4.2 FONCTIONS TRIGONOMÉTRIQUES

cours 24

Au dernier cours, nous avons vu

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SOH CAH TOA

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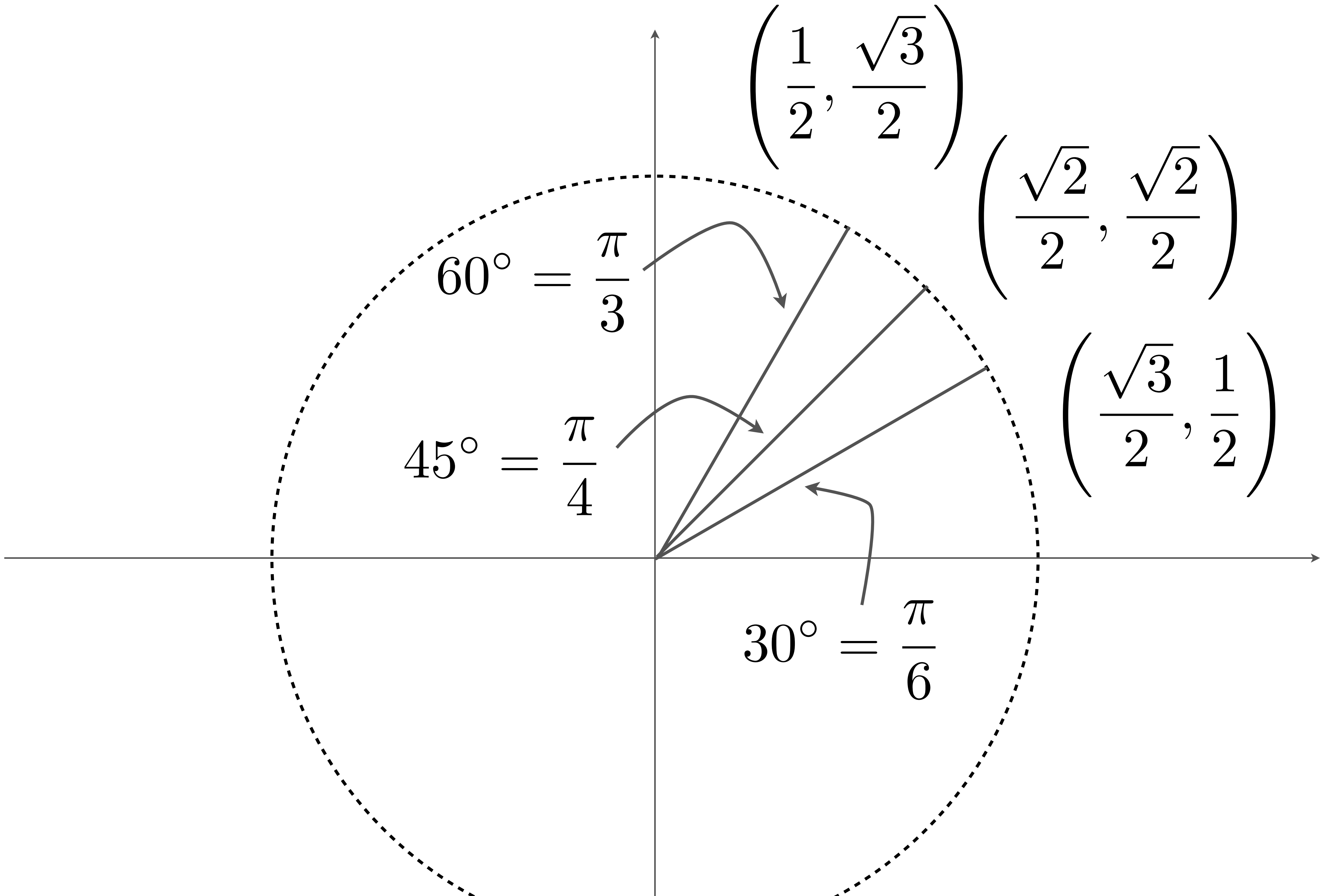

Au dernier cours, nous avons vu

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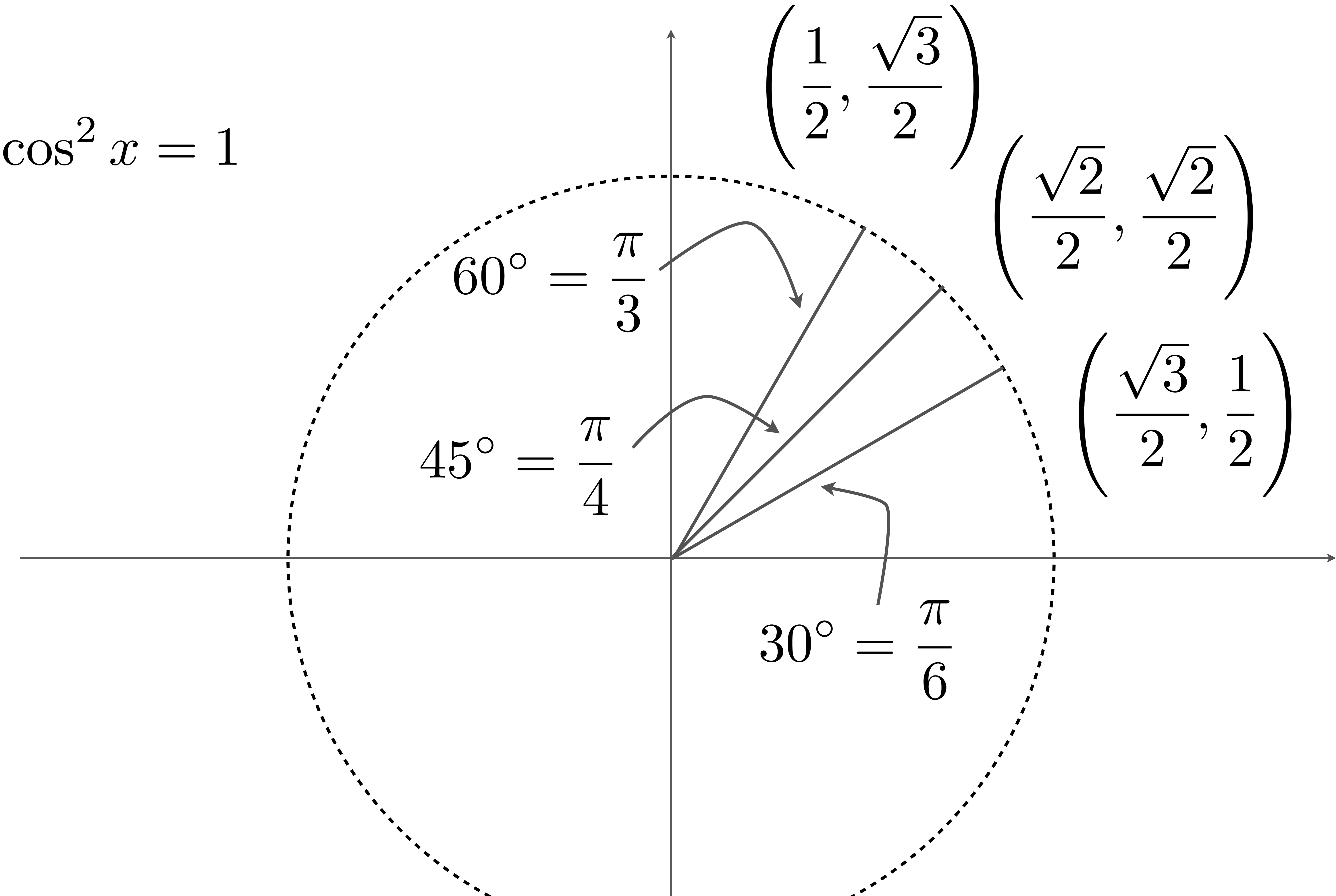
$$\sin^2 x + \cos^2 x = 1$$



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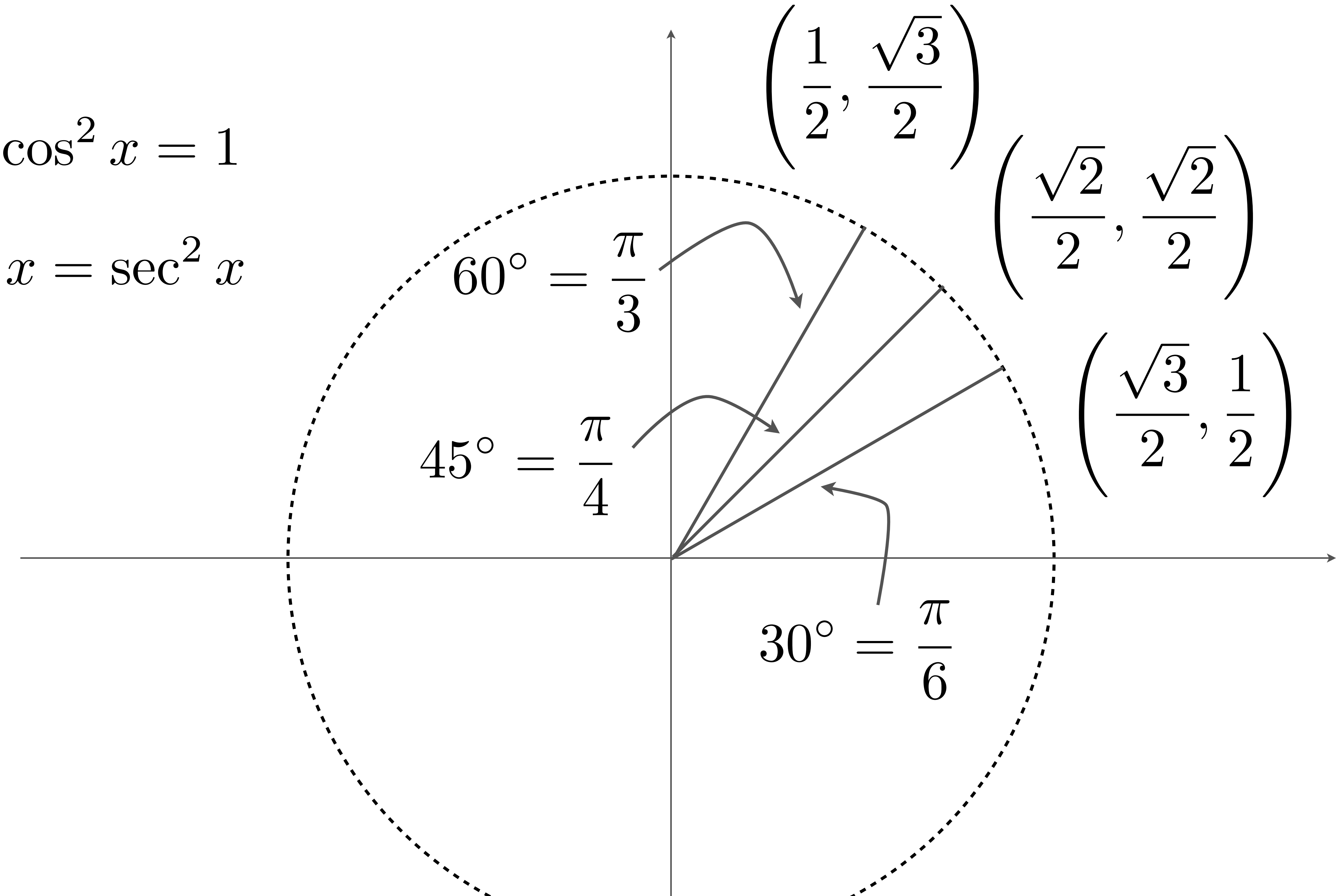

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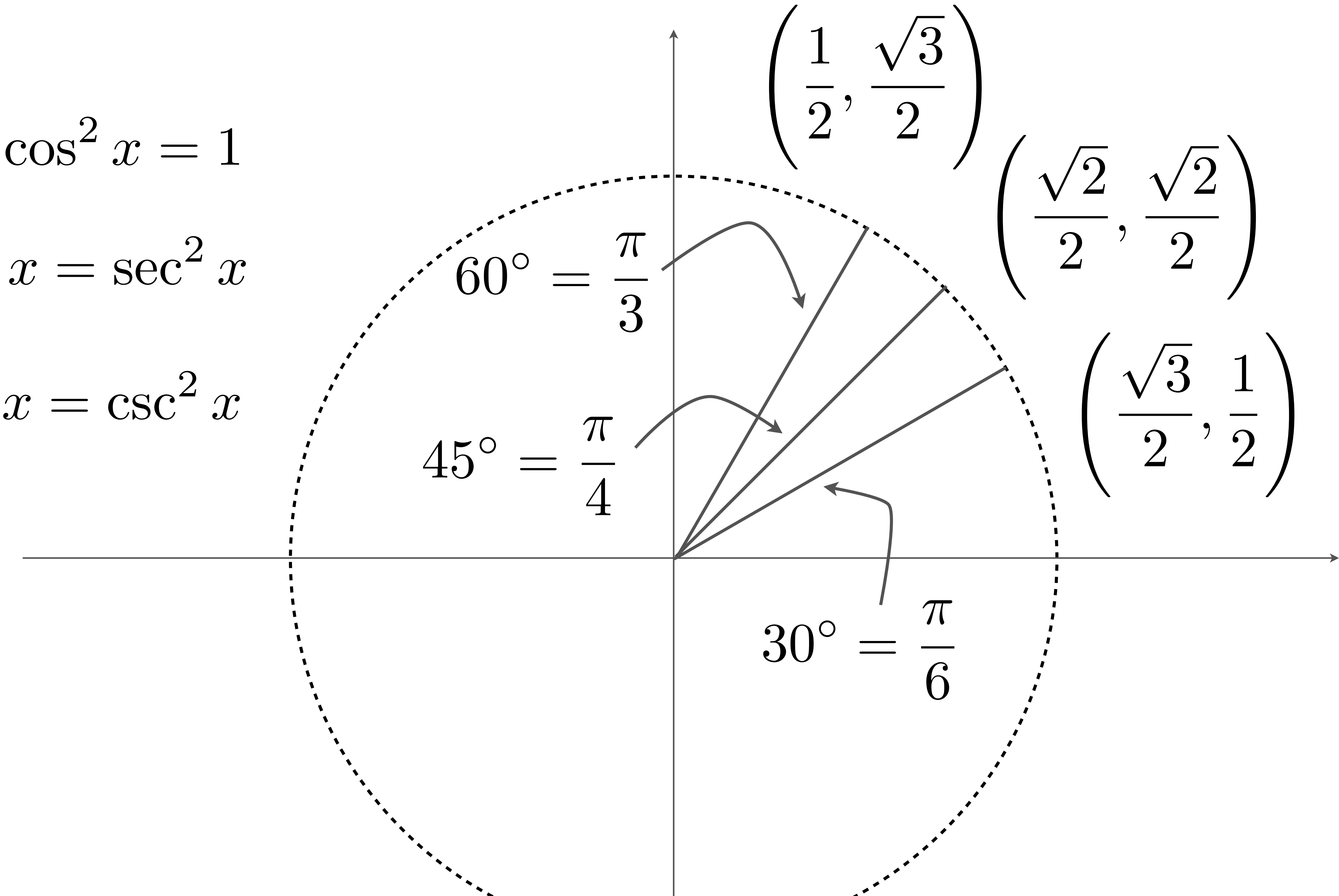

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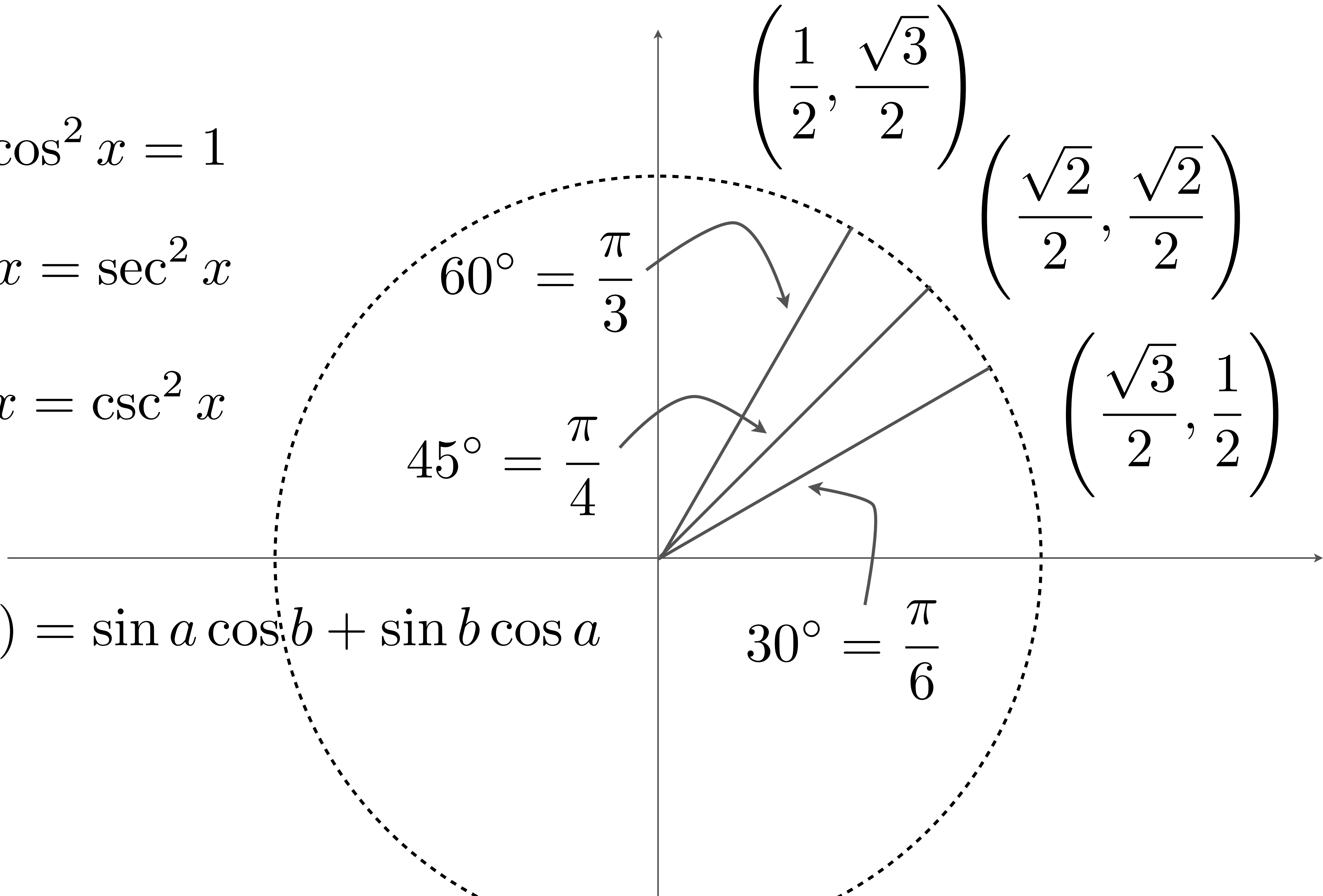

