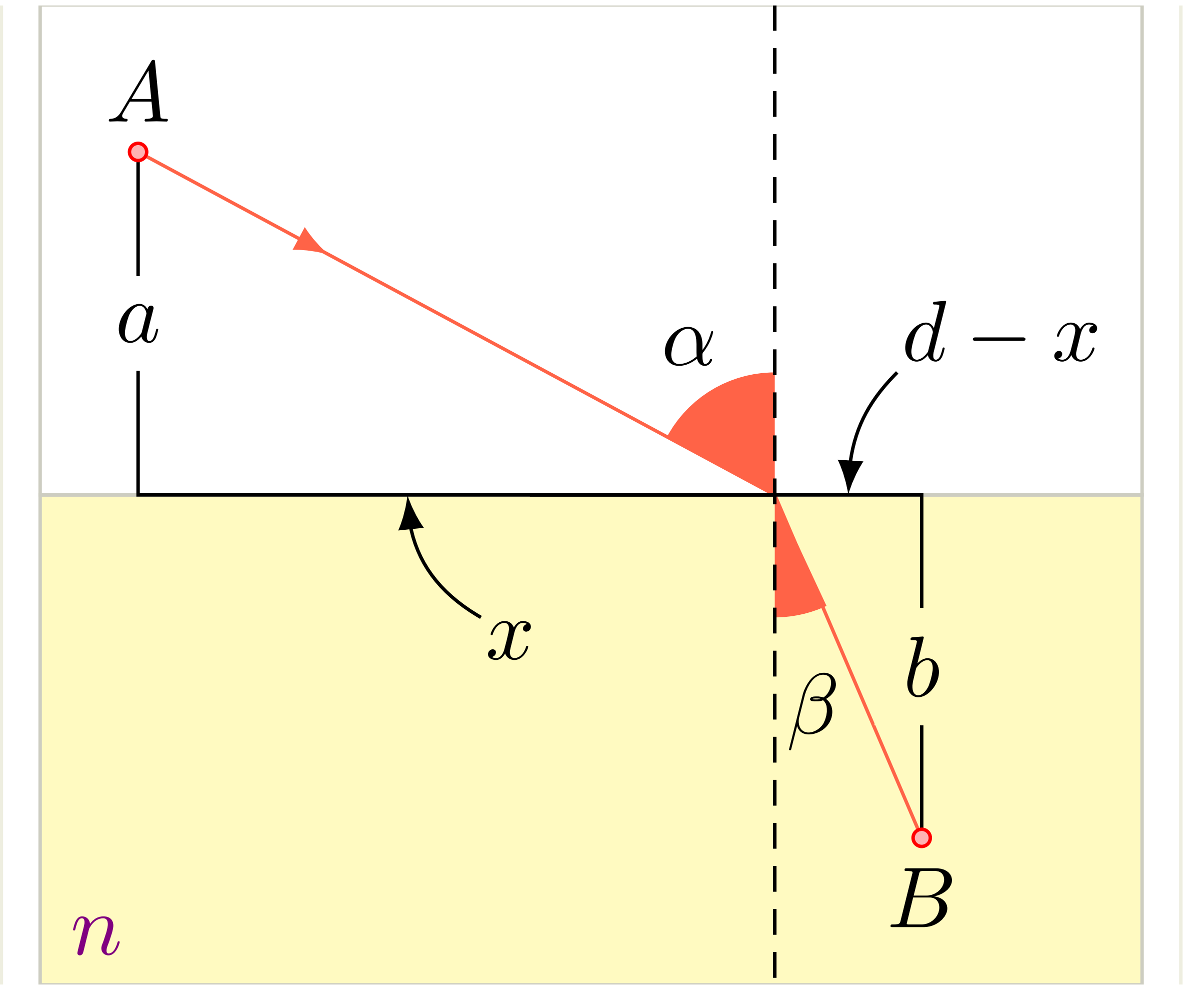
Princípio de Fermat



Minimiza o tempo

Princípio de Fermat

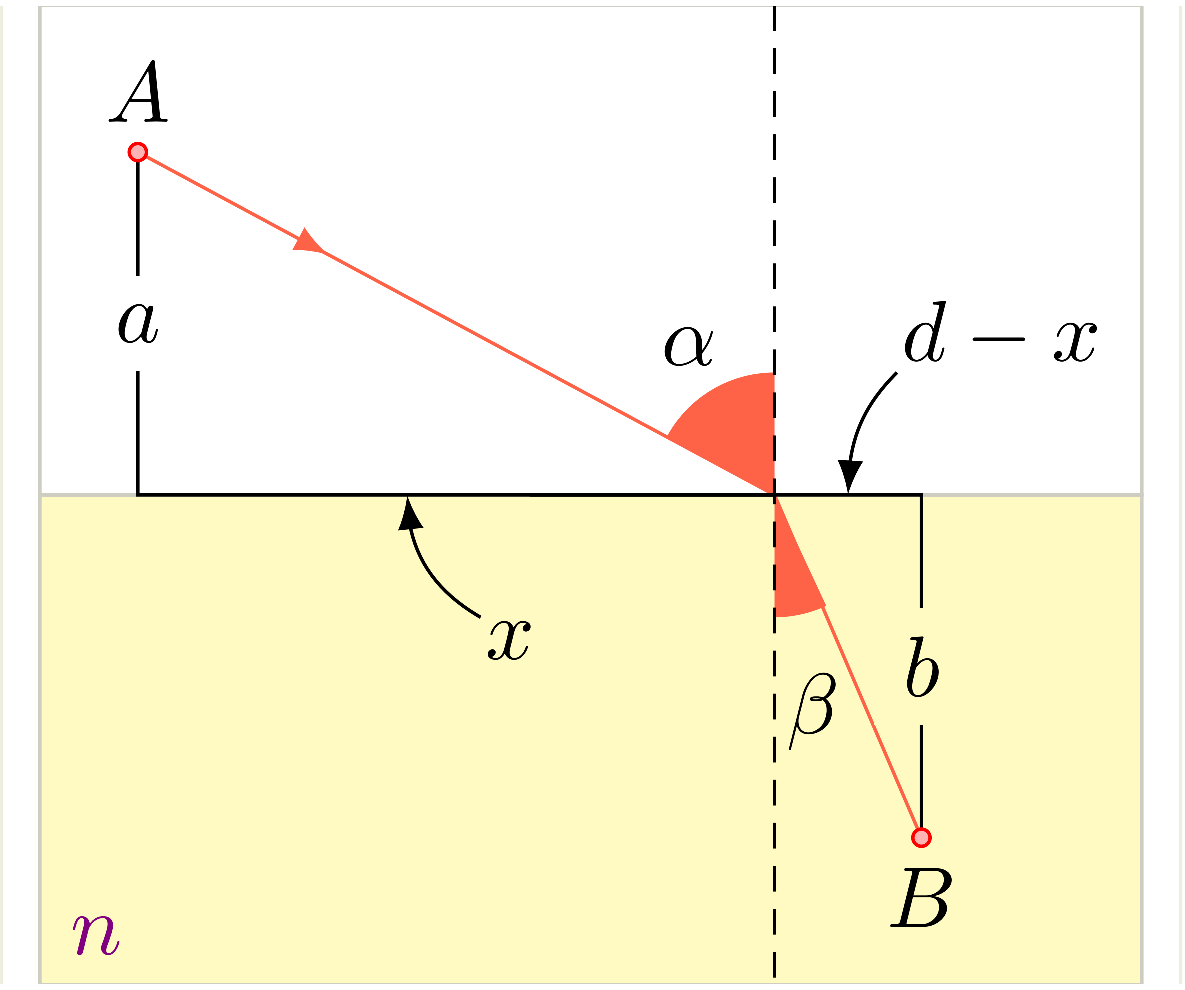
Refração



Princípio de Fermat

Refração

$$\Delta t_A = \frac{\sqrt{a^2 + x^2}}{c}$$

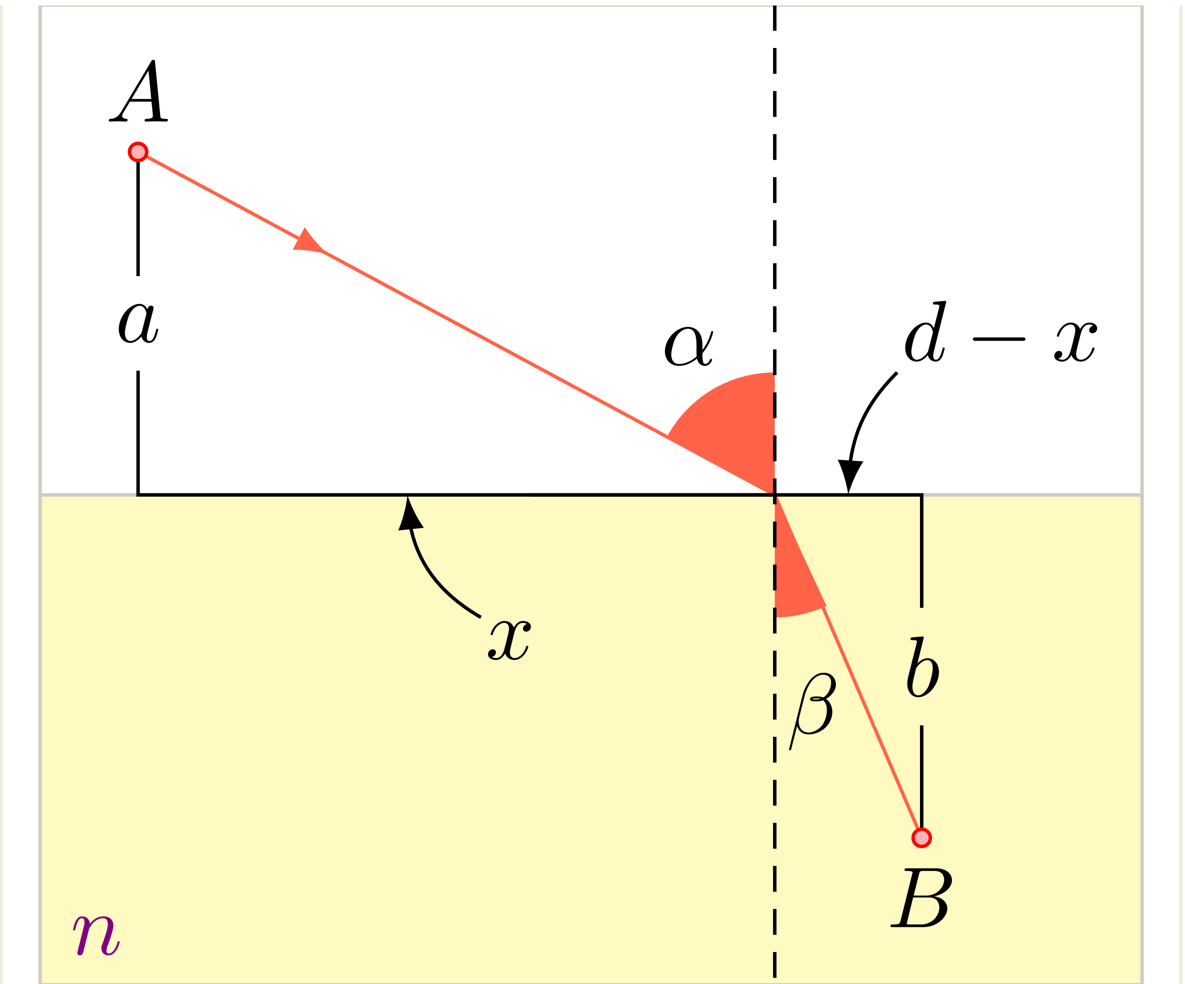


Princípio de Fermat

Refração

$$\Delta t_A = \frac{\sqrt{a^2 + x^2}}{c}$$

$$\Delta t_B = \frac{n\sqrt{b^2 + (d-x)^2}}{c}$$



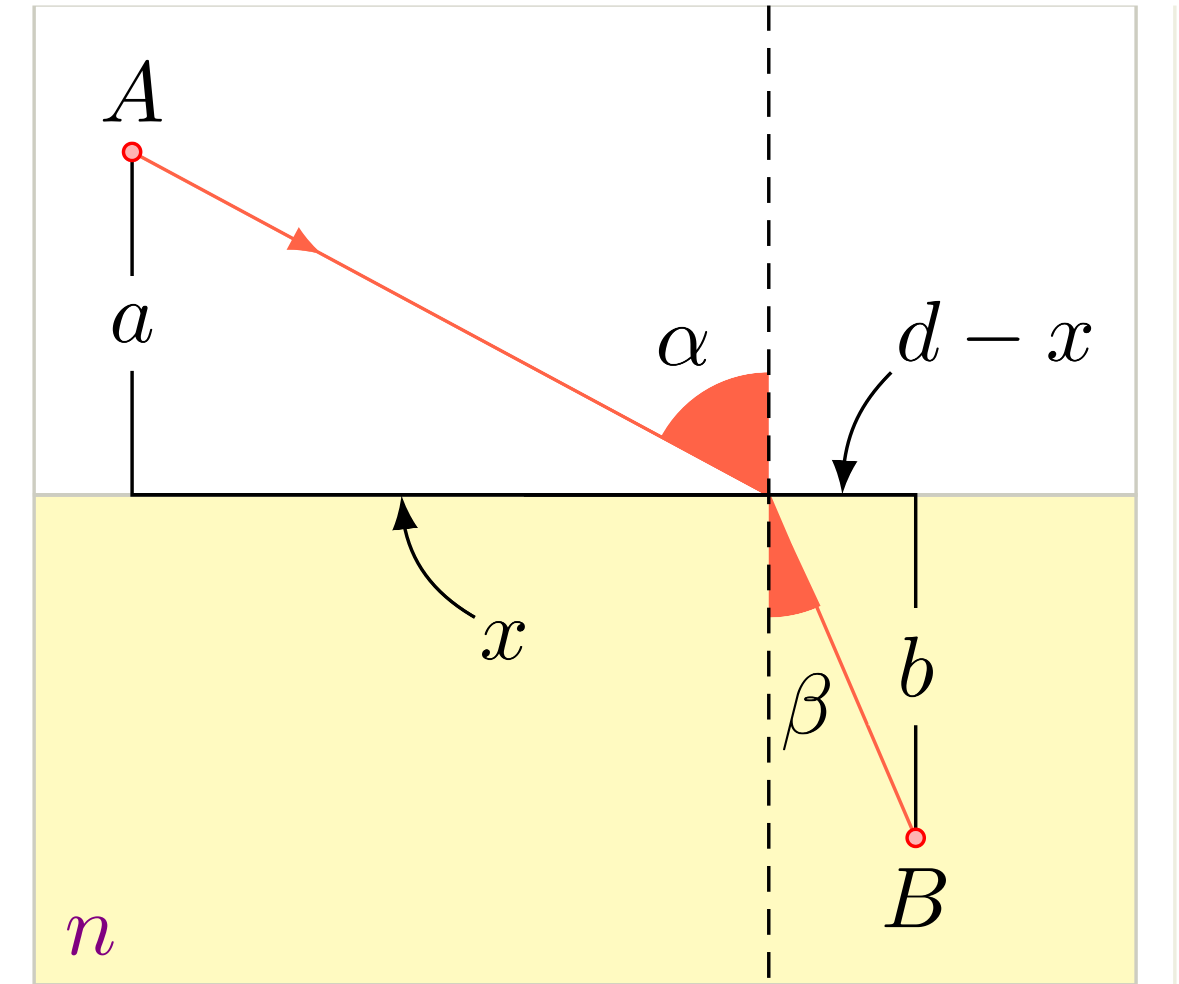
Princípio de Fermat