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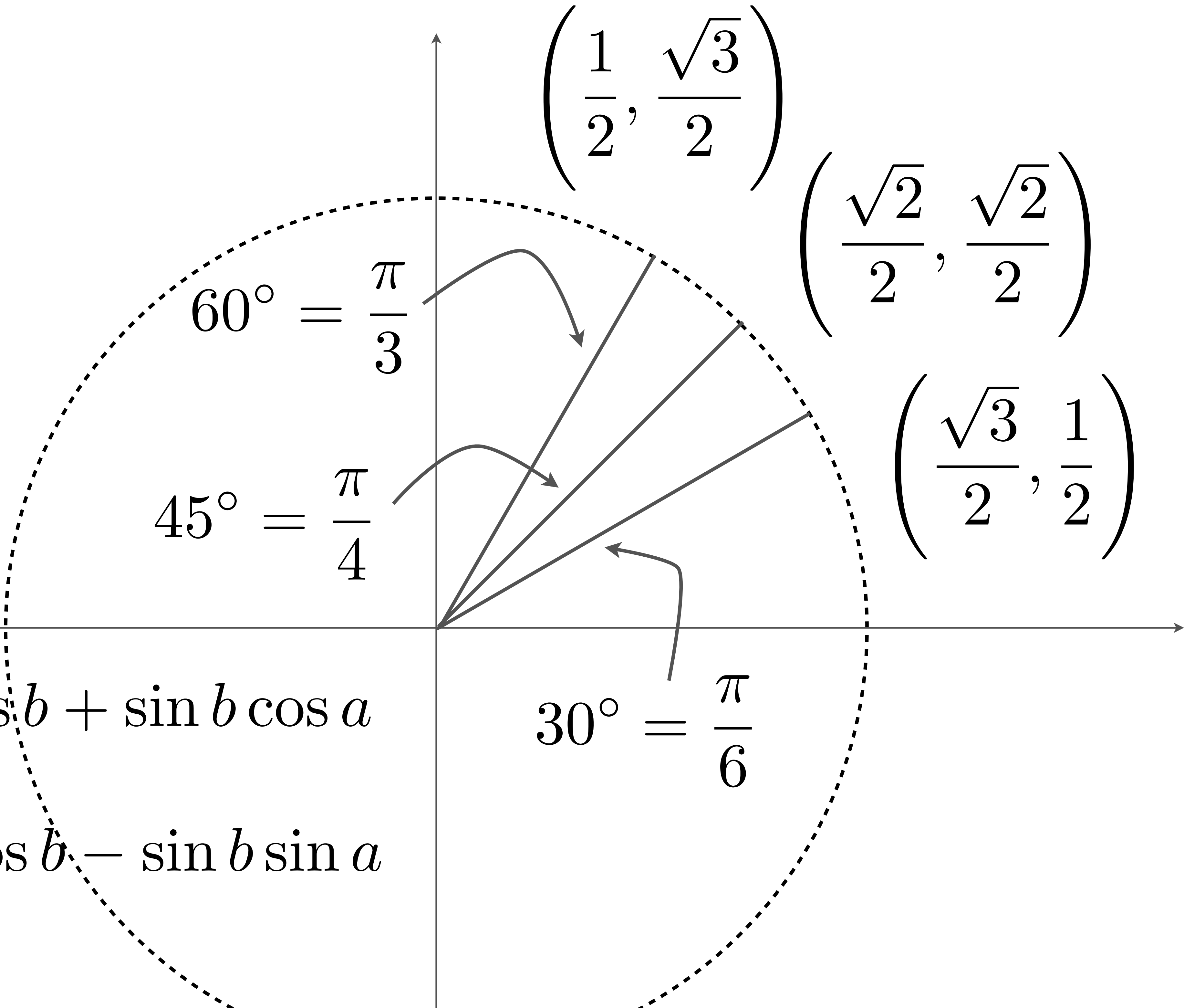
$$\cos(a+b) = \cos a \cos b - \sin b \sin a$$



Aujourd'hui, nous allons voir

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- ✓ La dérivée des fonctions trigonométrique

Quel est le lien entre l'aire d'un secteur et l'angle en radian?

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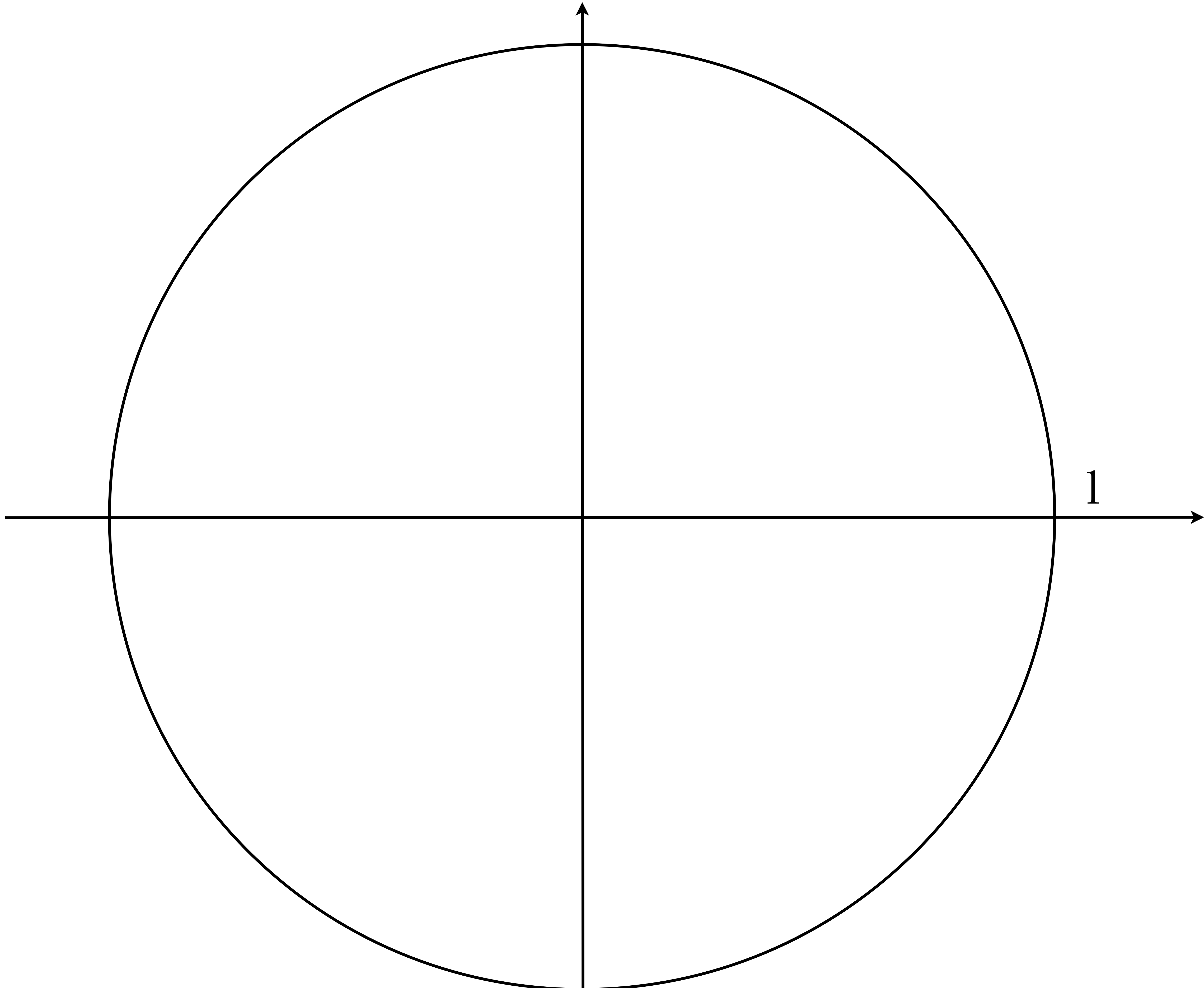
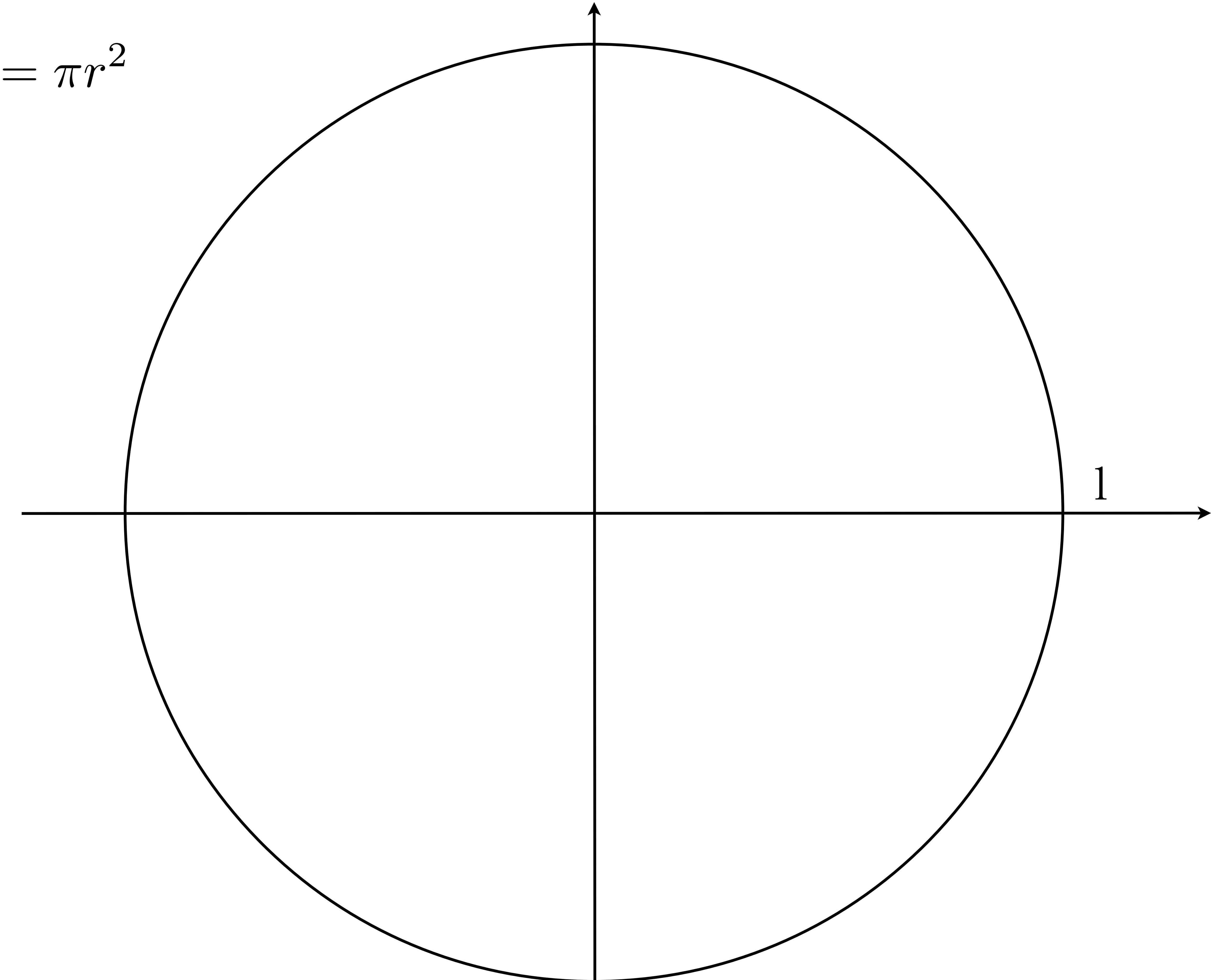


Quel est le lien entre l'aire d'un secteur et l'angle en radian?

$\text{Aire}_{\text{cercle}} = \pi r^2$



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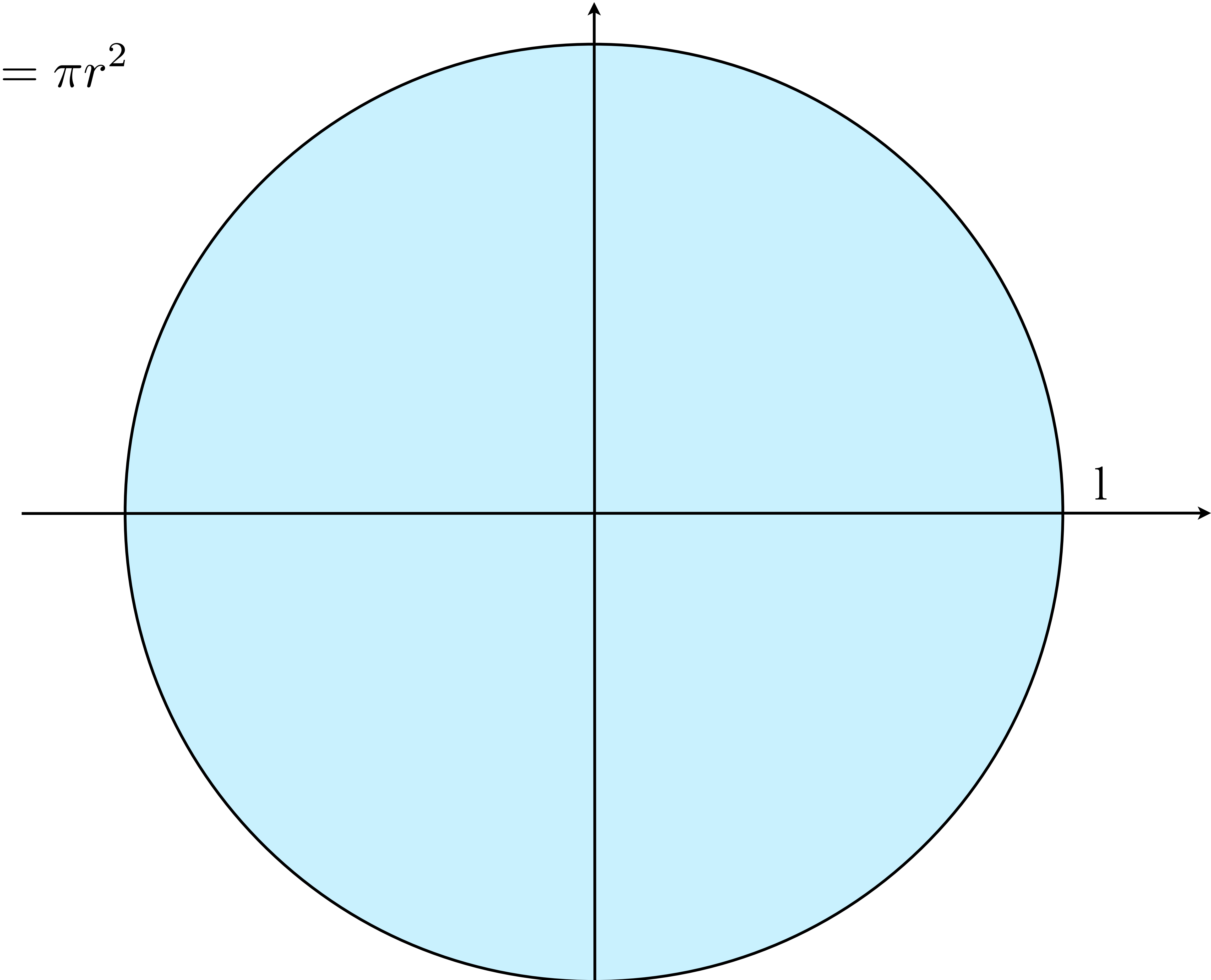

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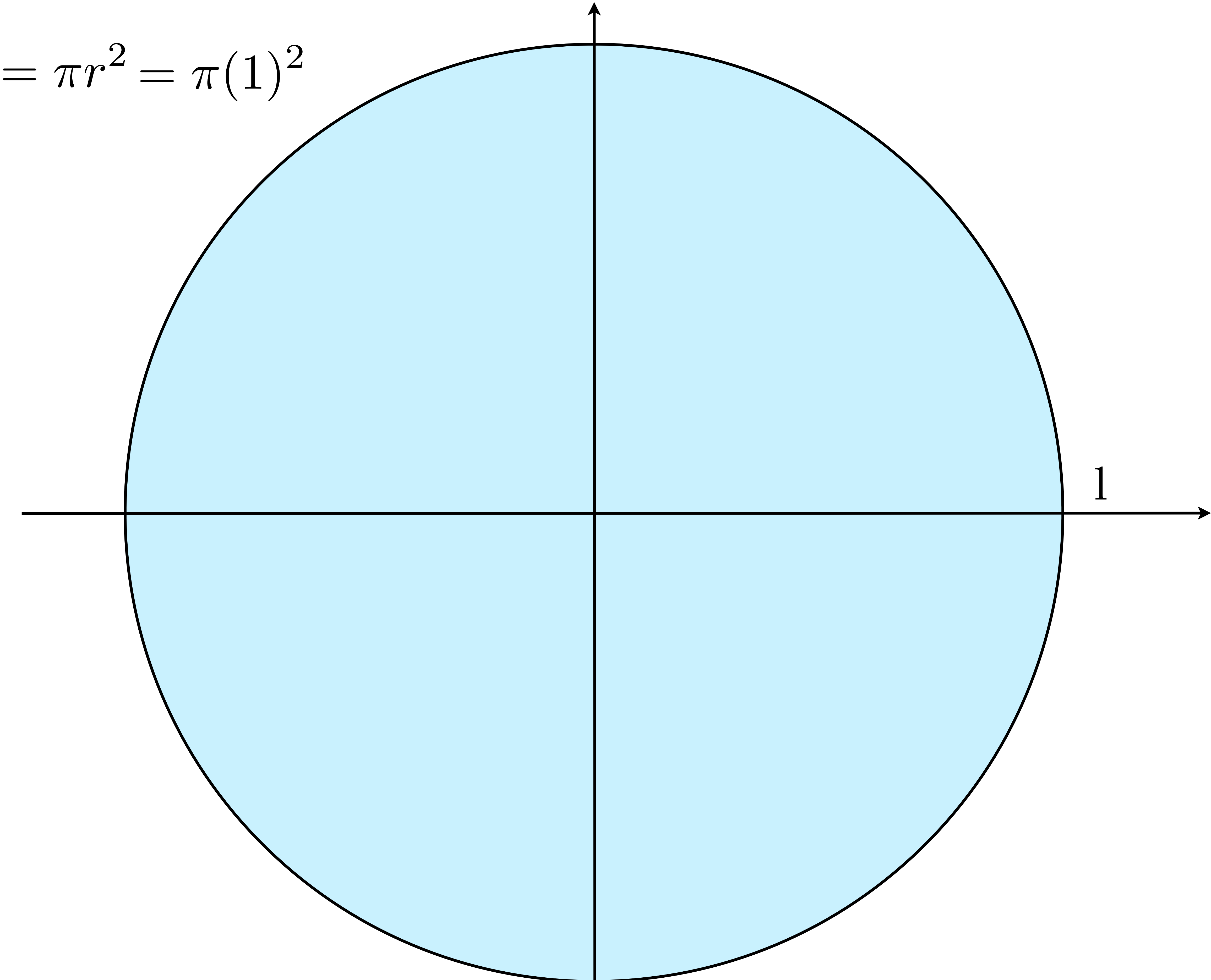

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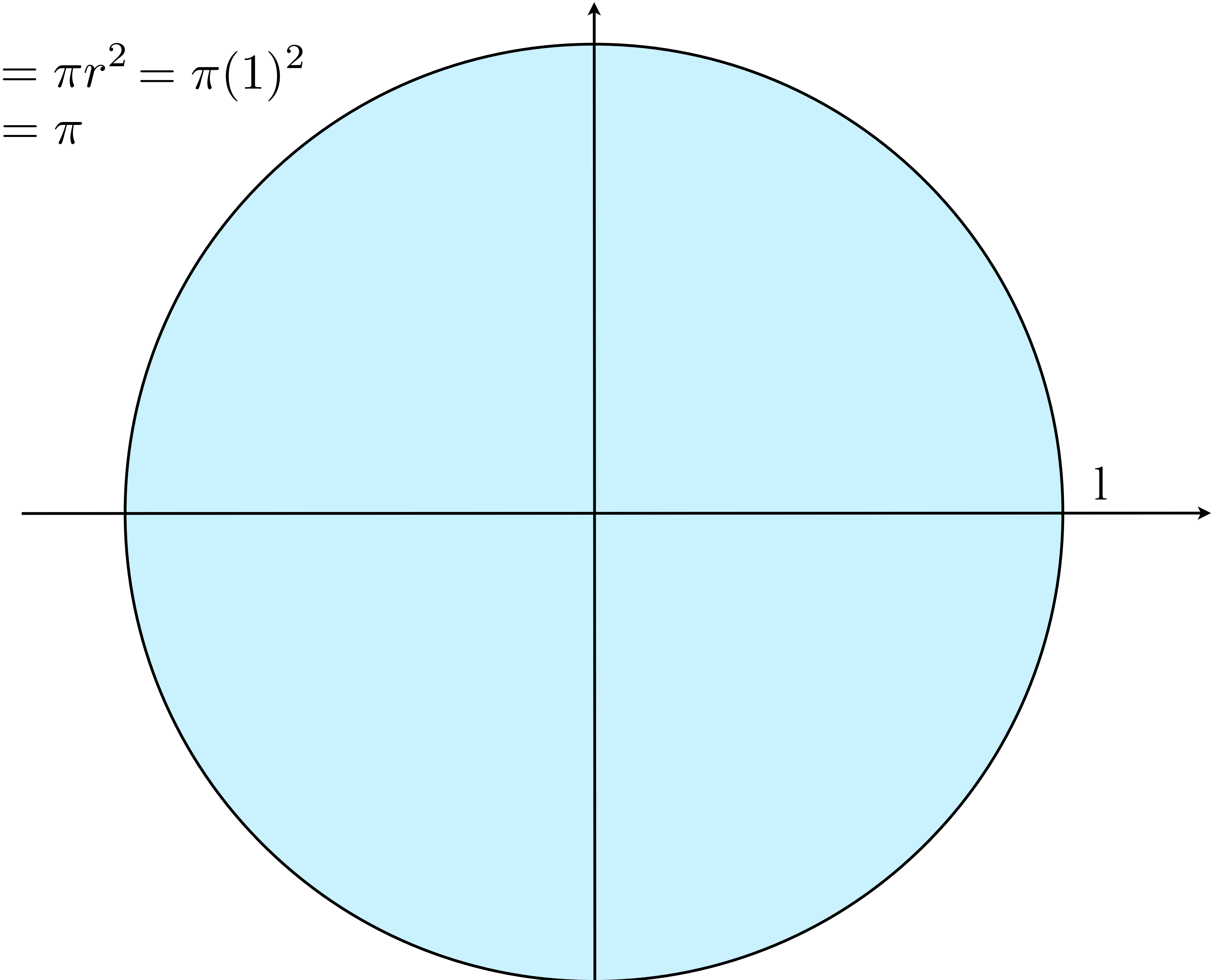

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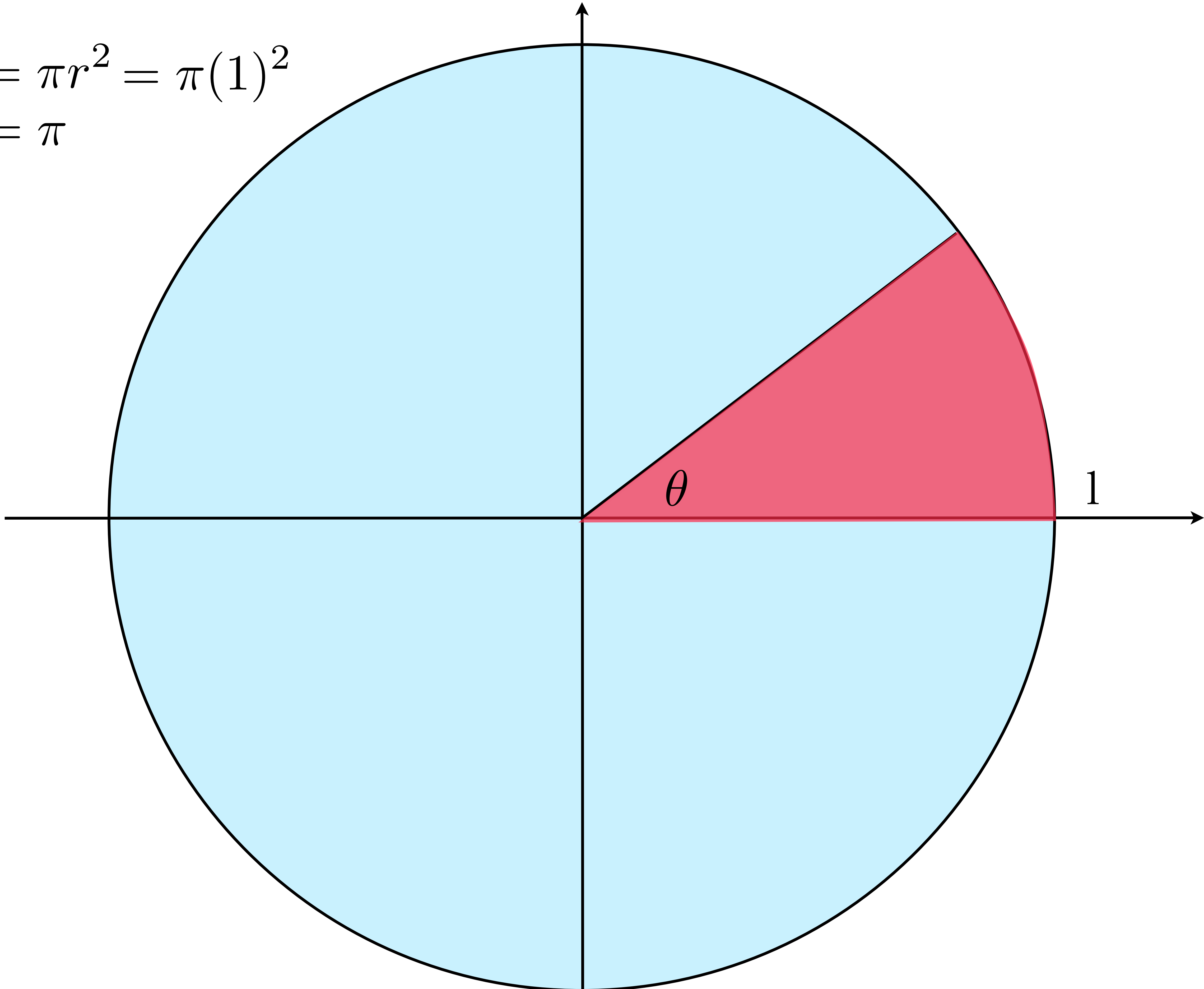

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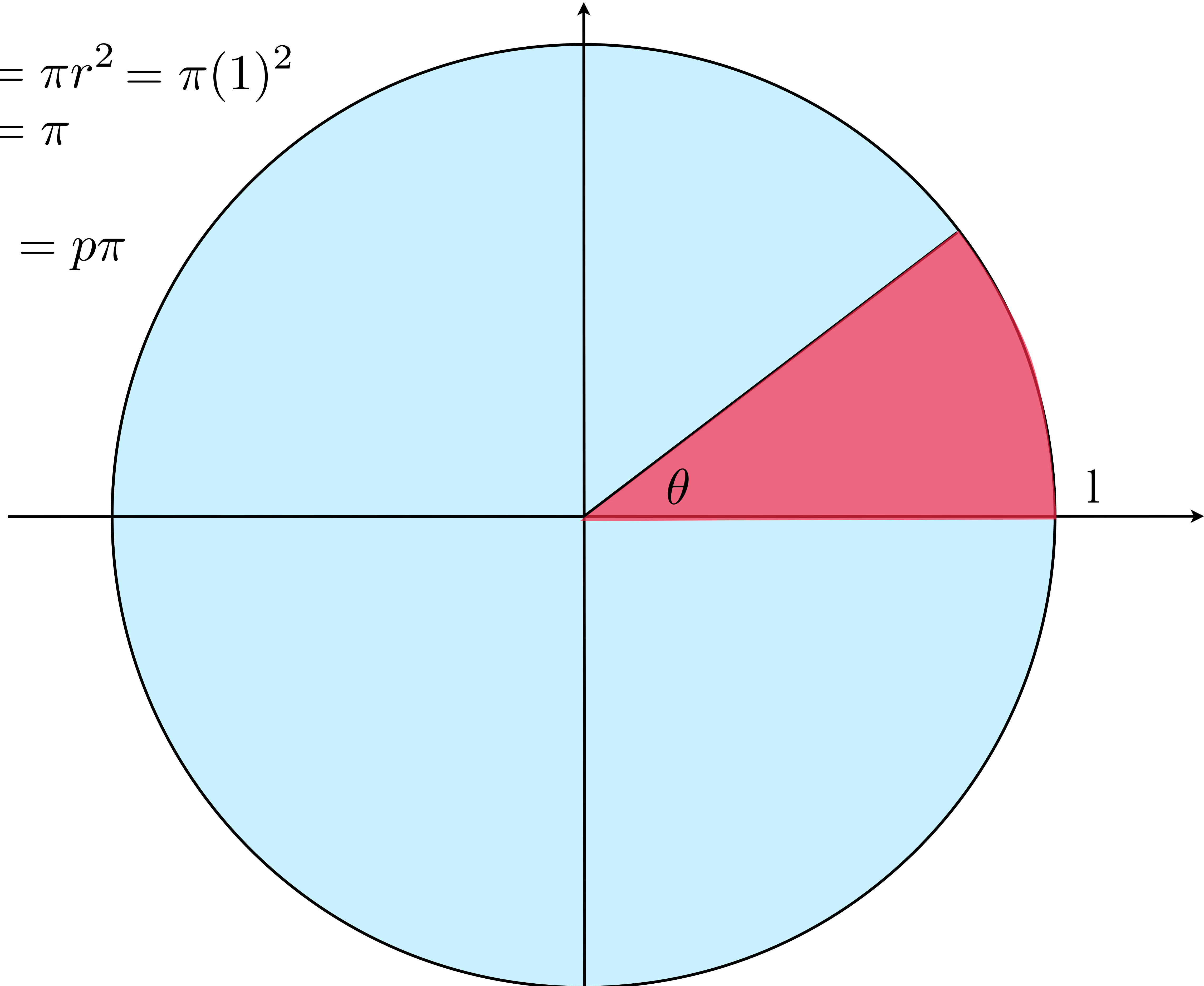

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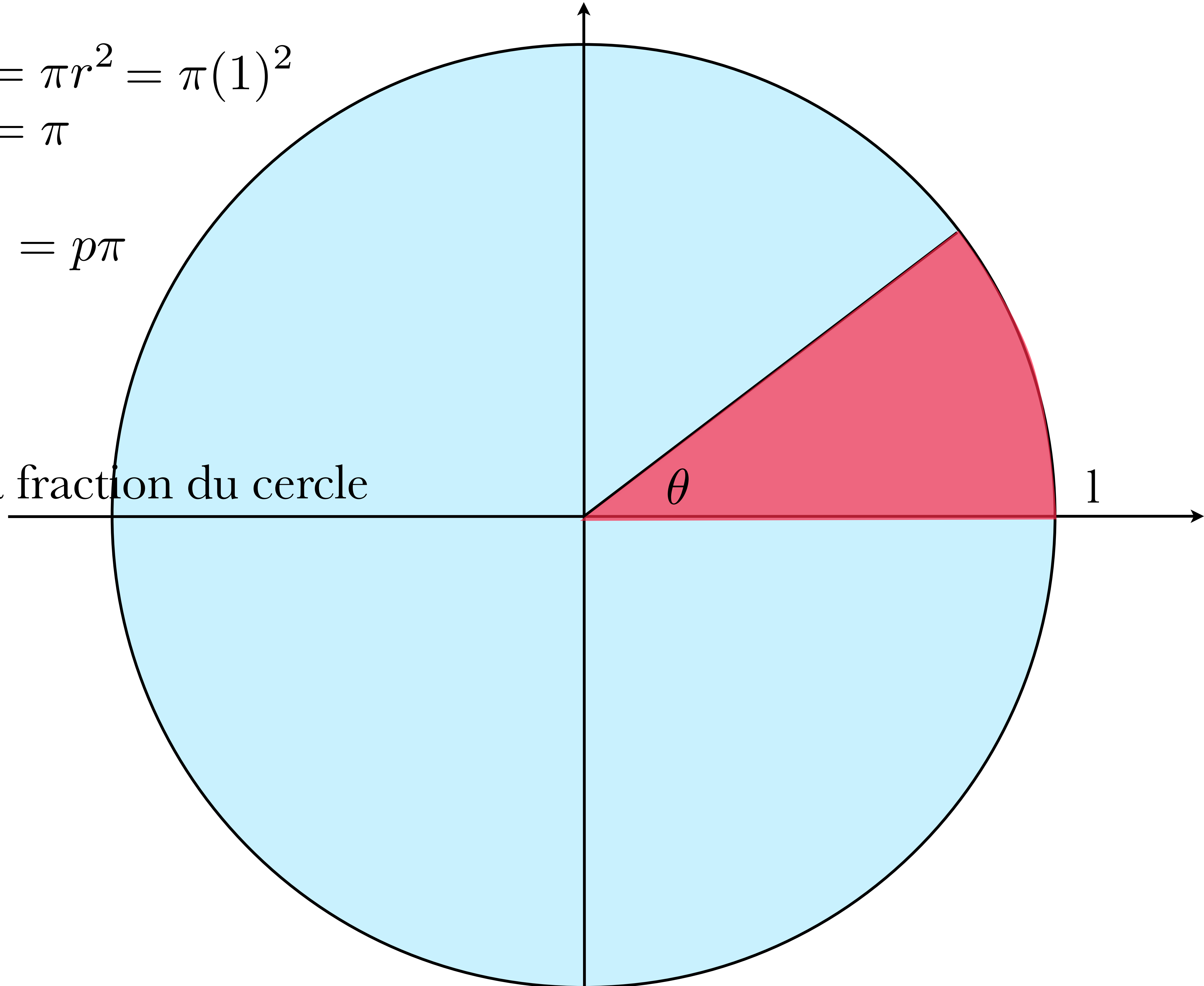
Où p est la fraction du cercle