Refração

$$\Delta t_A = \frac{\sqrt{a^2 + x^2}}{c}$$

$$\Delta t_B = \frac{c}{n\sqrt{b^2 + (d - x)^2}}$$

$$\Delta t = \Delta t_A + \Delta t_B$$



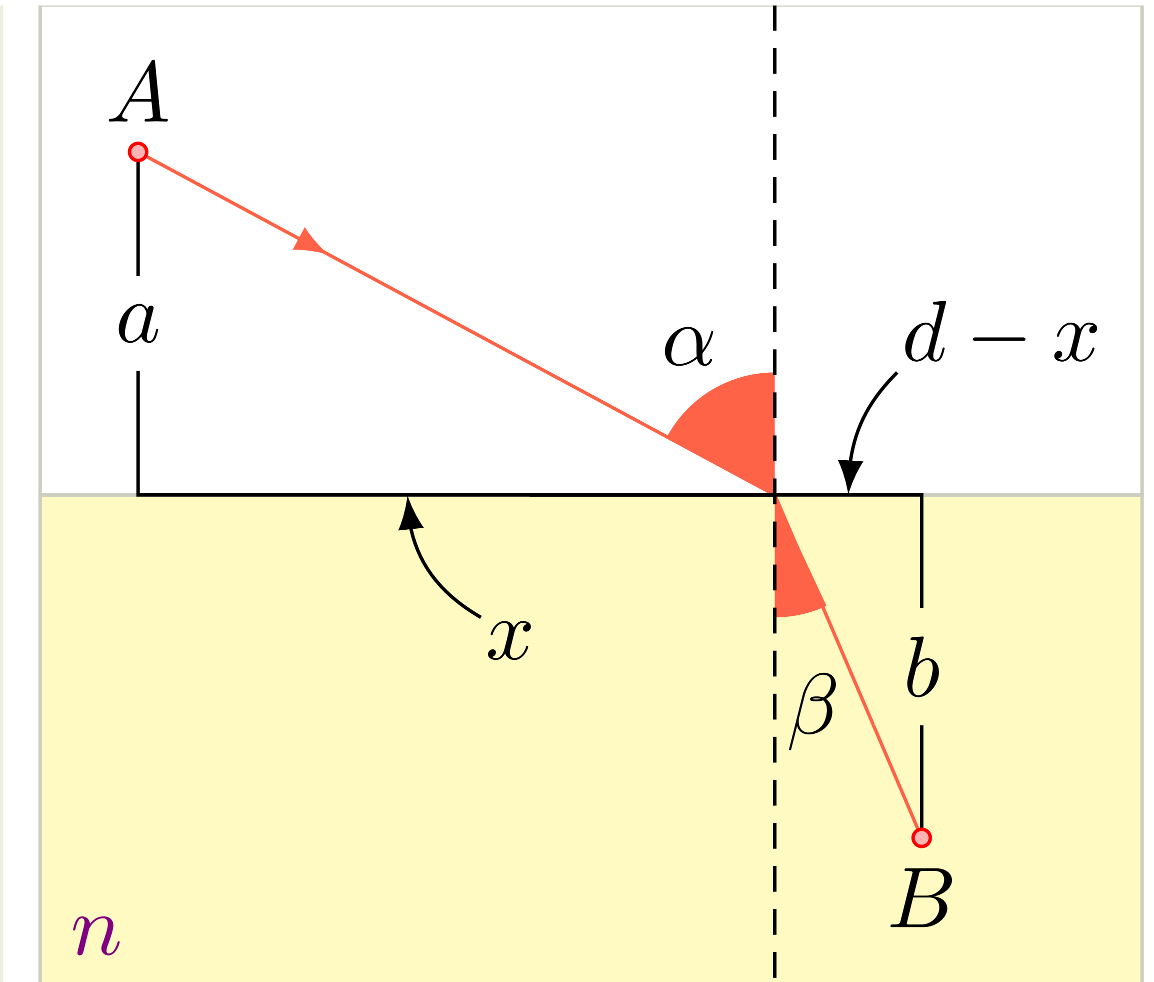
Princípio de Fermat

Refração

$$\Delta t_A = \frac{\sqrt{a^2 + x^2}}{c}$$

$$\Delta t_B = \frac{n\sqrt{b^2 + (d-x)^2}}{c}$$

$$\Delta t = \Delta t_A + \Delta t_B$$



$$\frac{d\Delta t}{dx} = 2c\left(\frac{x}{\sqrt{a^2 + x^2}} - n\frac{d-x}{\sqrt{b^2 + (d-x)^2}}\right)$$

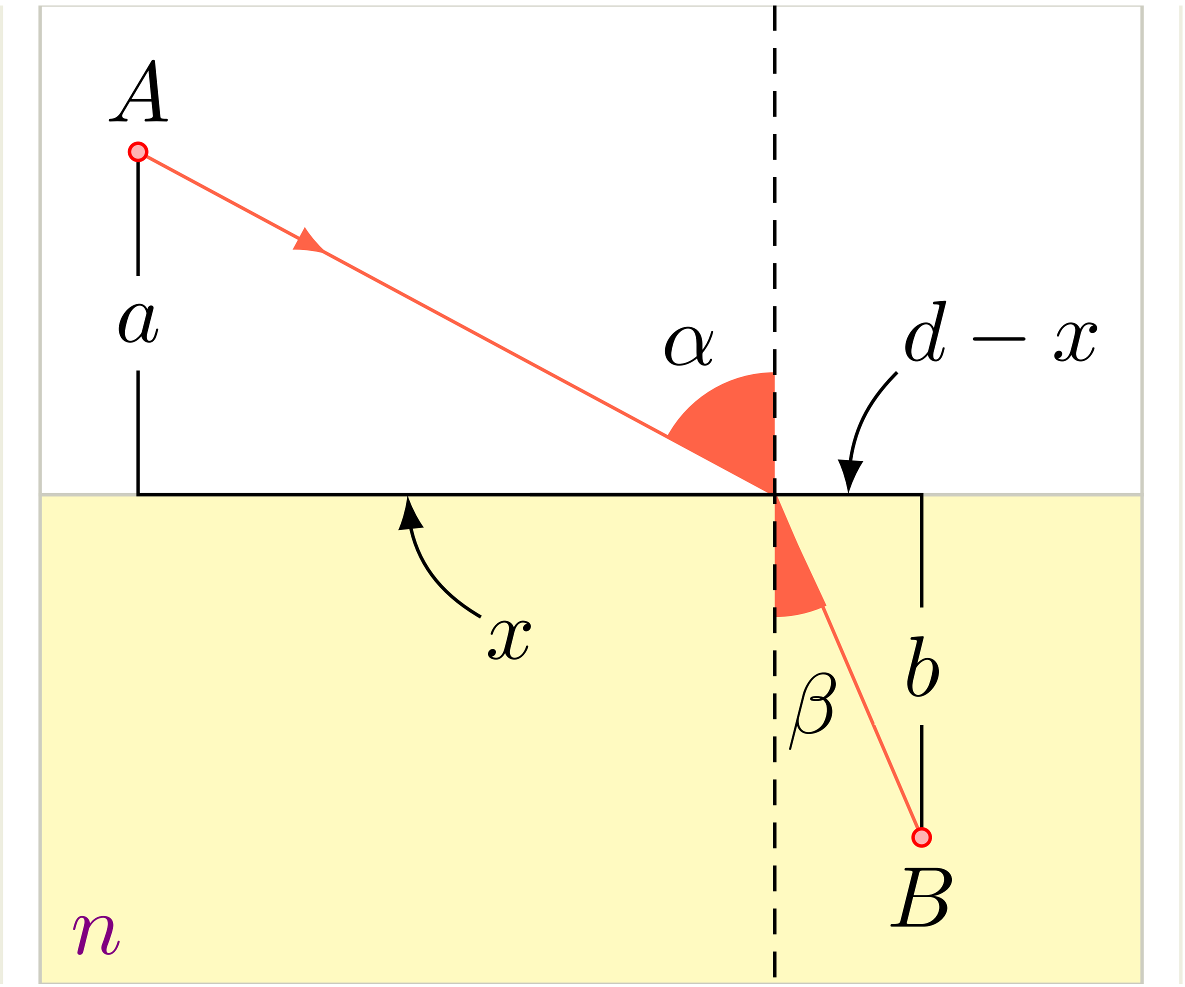
Princípio de Fermat

Refração

$$\Delta t_A = \frac{\sqrt{a^2 + x^2}}{c}$$

$$\Delta t_B = \frac{n\sqrt{b^2 + (d-x)^2}}{c}$$

$$\Delta t = \Delta t_A + \Delta t_B$$

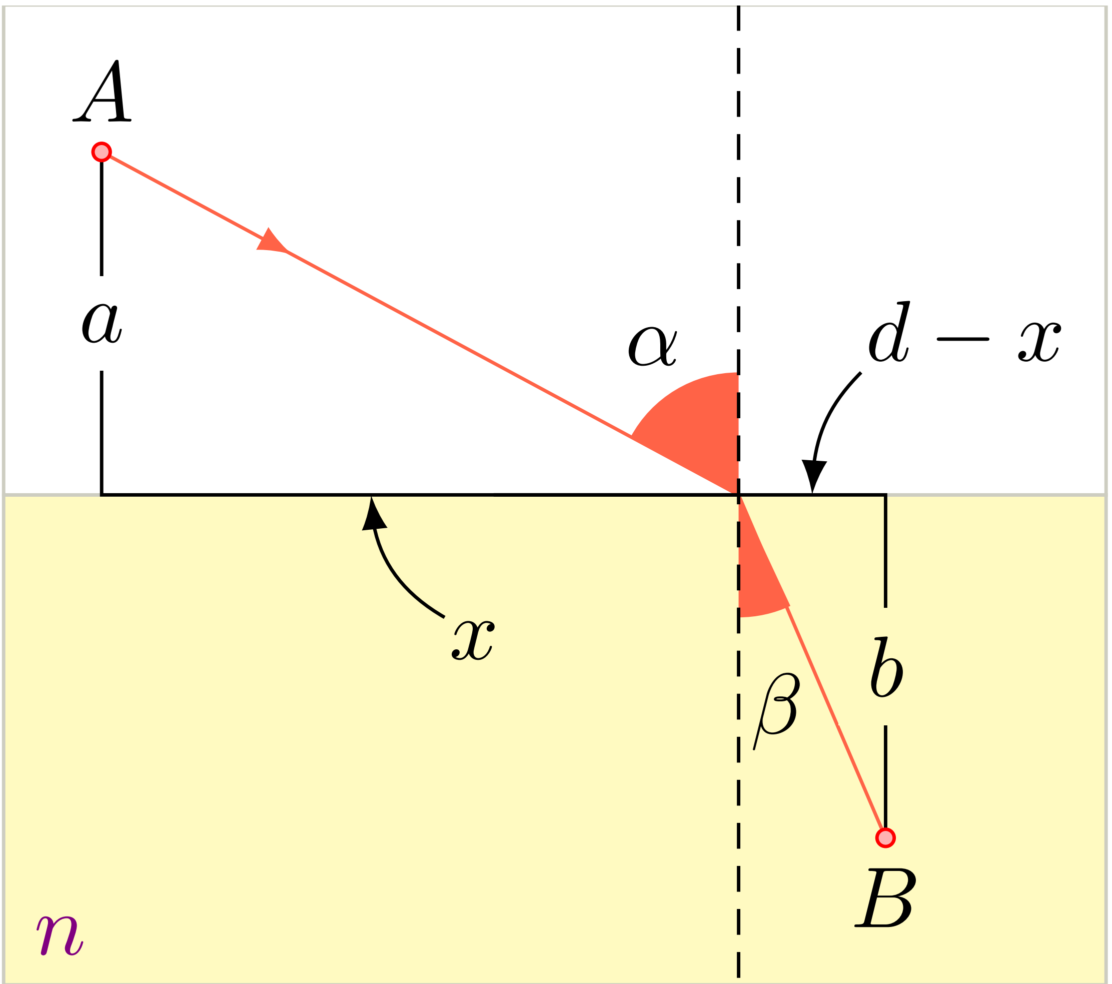


$$\frac{d\Delta t}{dx} = c\left(\frac{x}{\sqrt{a^2 + x^2}} - n\frac{(d-x)}{\sqrt{b^2 + (d-x)^2}}\right) = 0$$

Princípio de Fermat

Refração

$$\frac{x}{\sqrt{a^2+x^2}} = n\frac{d-x}{\sqrt{b^2+(d-x)^2}}$$



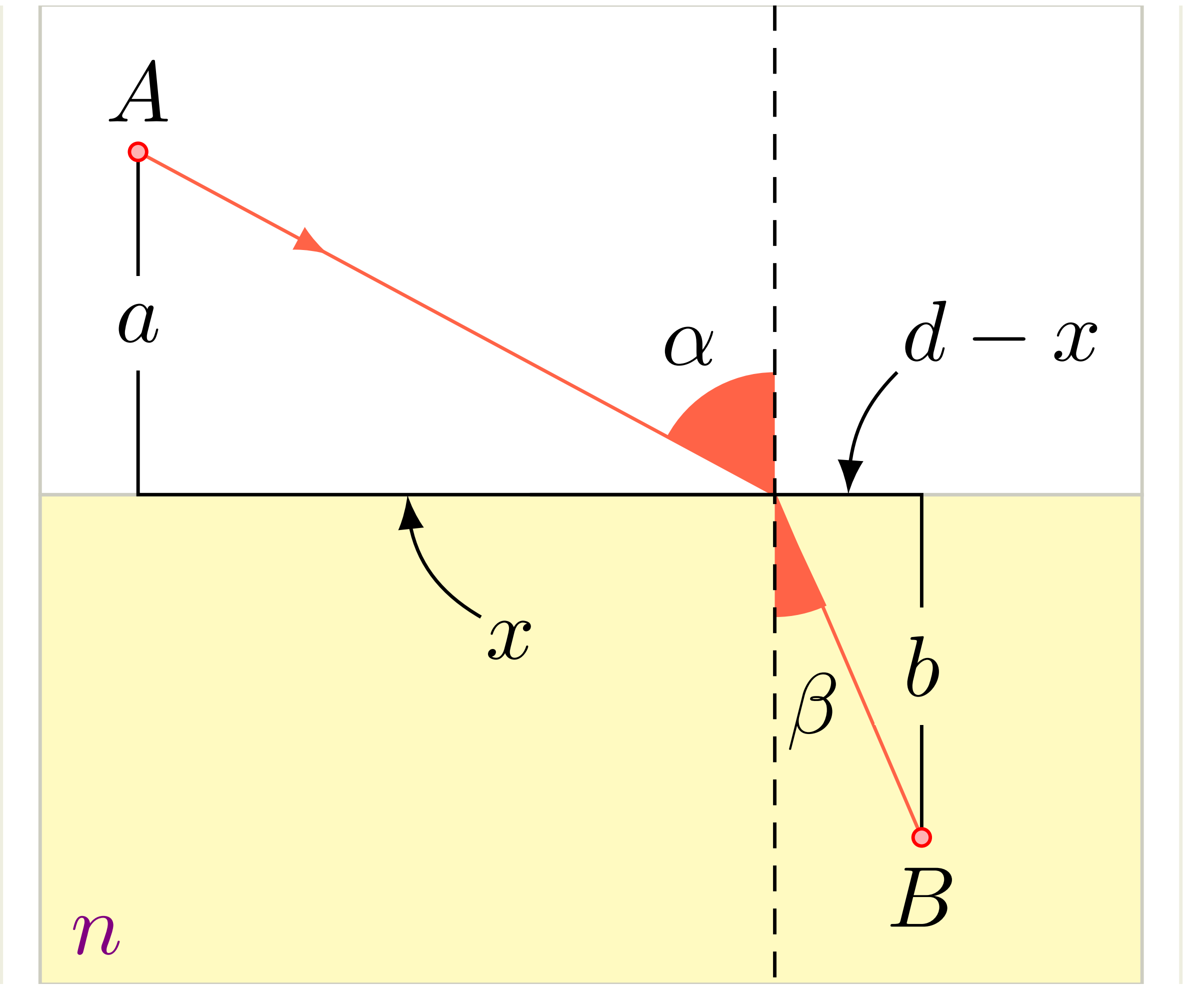
$$\frac{d\Delta t}{dx} = 2c\left(\frac{x}{\sqrt{a^2+x^2}} - n\frac{d-x}{\sqrt{b^2+(d-x)^2}}\right) = 0$$