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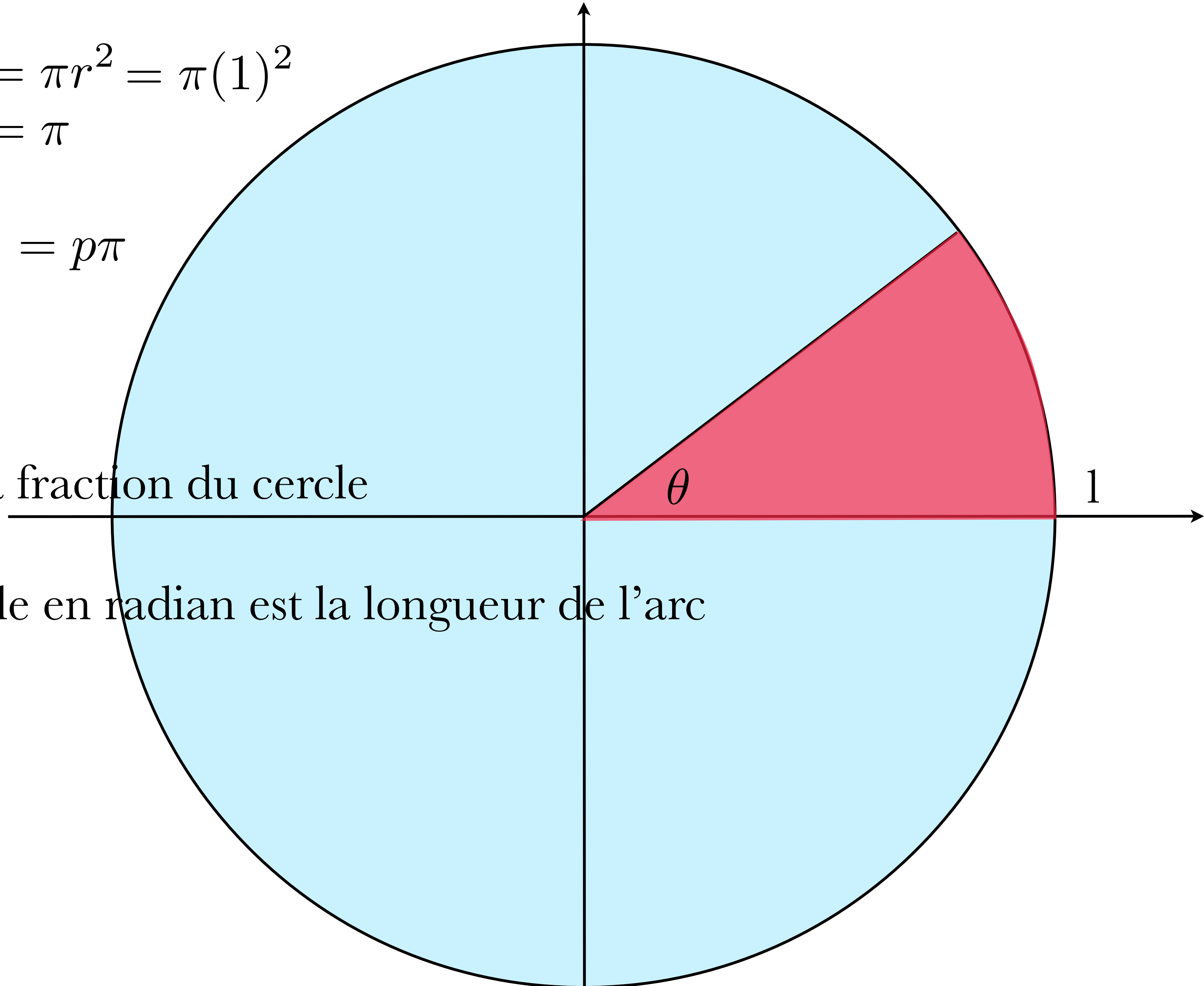
Mais l'angle en radian est la longueur de l'arc



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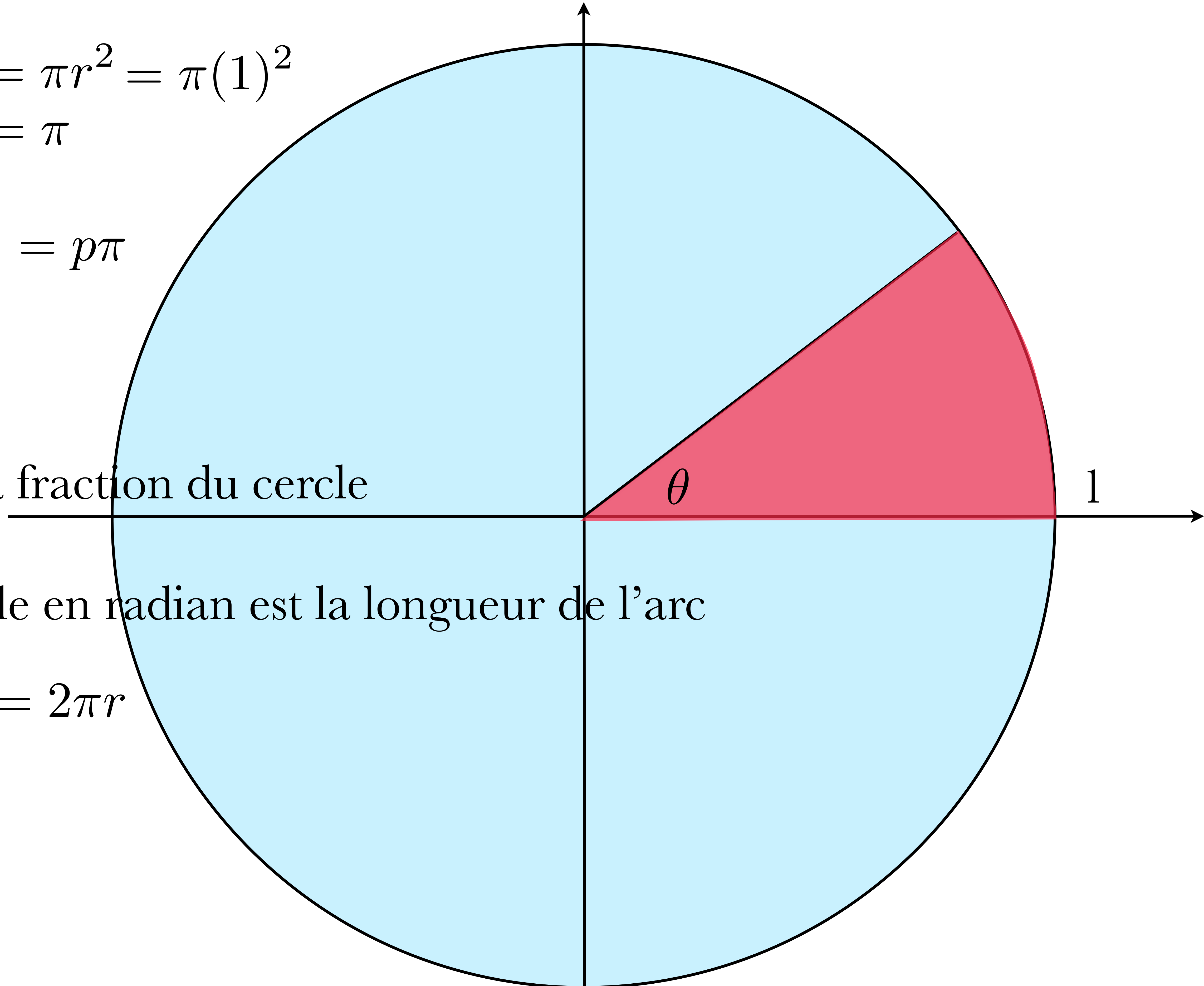

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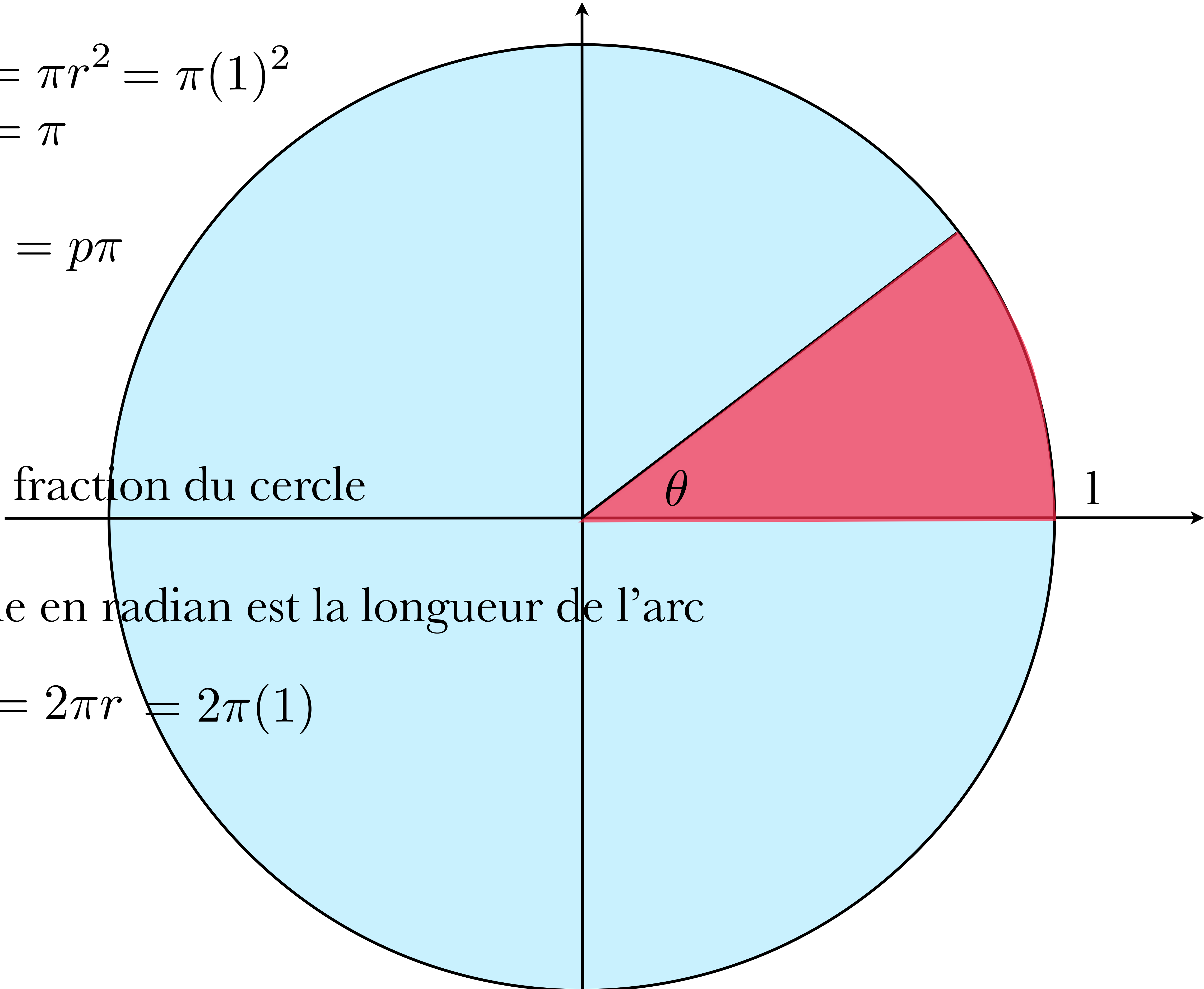

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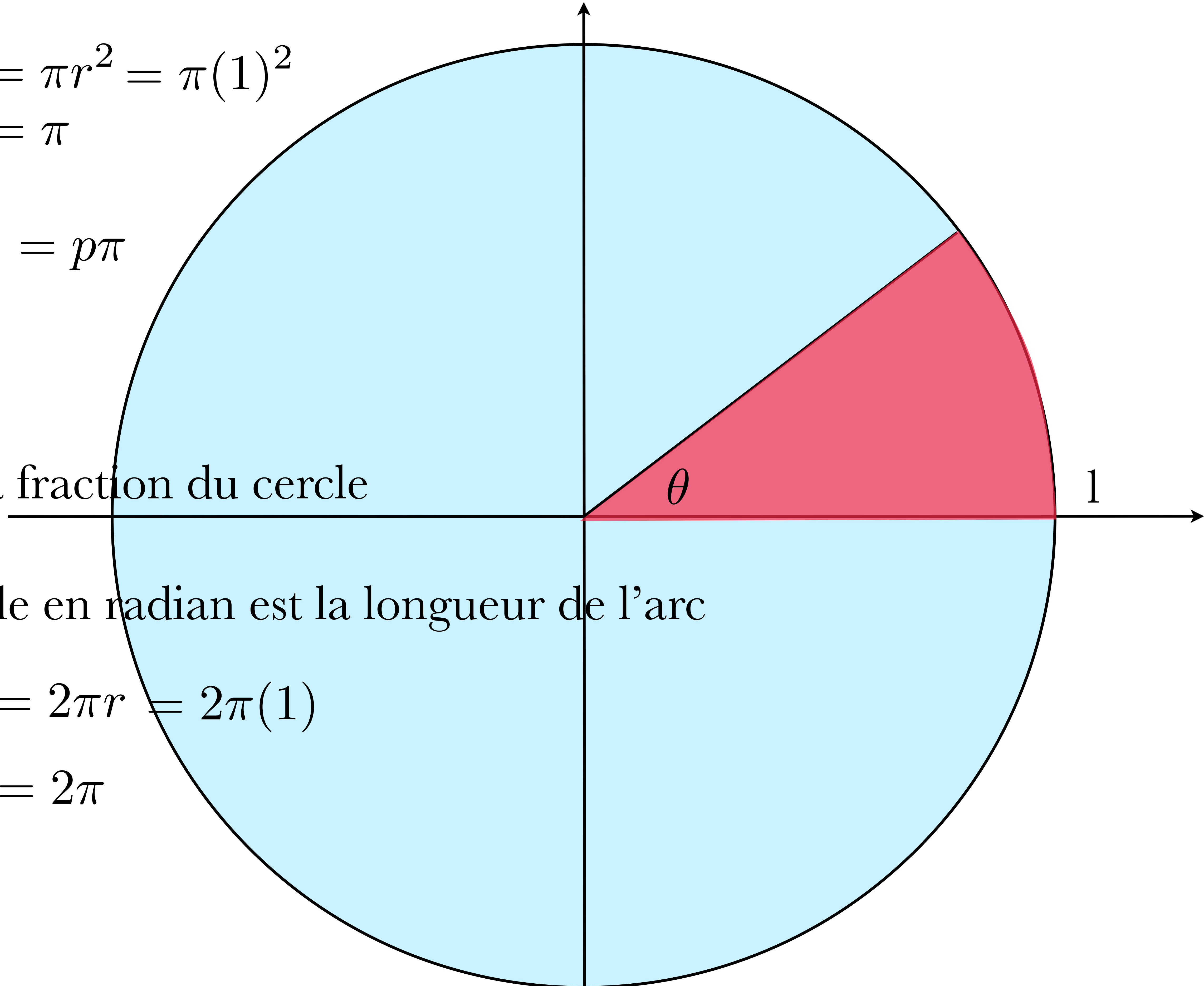

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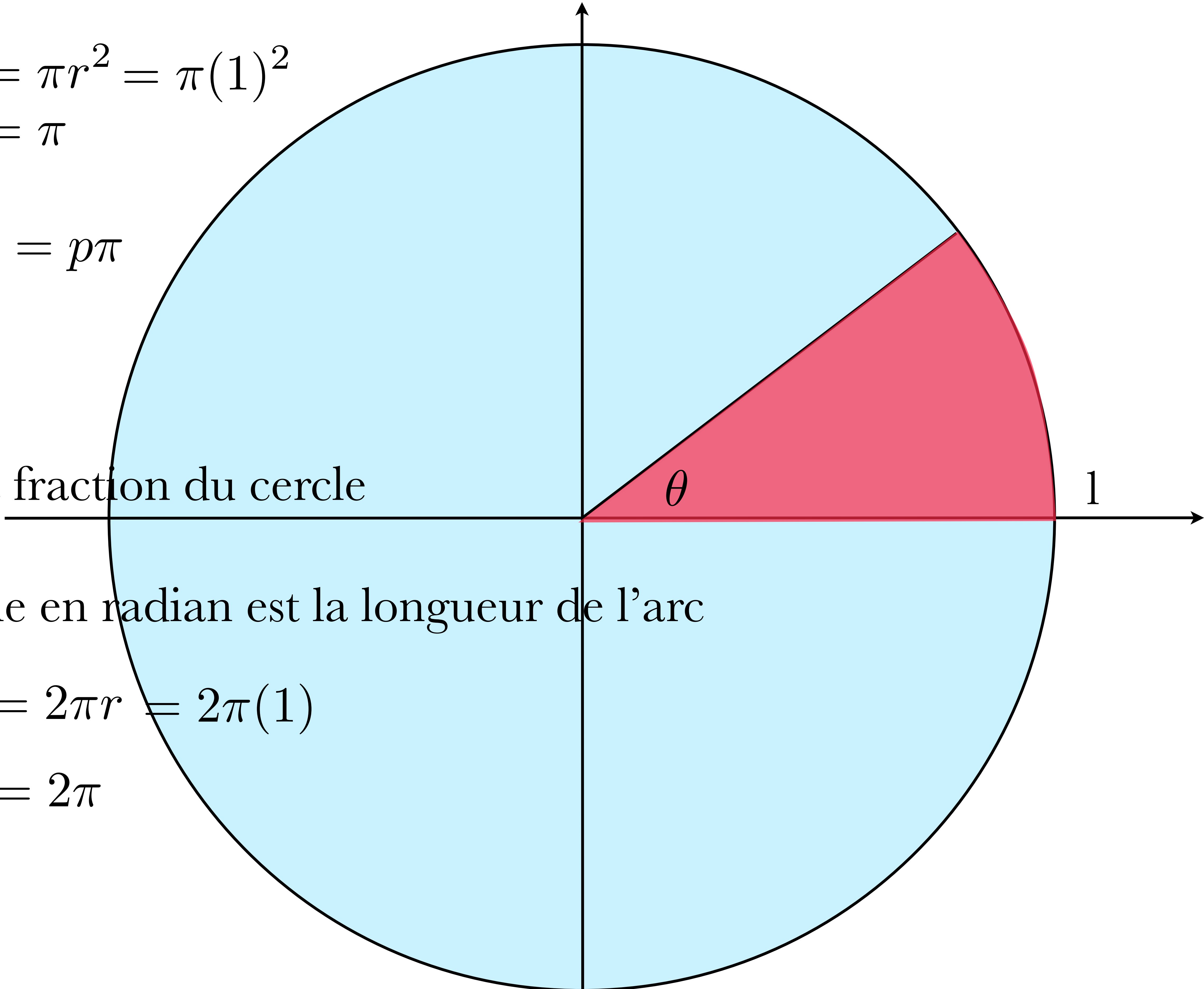

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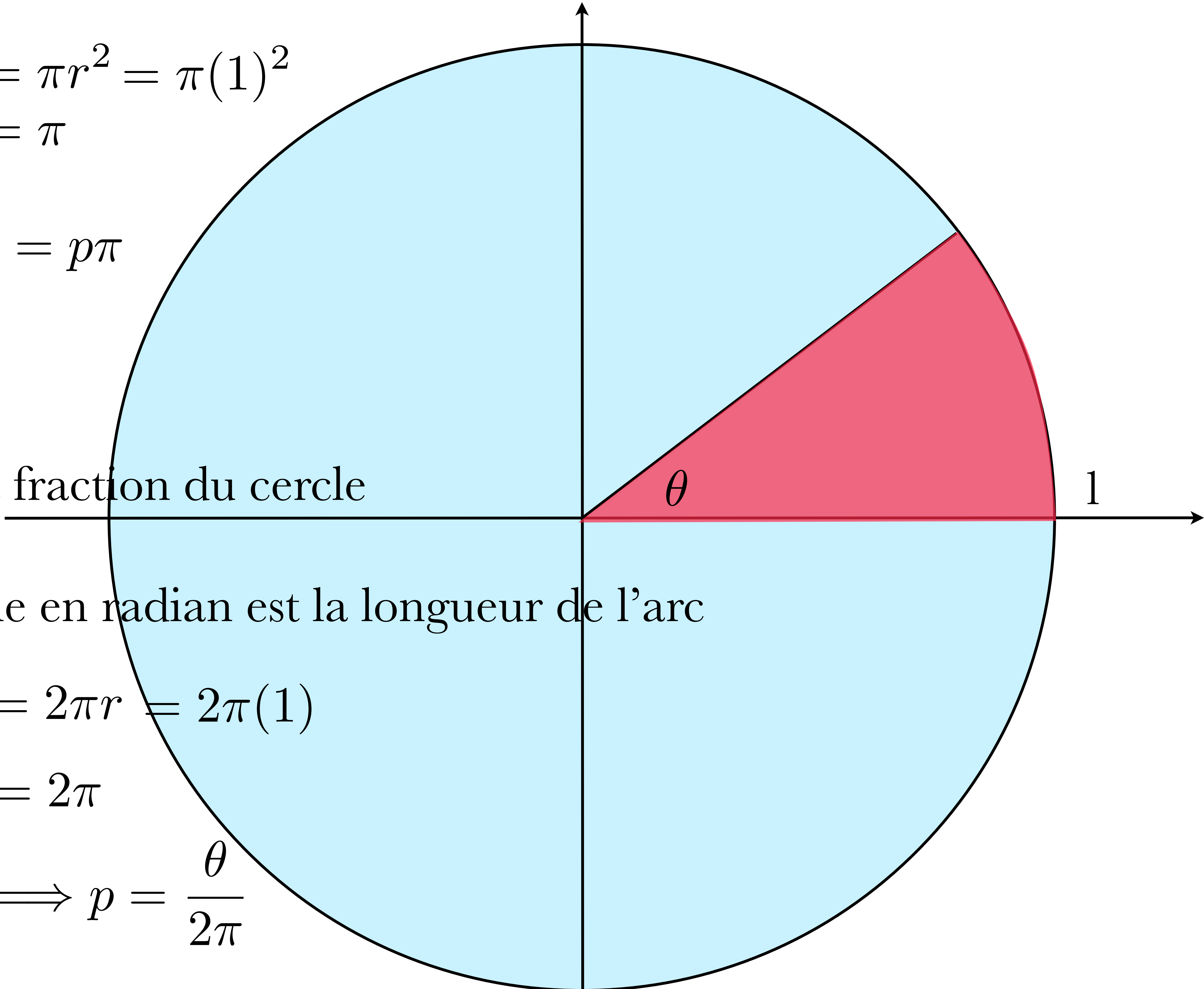

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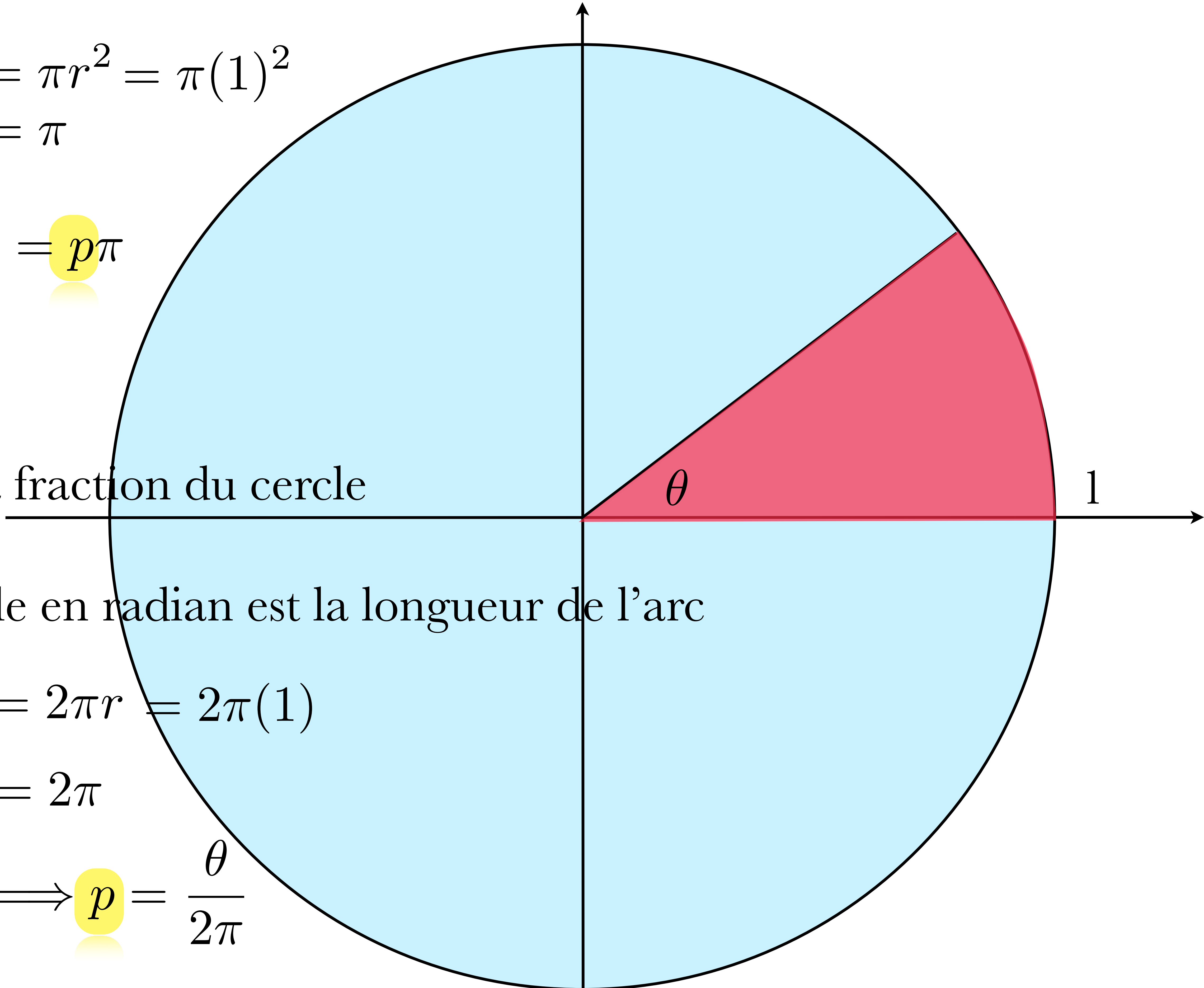

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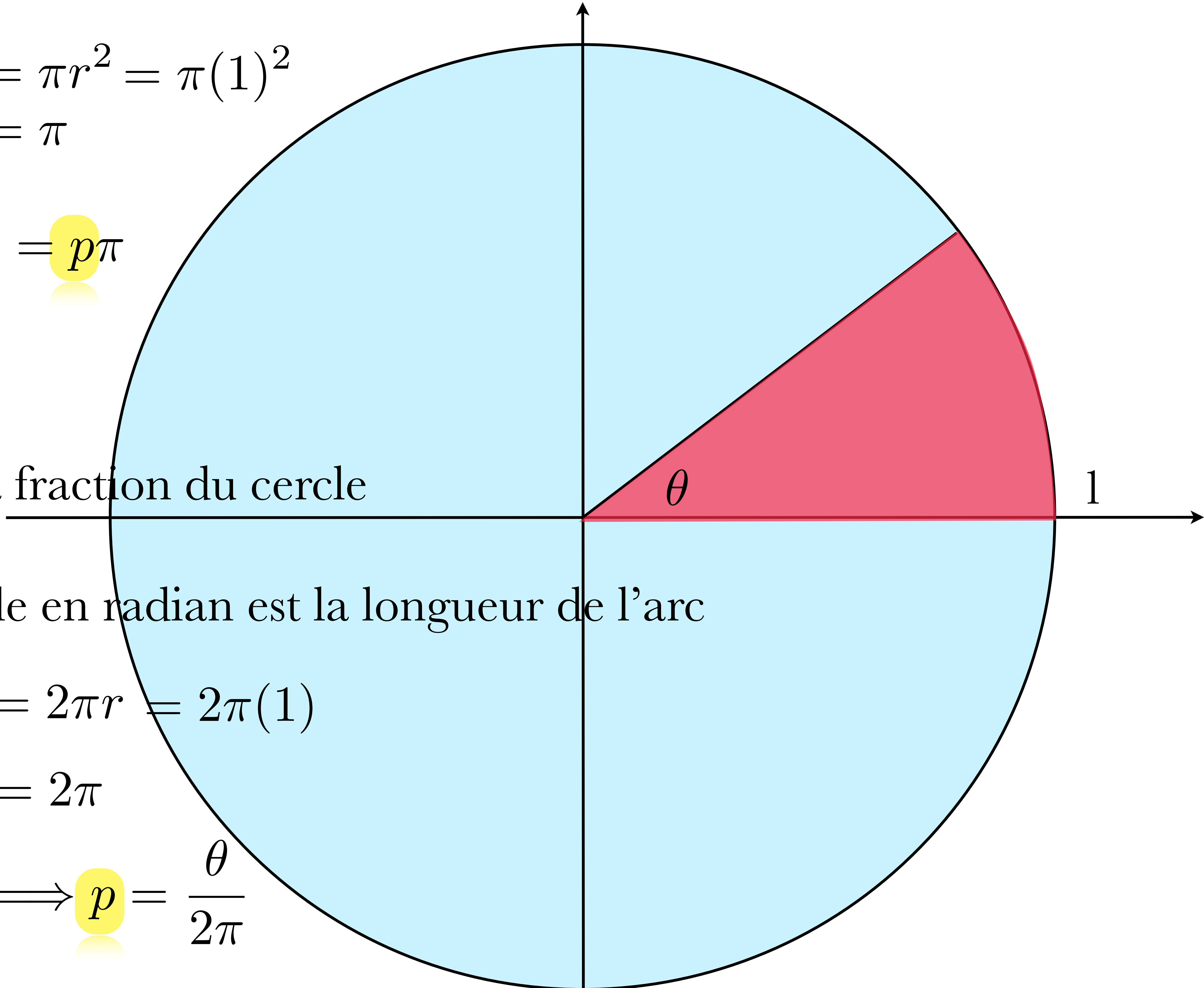

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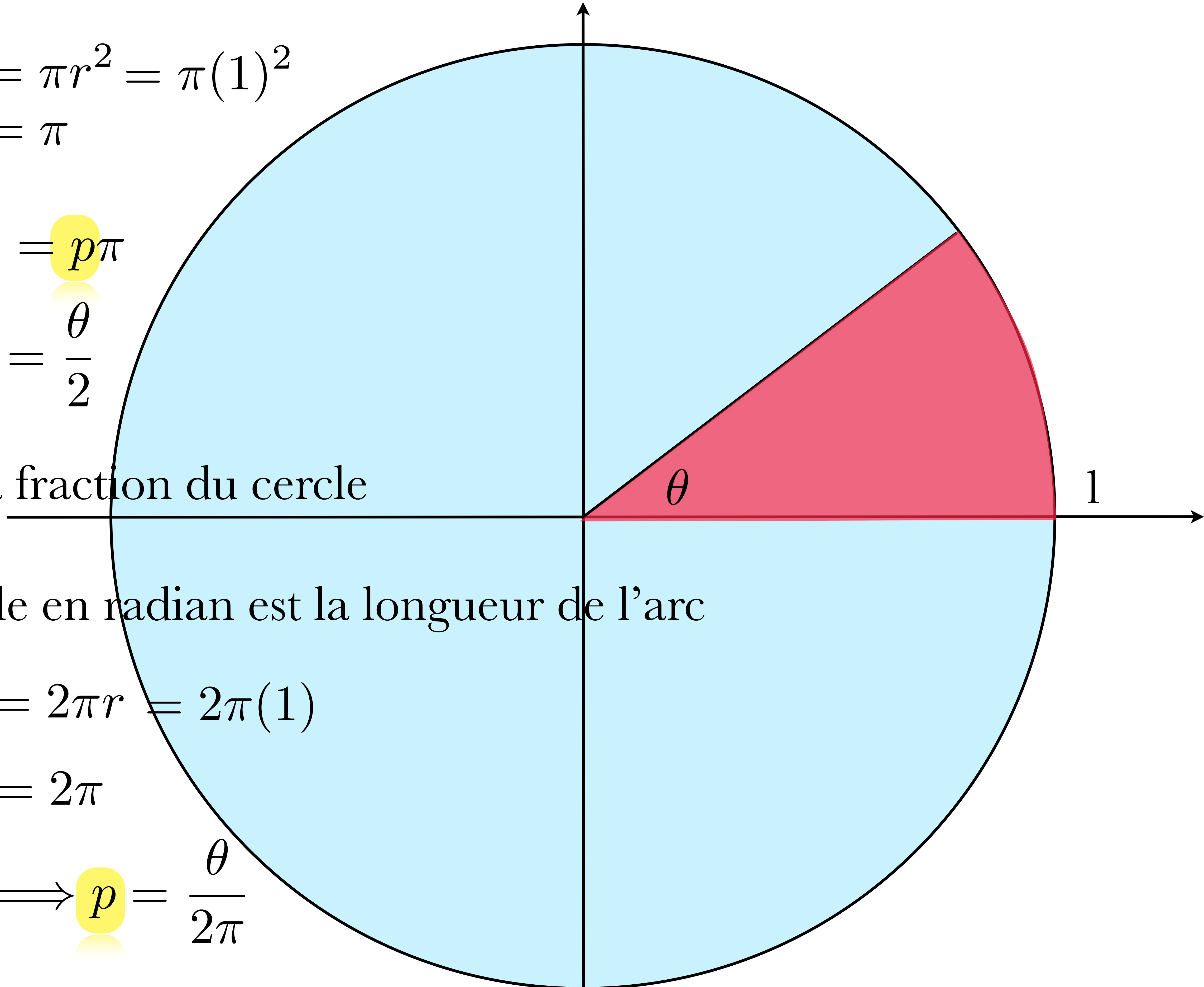