Princípio de Fermat

Refração

$$\frac{x}{\sqrt{a^2 + x^2}} = n\frac{d - x}{\sqrt{b^2 + (d - x)^2}}$$

$$\sin\alpha = n\sin(\beta)$$



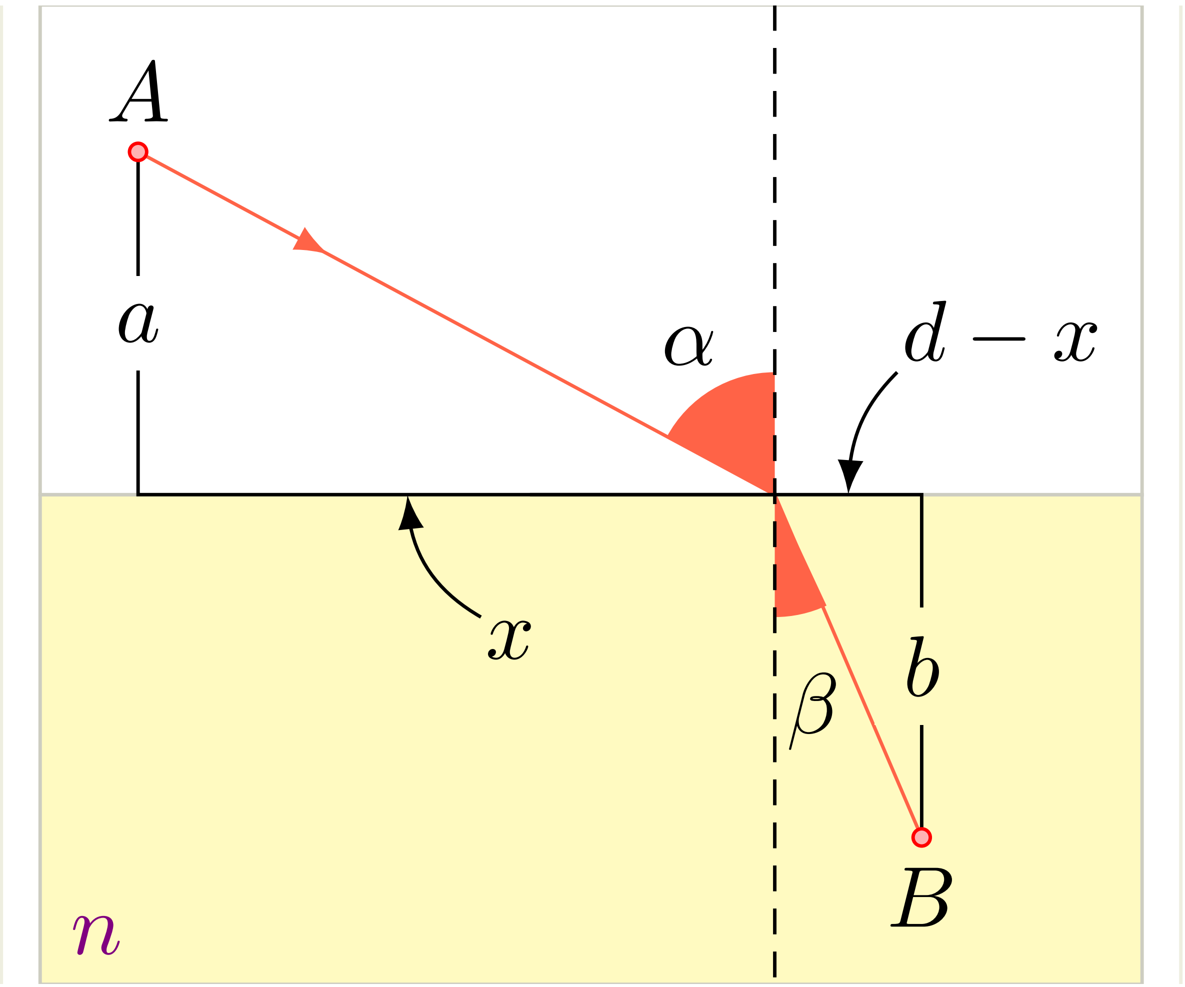
Princípio de Fermat

Refração

$$\frac{x}{\sqrt{a^2 + x^2}} = n \frac{d - x}{\sqrt{b^2 + (d - x)^2}}$$

$$\sin \alpha = n \sin(\beta)$$

Snell-Descartes



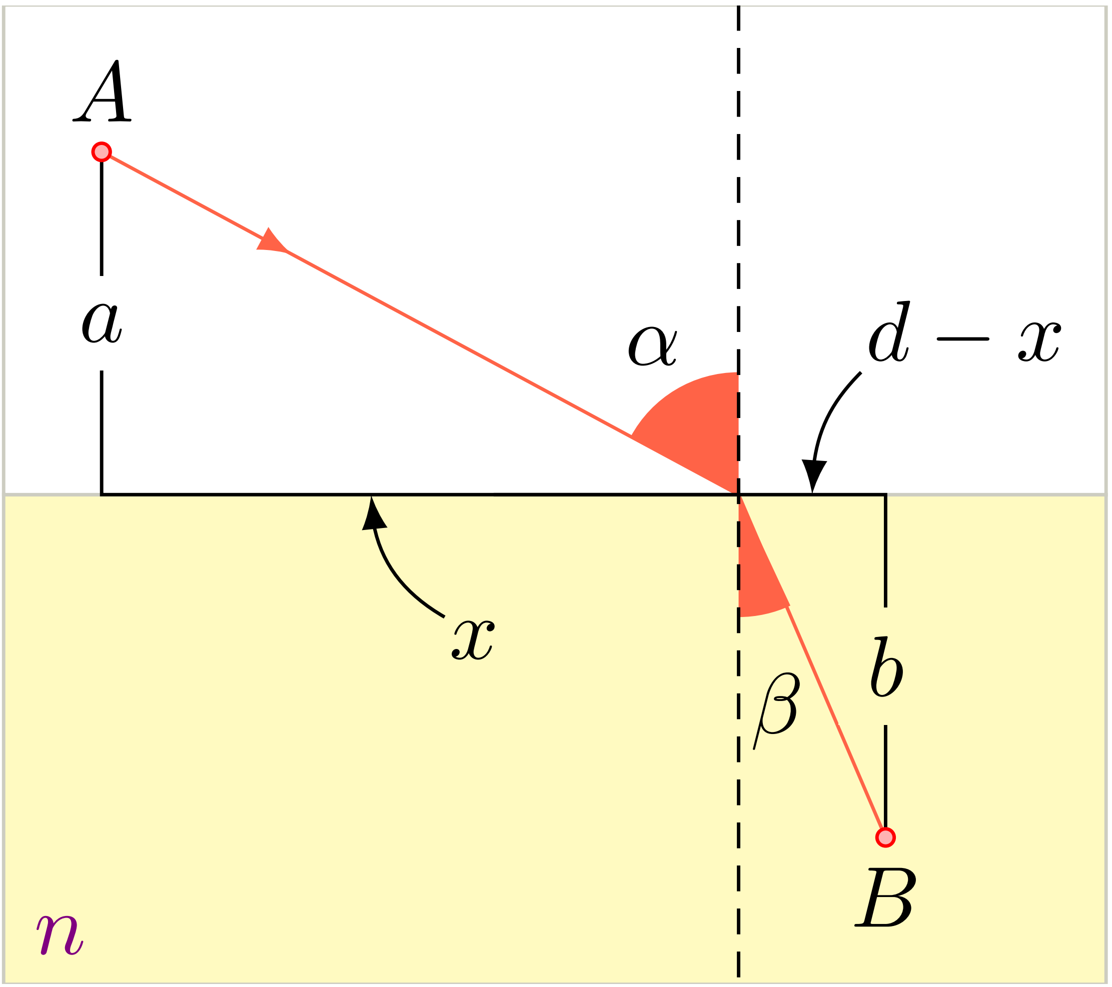