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Donc

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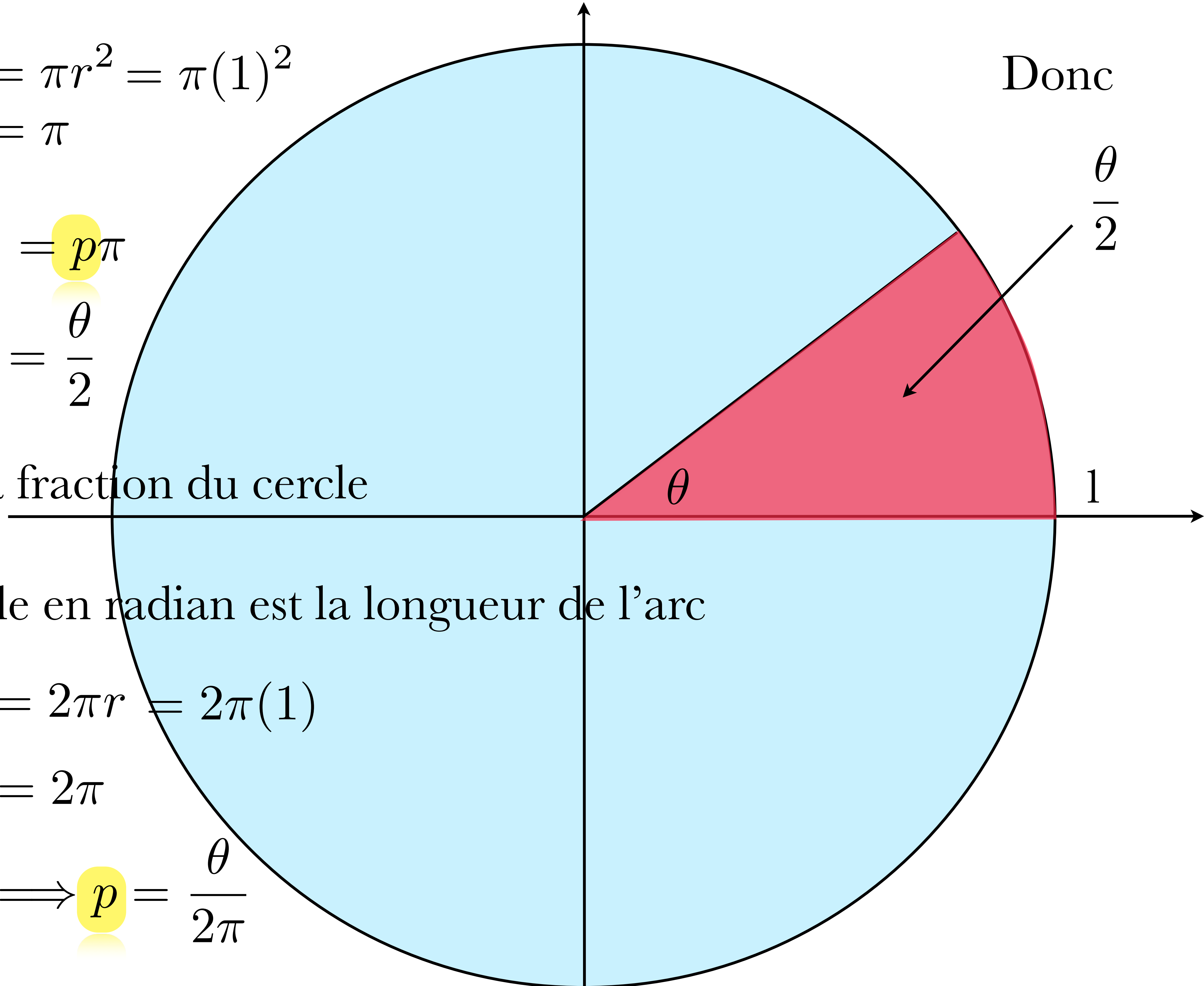

Pour trouver la dérivée de la fonction

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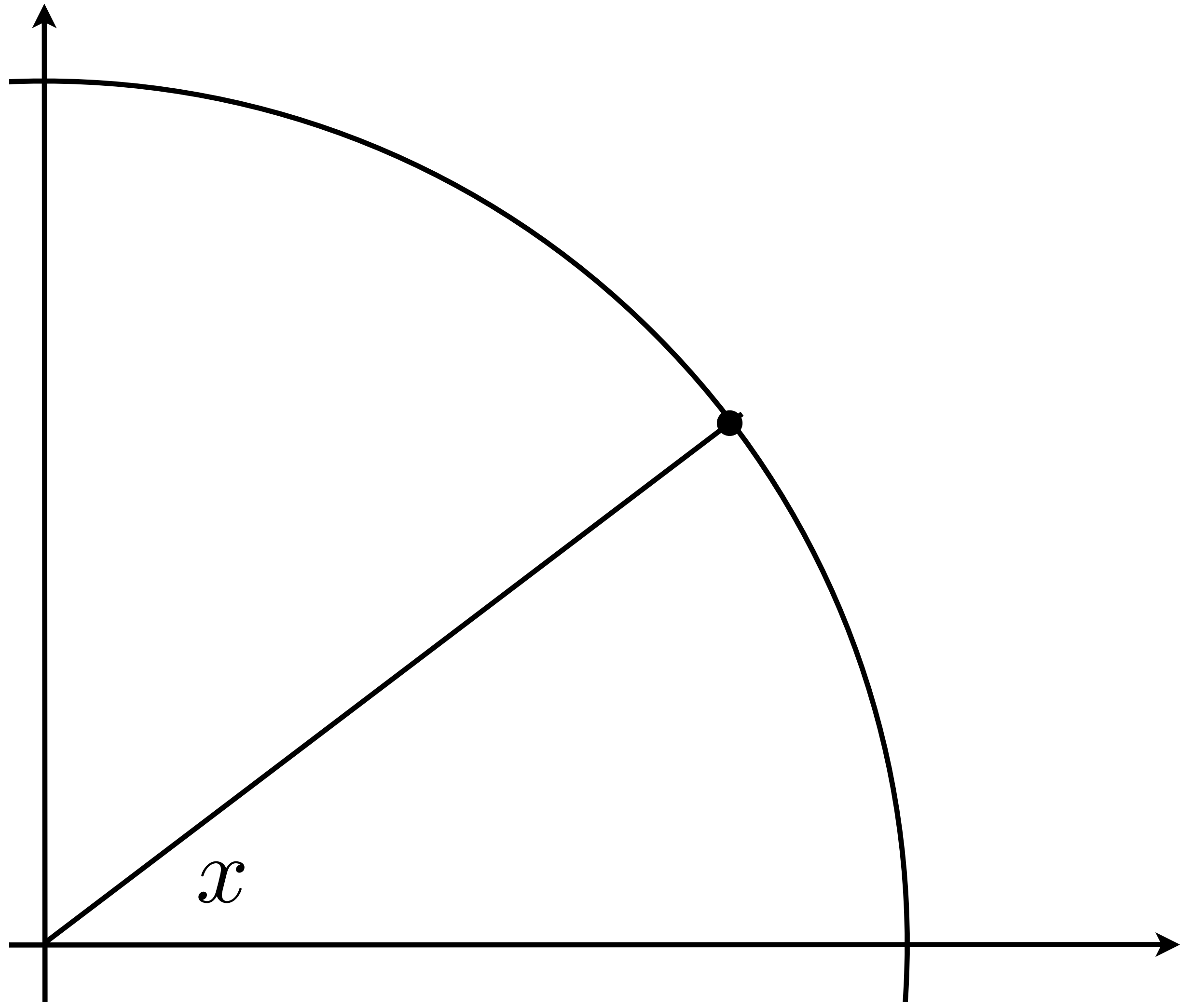
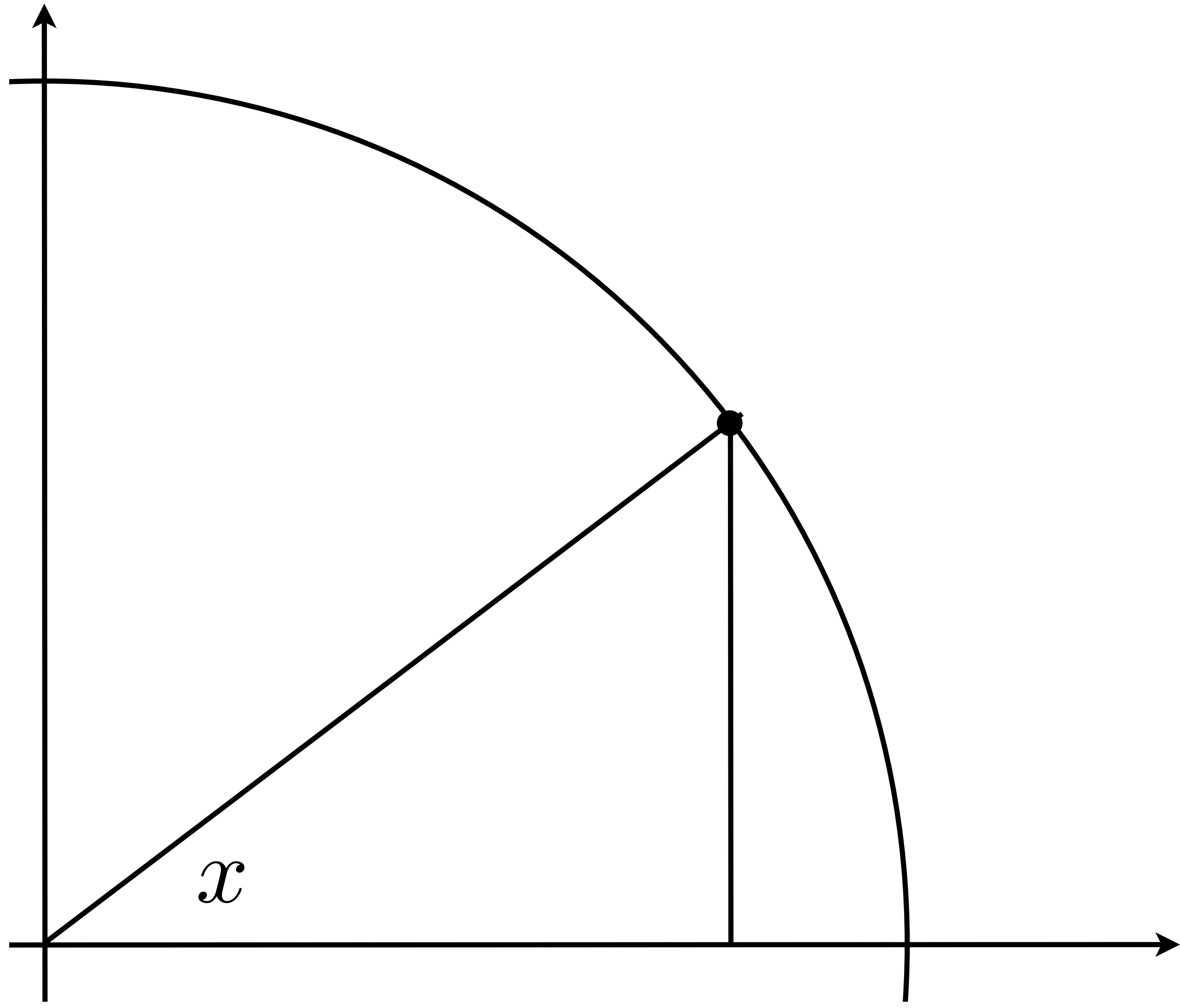

x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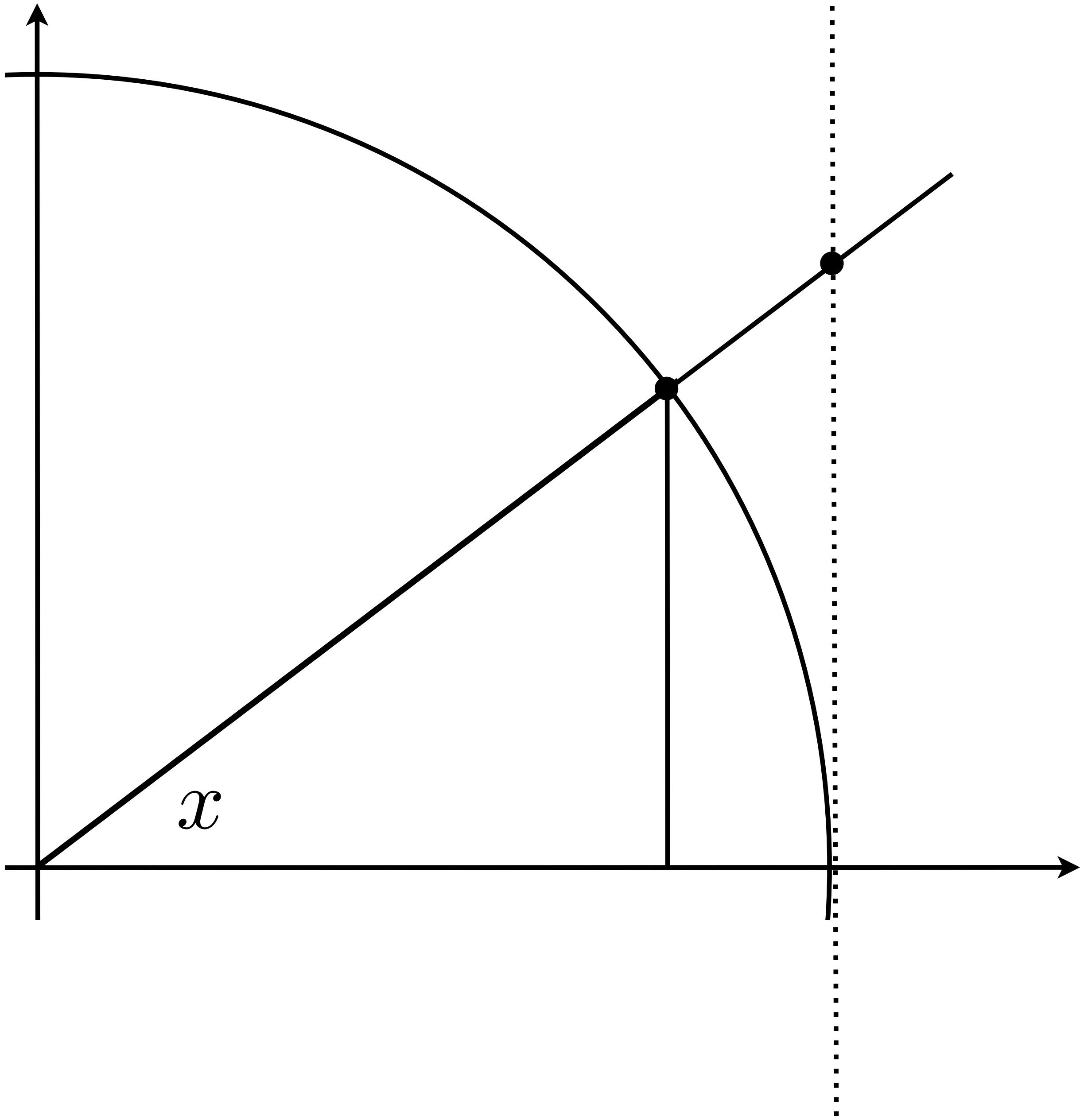
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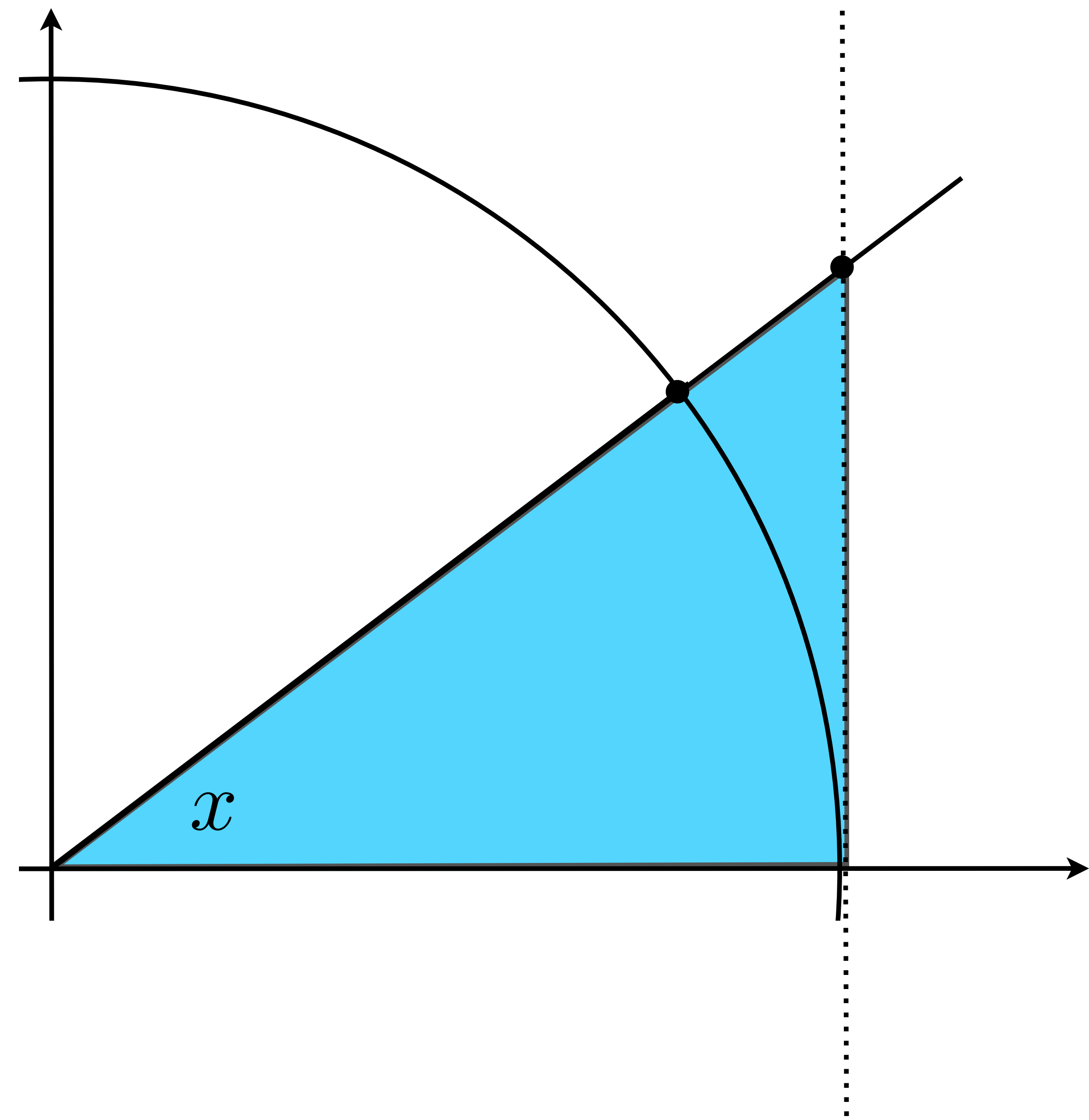
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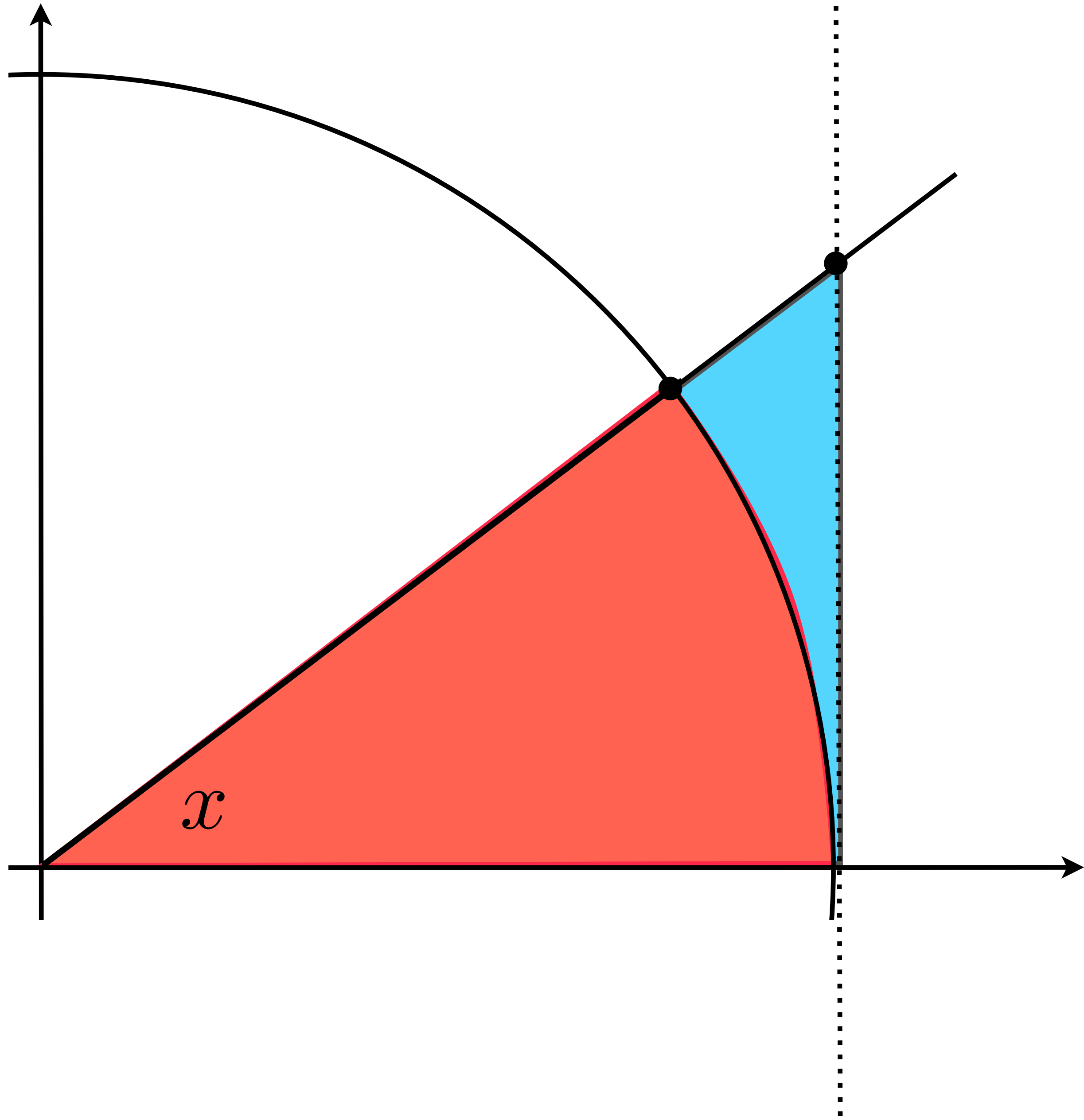

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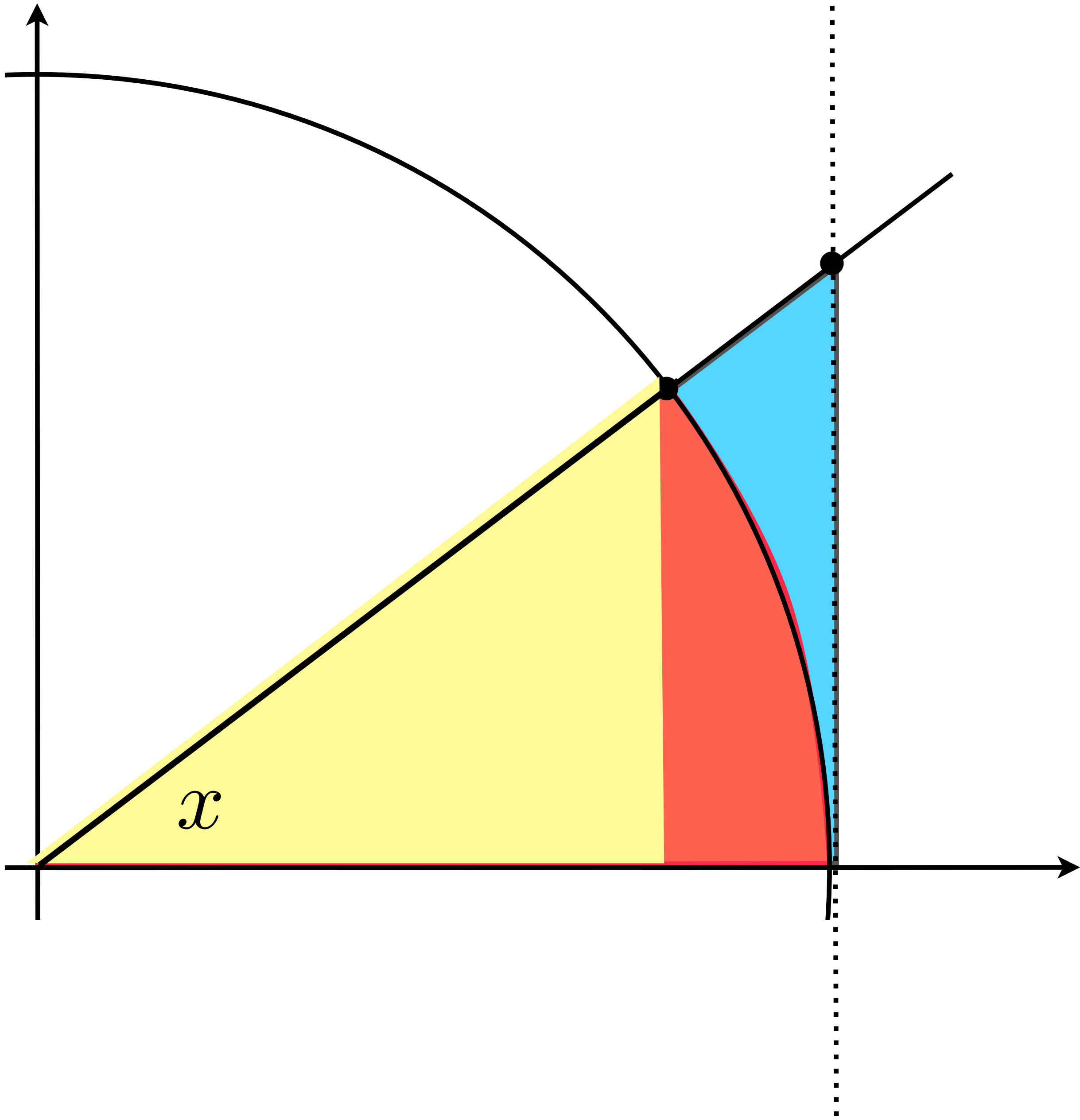

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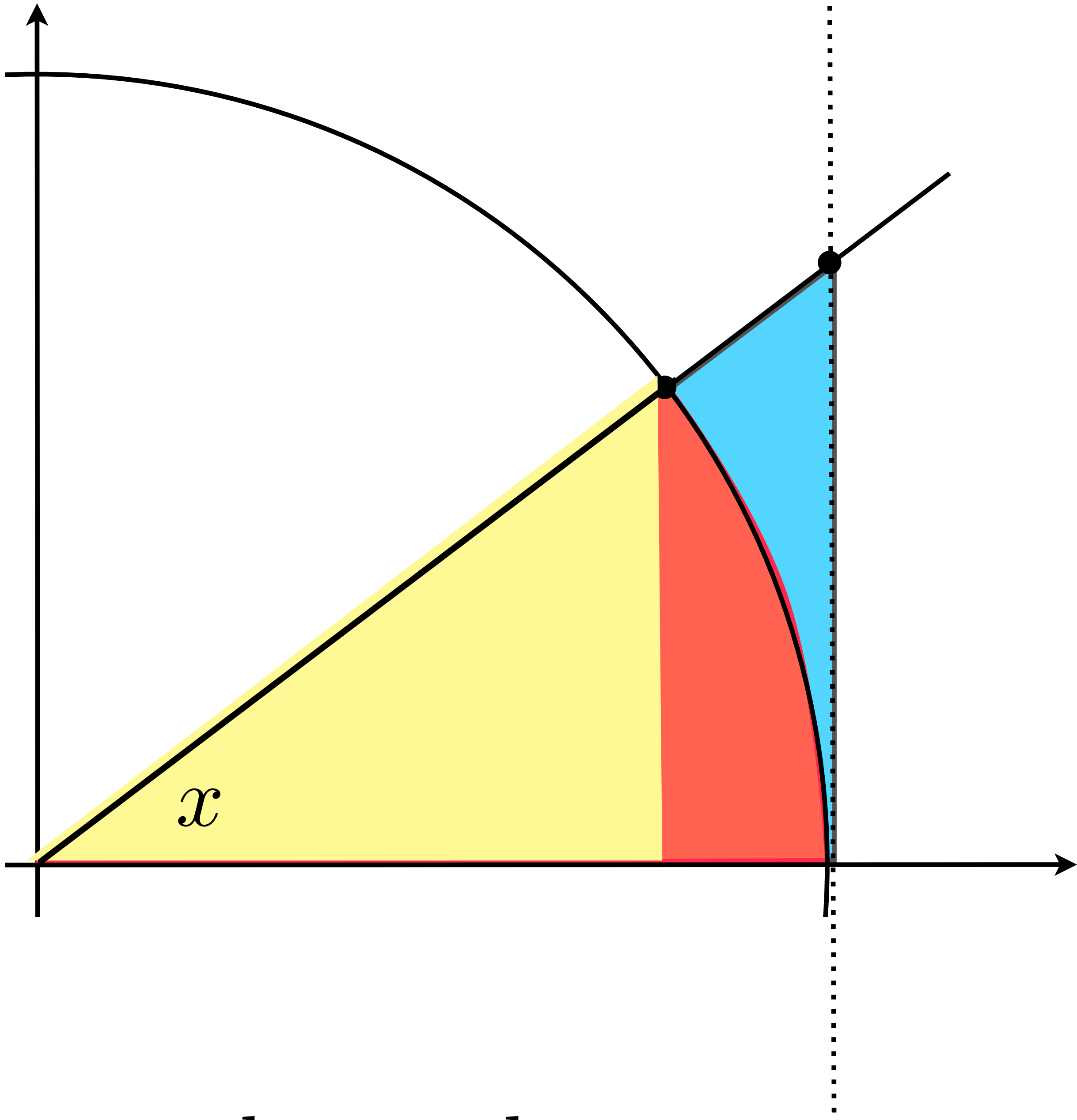
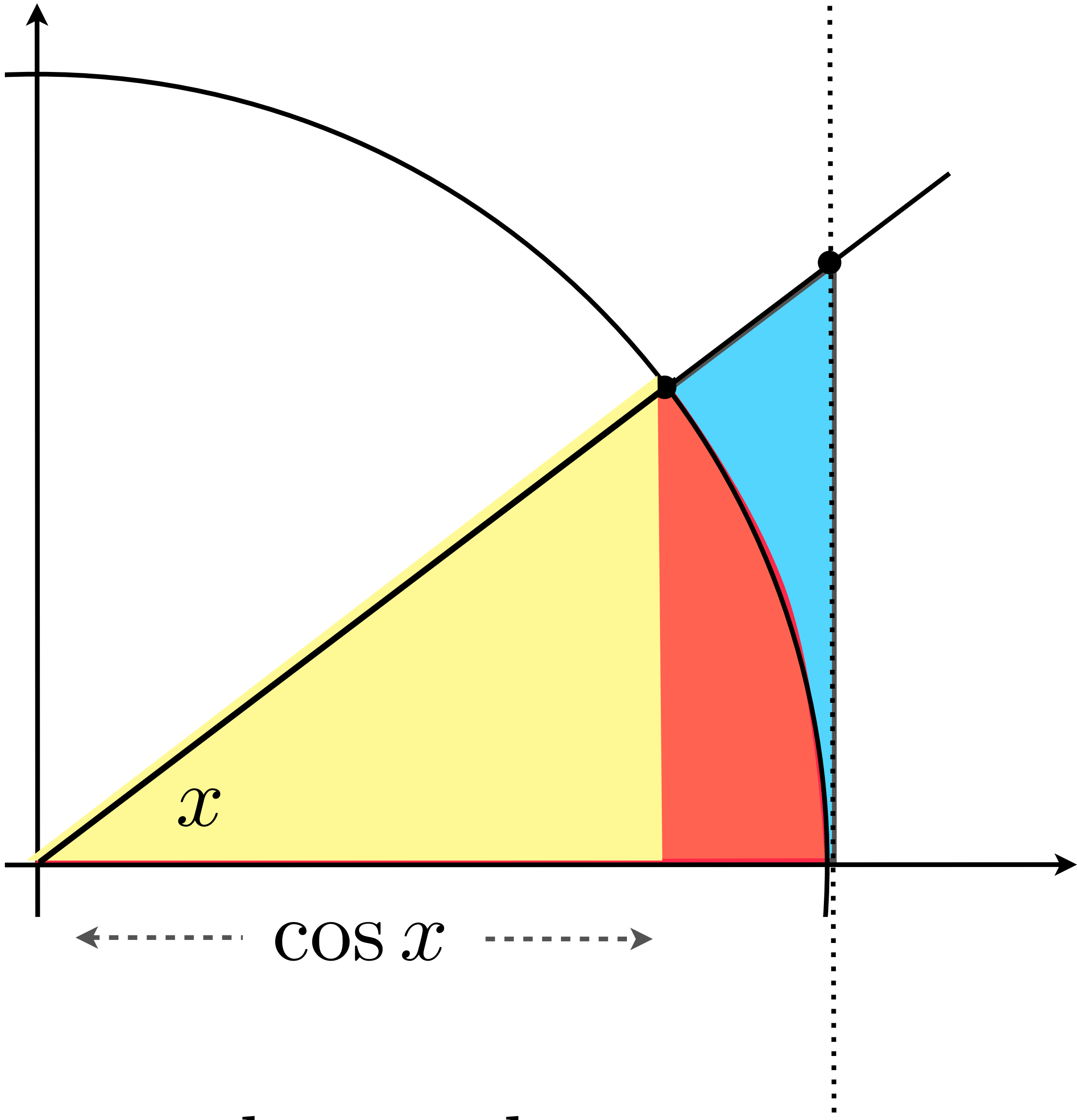


$$\text{Aire}_{\triangle} = \frac{\text{base} \times \text{hauteur}}{2}$$



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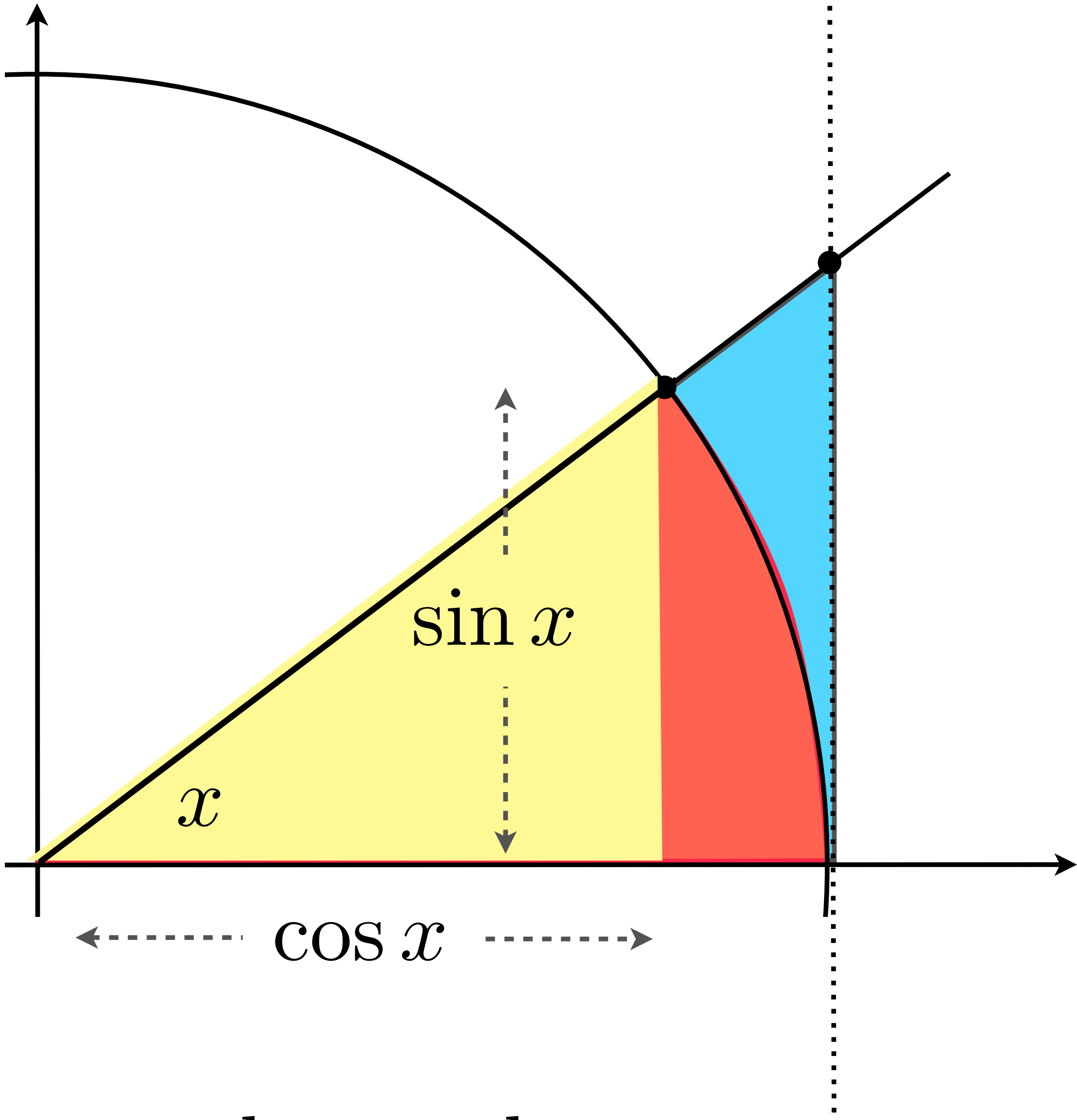