Princípio de Fermat

Refração

$$\Delta t_A = \frac{c}{\sqrt{a^2 + x^2}}$$

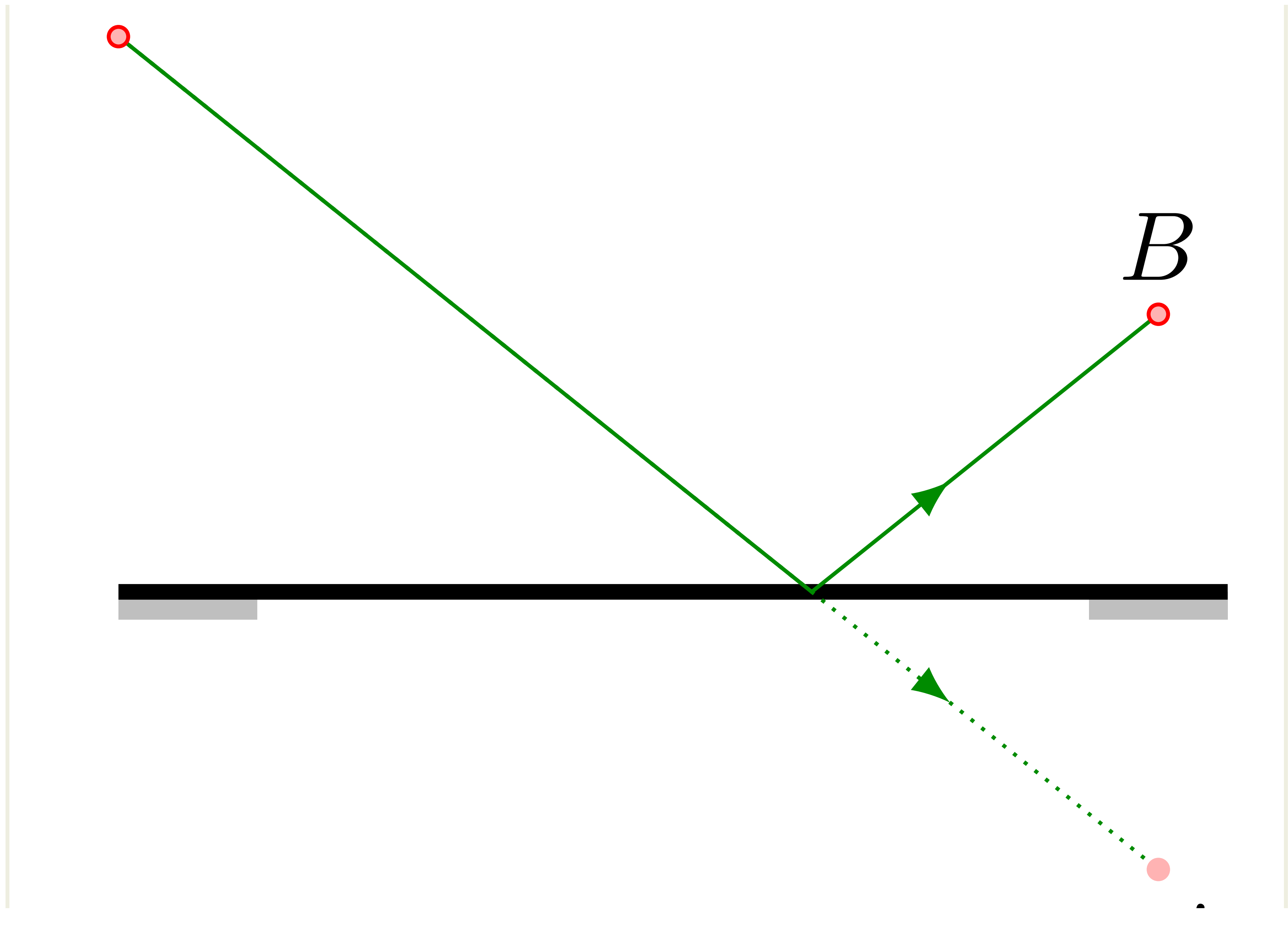
$$\Delta t_B = \frac{c}{n\sqrt{b^2 + (d-x)^2}}$$

$$\Delta t = \Delta t_A + \Delta t_B$$

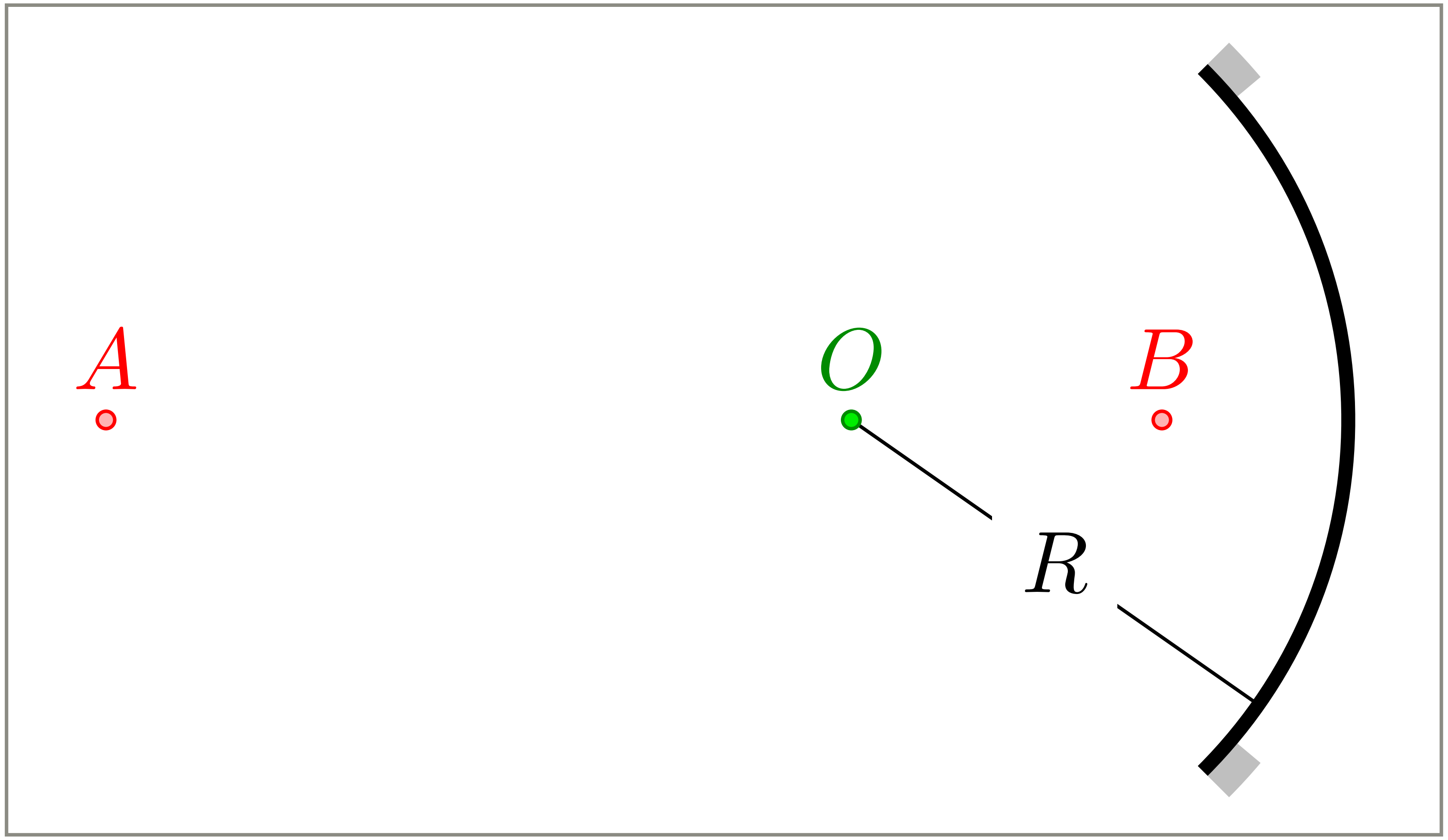


$$\frac{d\Delta t}{x} = 2c\left(\frac{x}{\sqrt{a^2 + x^2}} - \frac{d-x}{n\sqrt{b^2 + (d-x)^2}}\right) = 0$$

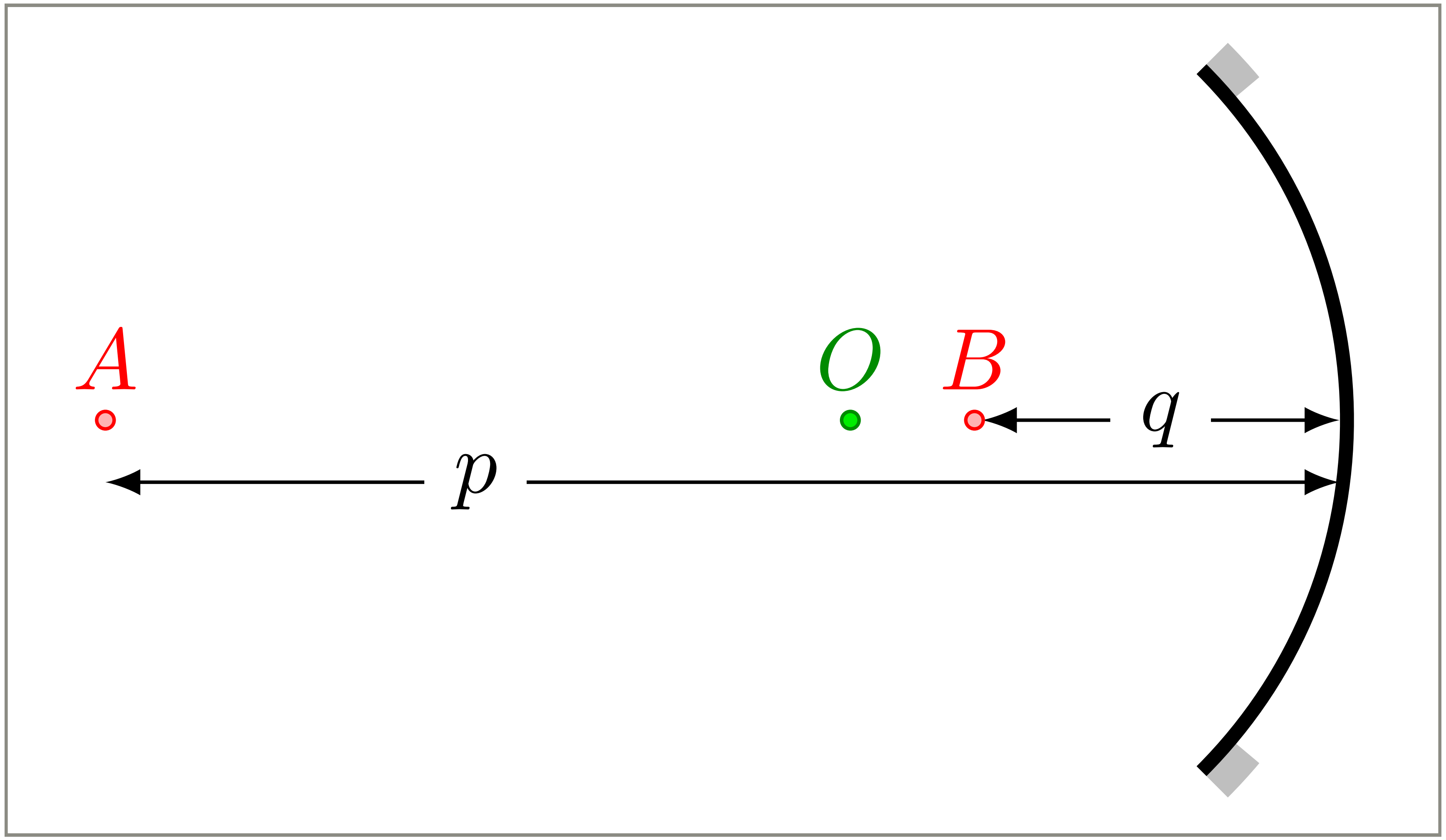
Princípio de Fermat
Espelho plano



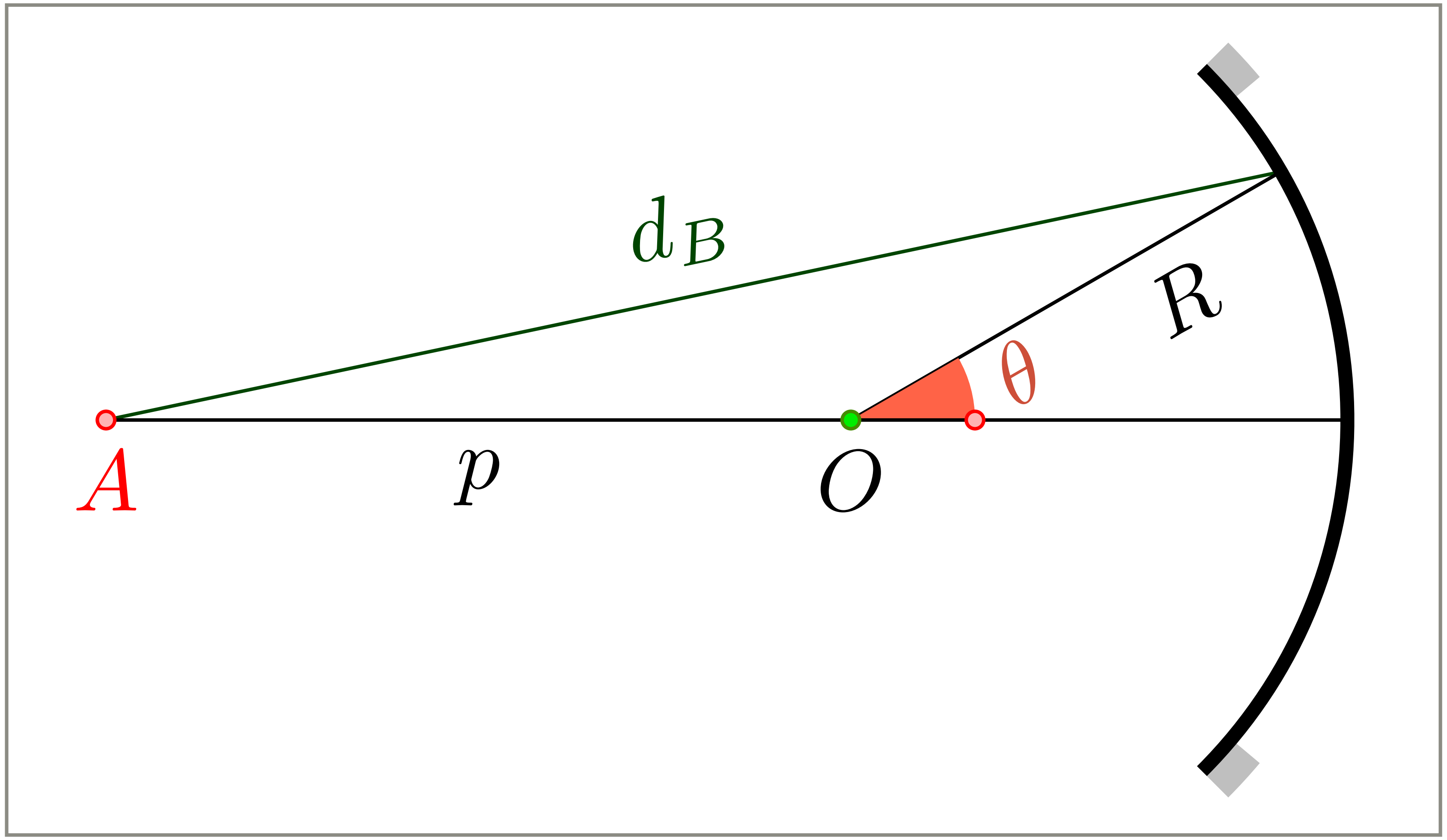
Princípio de Fermat
Espelho esférico



Princípio de Fermat
Espelho esférico

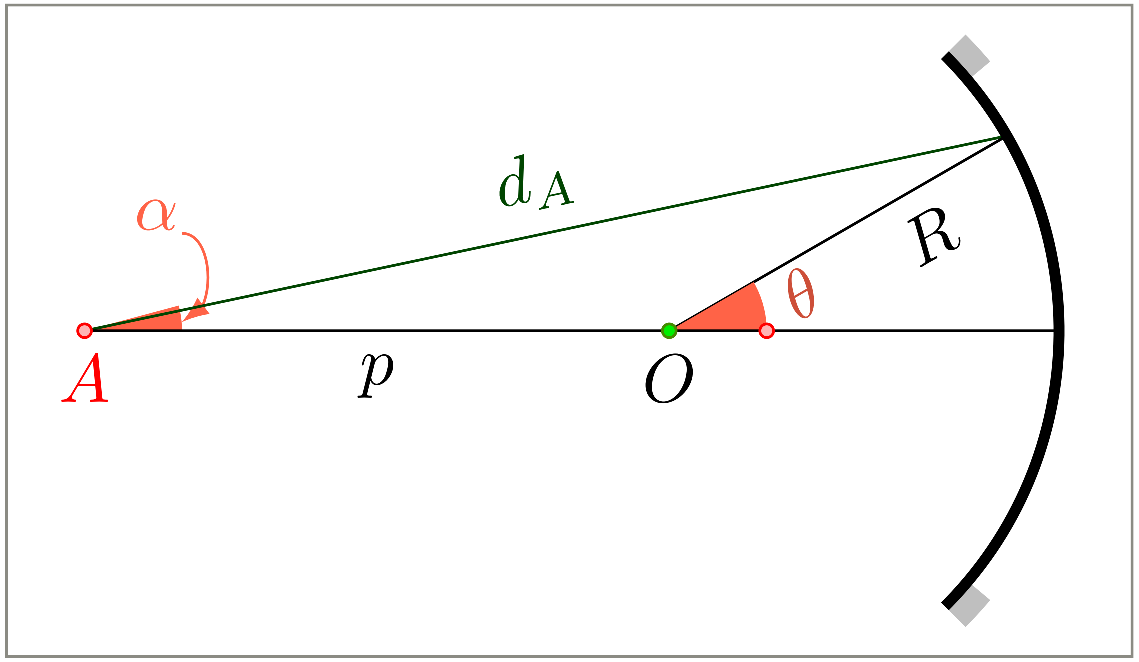


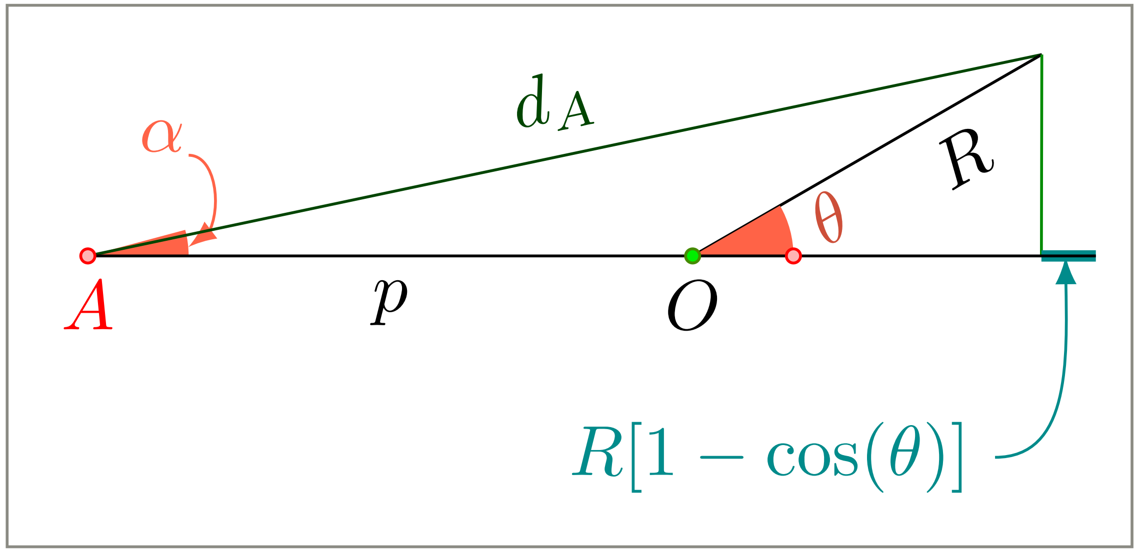
Princípio de Fermat
Espelho esférico



Princípio de Fermat
Espelho esférico

$$d_B^2 = R^2 \sin^2\theta + \Big(p - R(1 - \cos\theta)\Big)^2$$

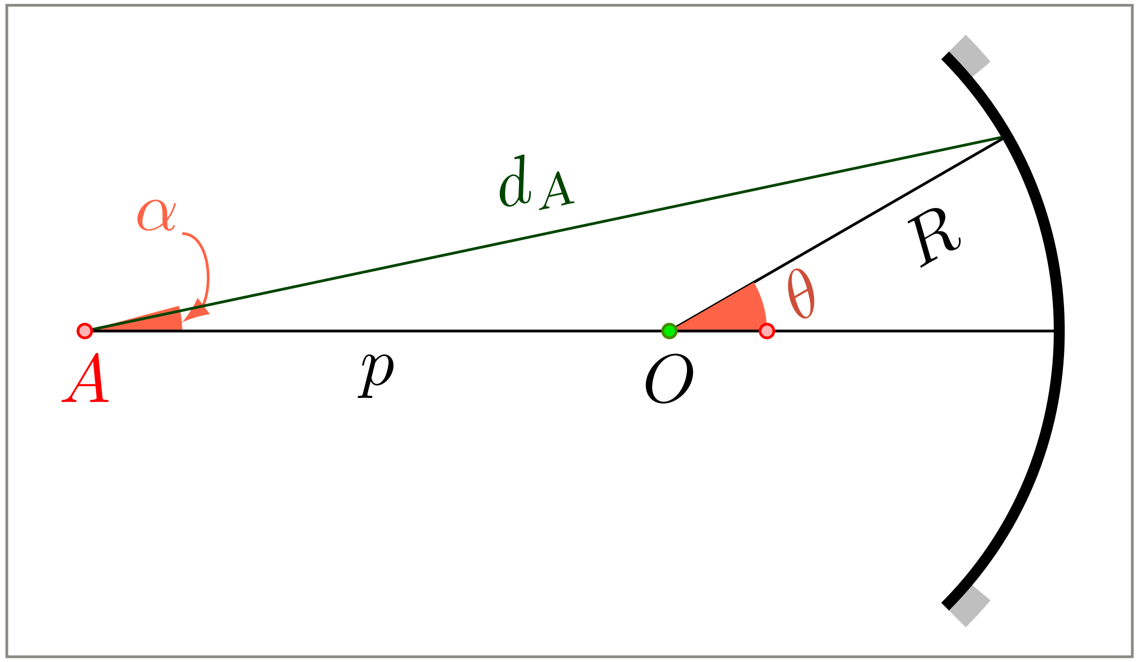


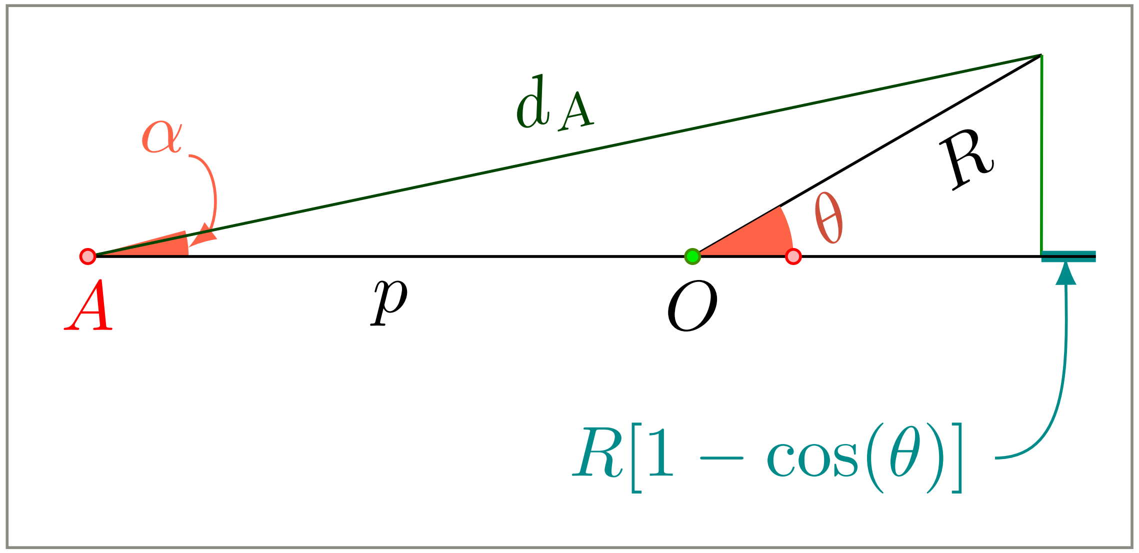


Princípio de Fermat
Espelho esférico

$$d_B^2 = R^2 \sin^2\theta + \left(p - R(1 - \cos\theta)\right)^2$$

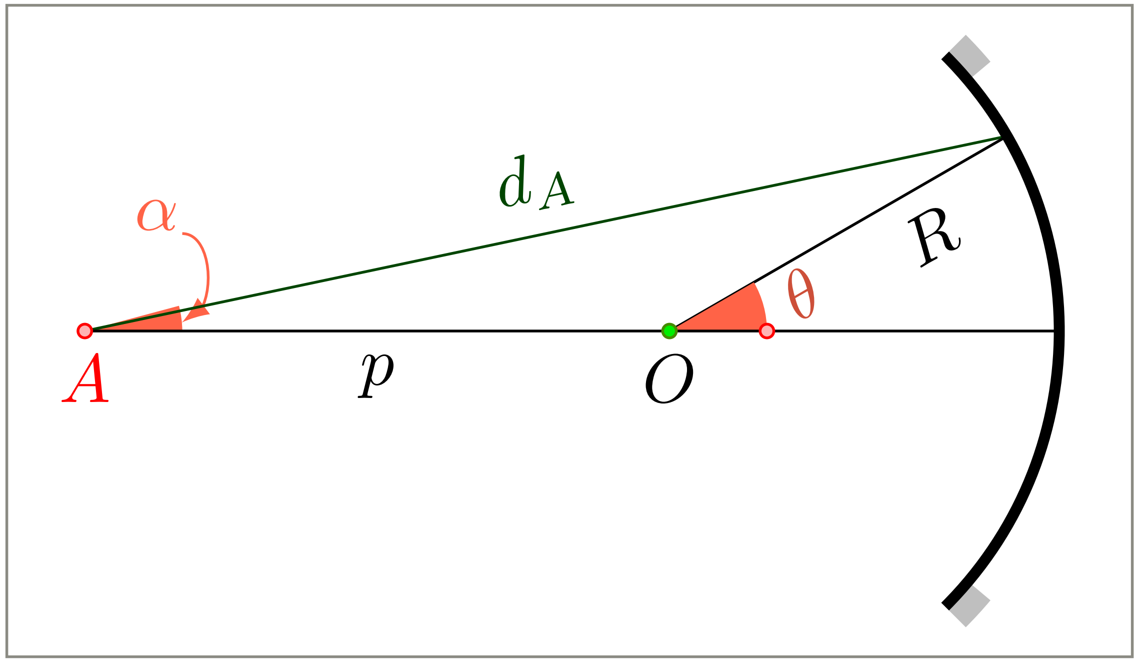
$$\Delta t_B = \frac{d_B}{c}$$





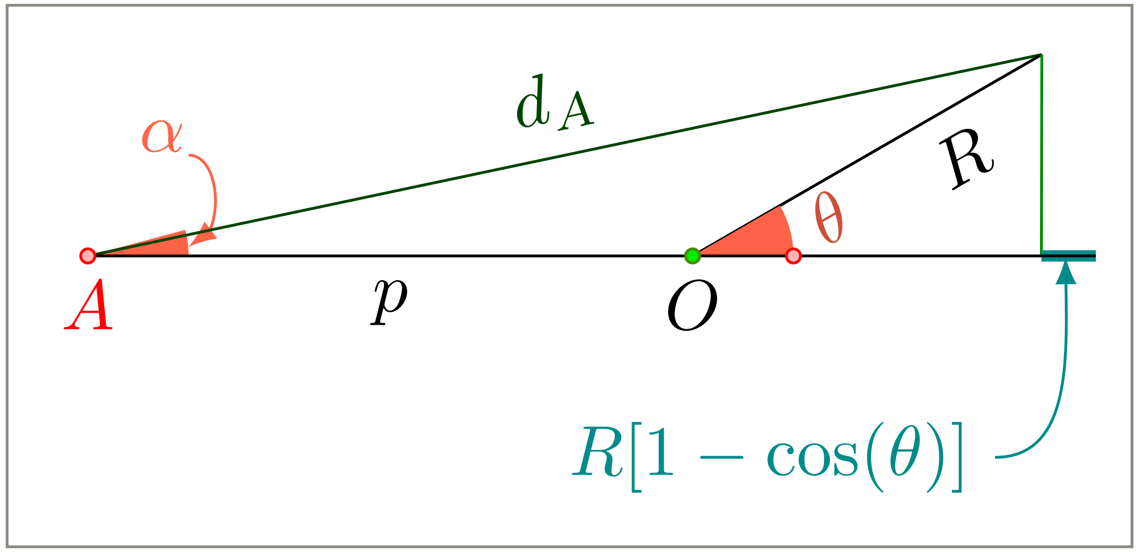
Princípio de Fermat
Espelho esférico

$$d_B^2 = R^2 \sin^2\theta + \left(p - R(1-\cos\theta)\right)^2$$



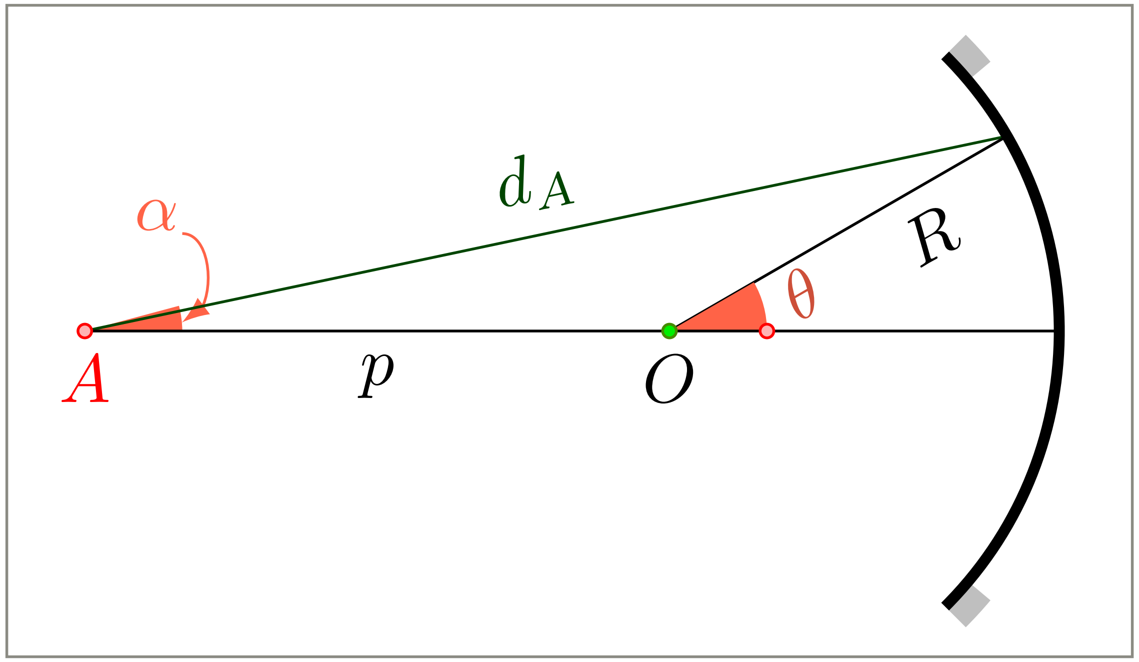
$$\Delta t_B = \frac{d_B}{c}$$

$$\frac{d\Delta t_B}{d\theta} = \frac{-2R(p-R)\sin\theta}{cp}$$



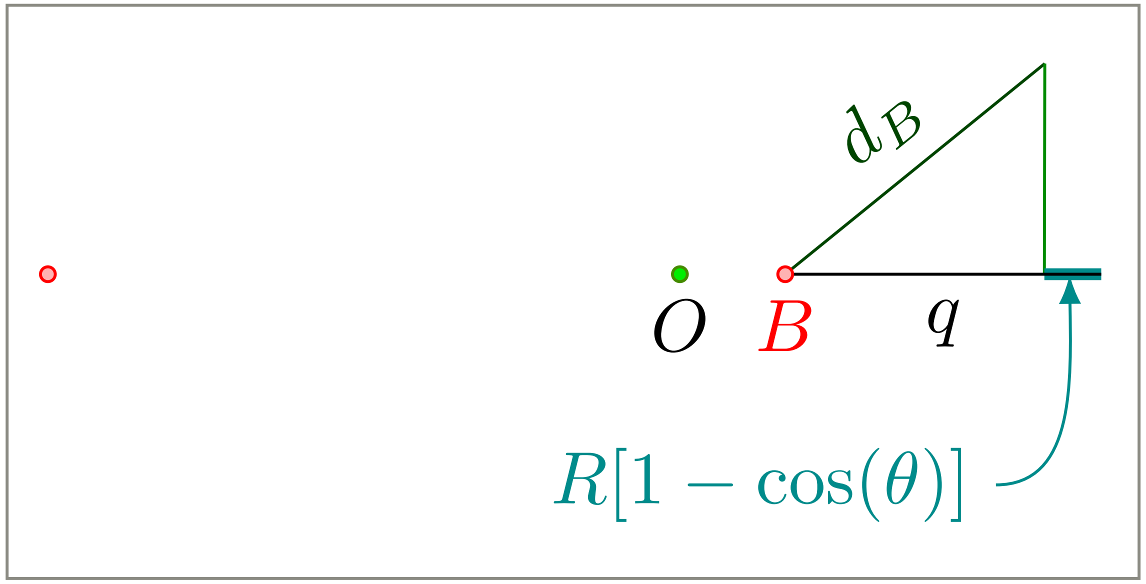
Princípio de Fermat
Espelho esférico

$$d_B^2 = R^2 \sin^2\theta + \left(p - R(1 - \cos\theta)\right)^2$$



$$\Delta t_B = \frac{d_B}{c}$$

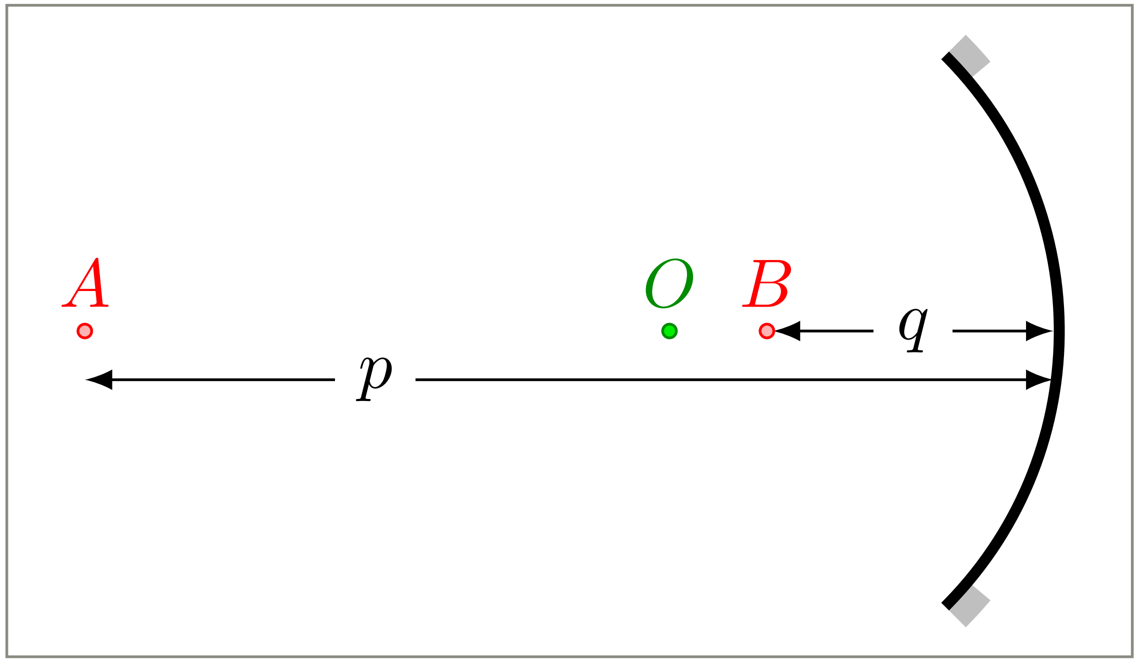
$$\frac{d\Delta t_B}{d\theta} = \frac{-2R(p-R)\sin\theta}{cp}$$



$$\frac{d\Delta t_A}{d\theta} = \frac{-2R(q-R)\sin\theta}{cq}$$

Princípio de Fermat
Espelho esférico

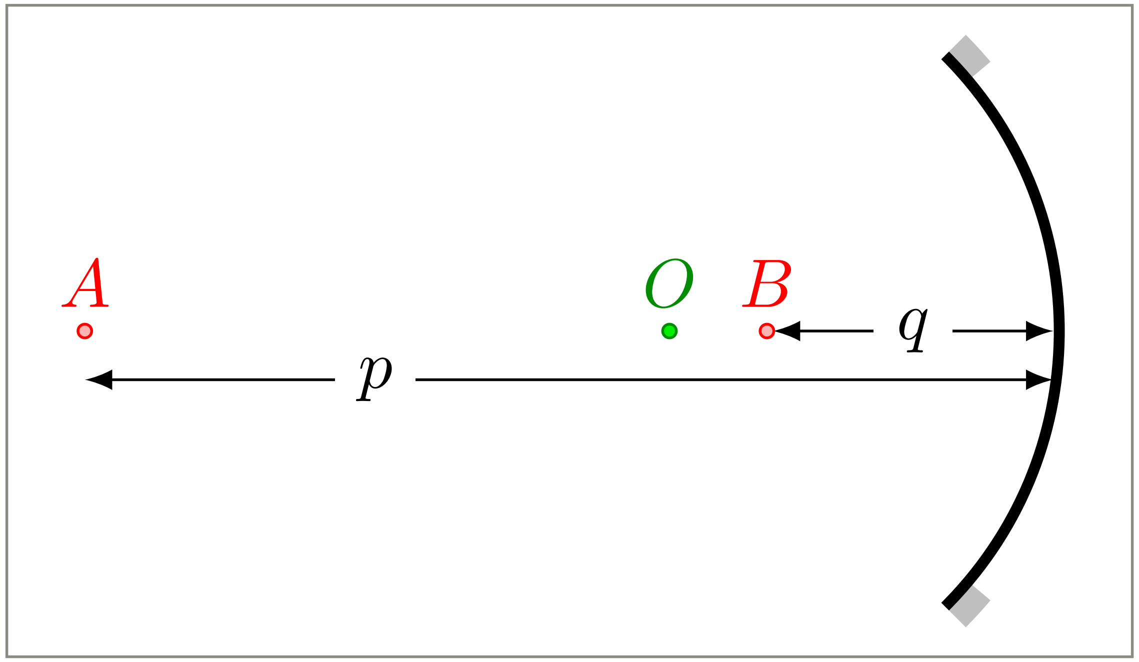
$$\frac{d\Delta t_B}{d\theta} = \frac{-2R(p-R)\sin\theta}{cp}$$



$$\frac{d\Delta t_A}{d\theta} = \frac{-2R(q-R)\sin\theta}{cq}$$

$$-2R\sin\theta\left(\frac{q-R}{q} + \frac{p-R}{p}\right) = 0$$

$$\frac{d\Delta t_B}{d\theta} = \frac{-2R(p-R)\sin\theta}{cp}$$



$$\frac{d\Delta t_A}{d\theta} = \frac{-2R(q-R)\sin\theta}{cq}$$

$$-2R\sin\theta\left(\frac{q-R}{q}+\frac{p-R}{p}\right)=0$$

$$\frac{q-R}{q}+\frac{p-R}{p}=0 \quad \Rightarrow \quad \frac{1}{p}+\frac{1}{q}=\frac{2}{R}$$