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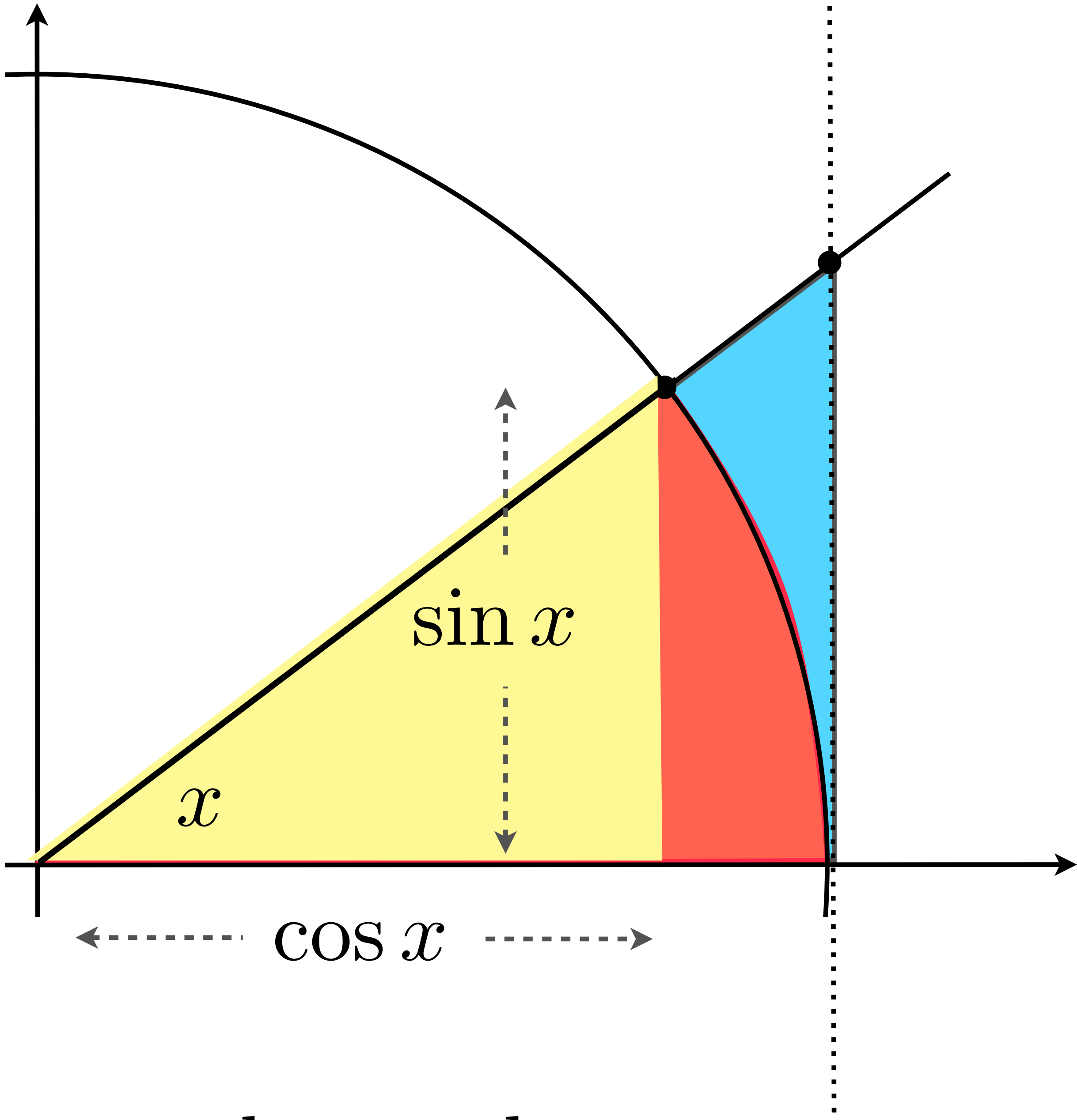

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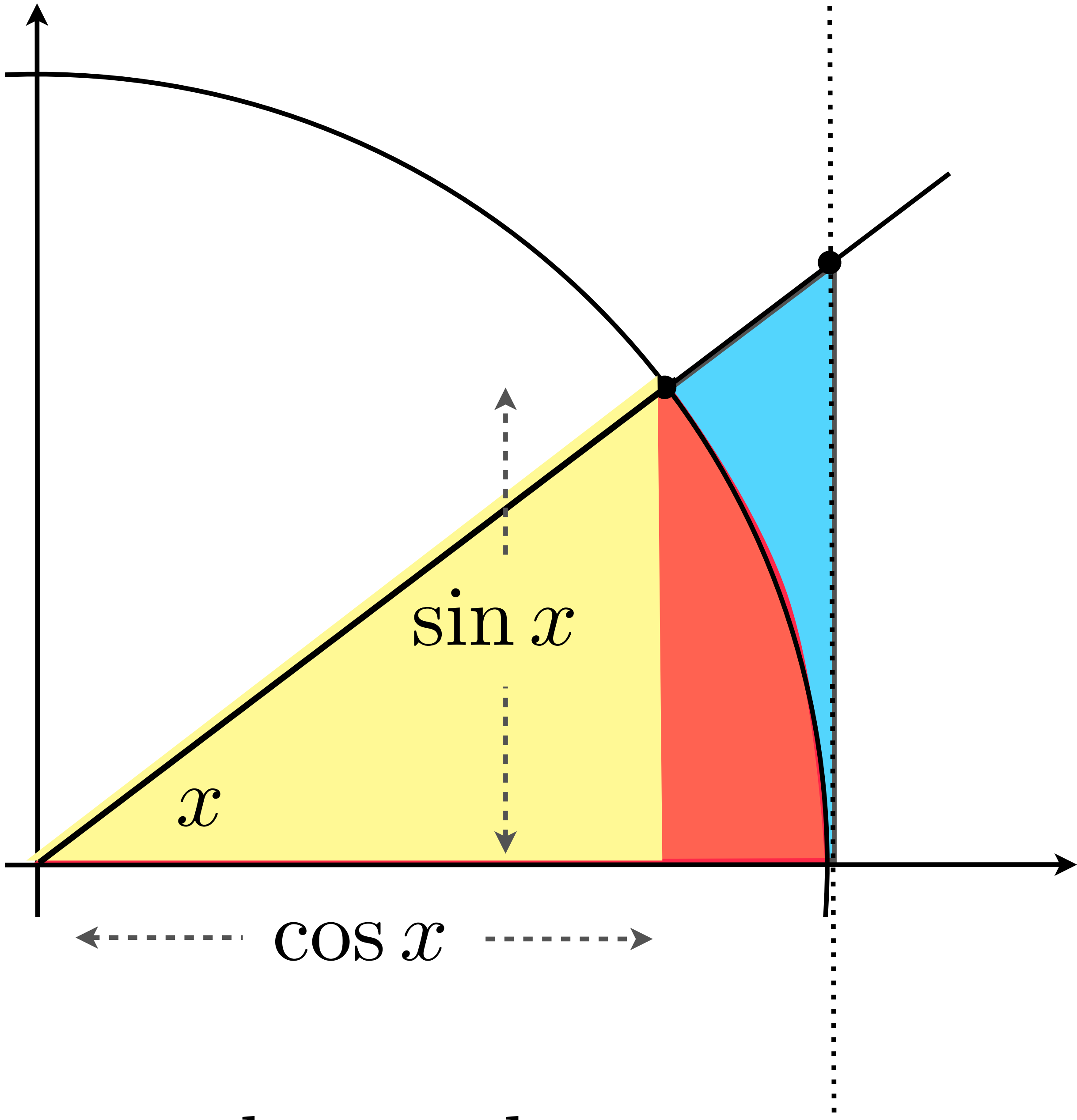

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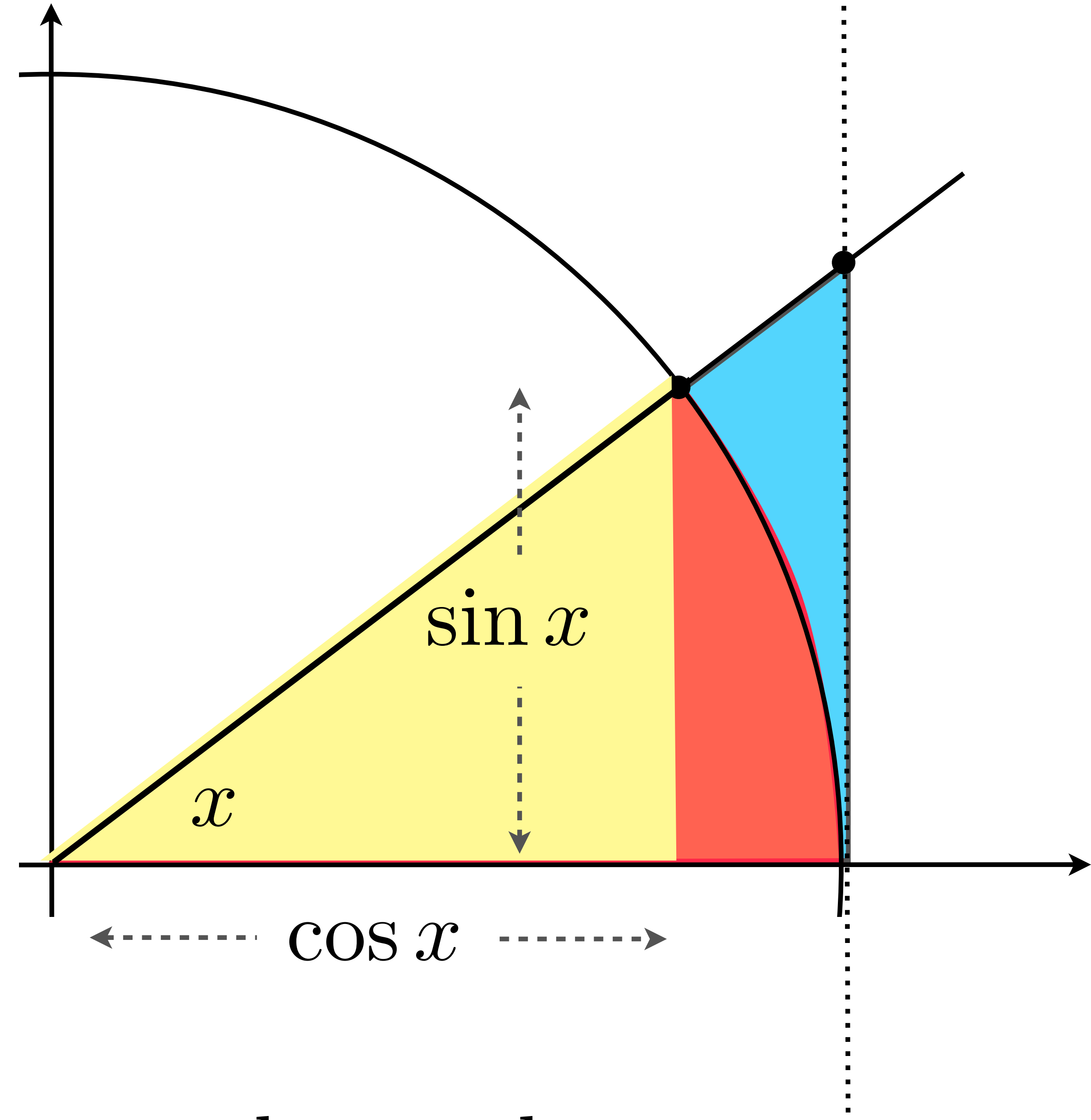

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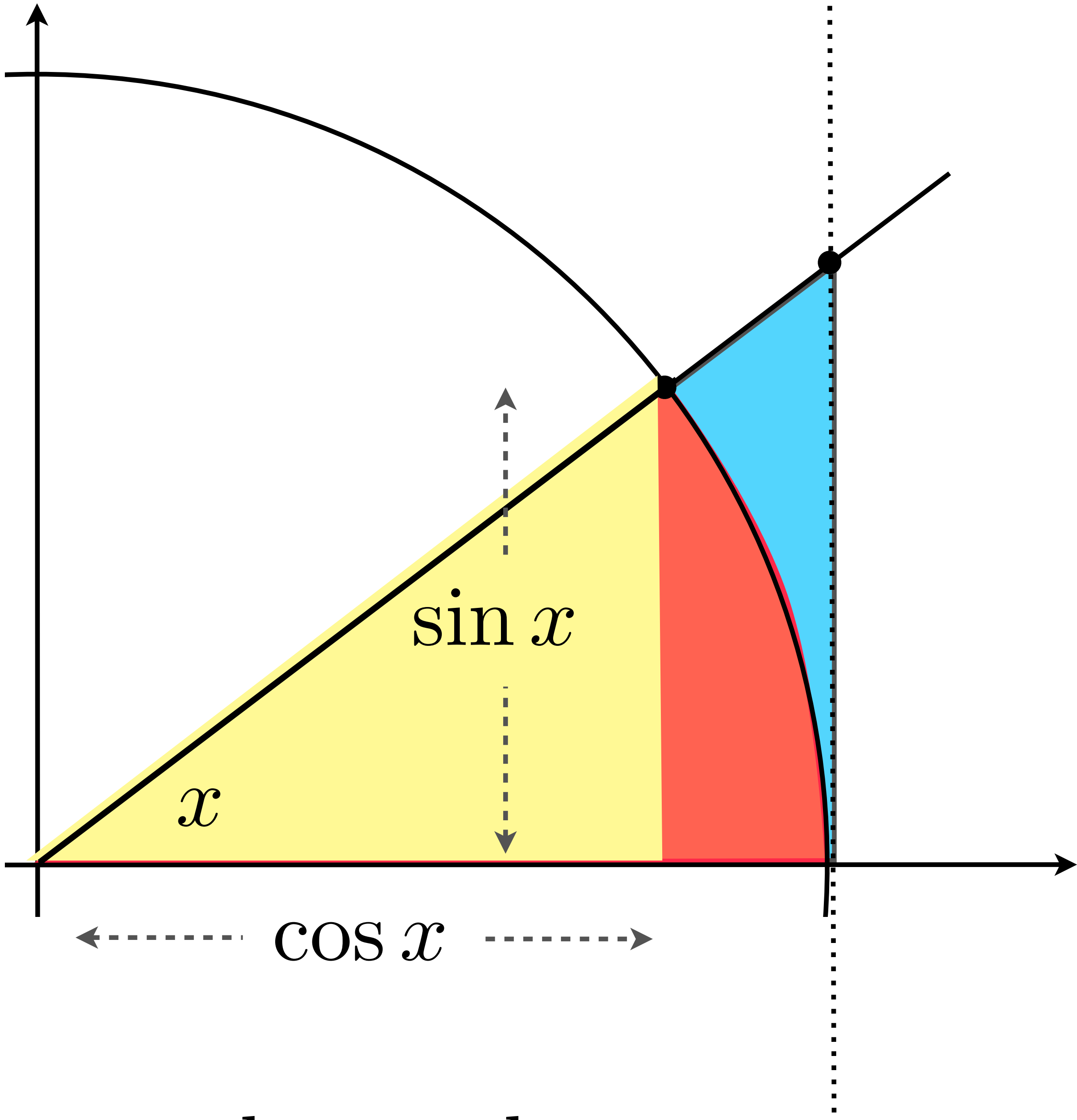

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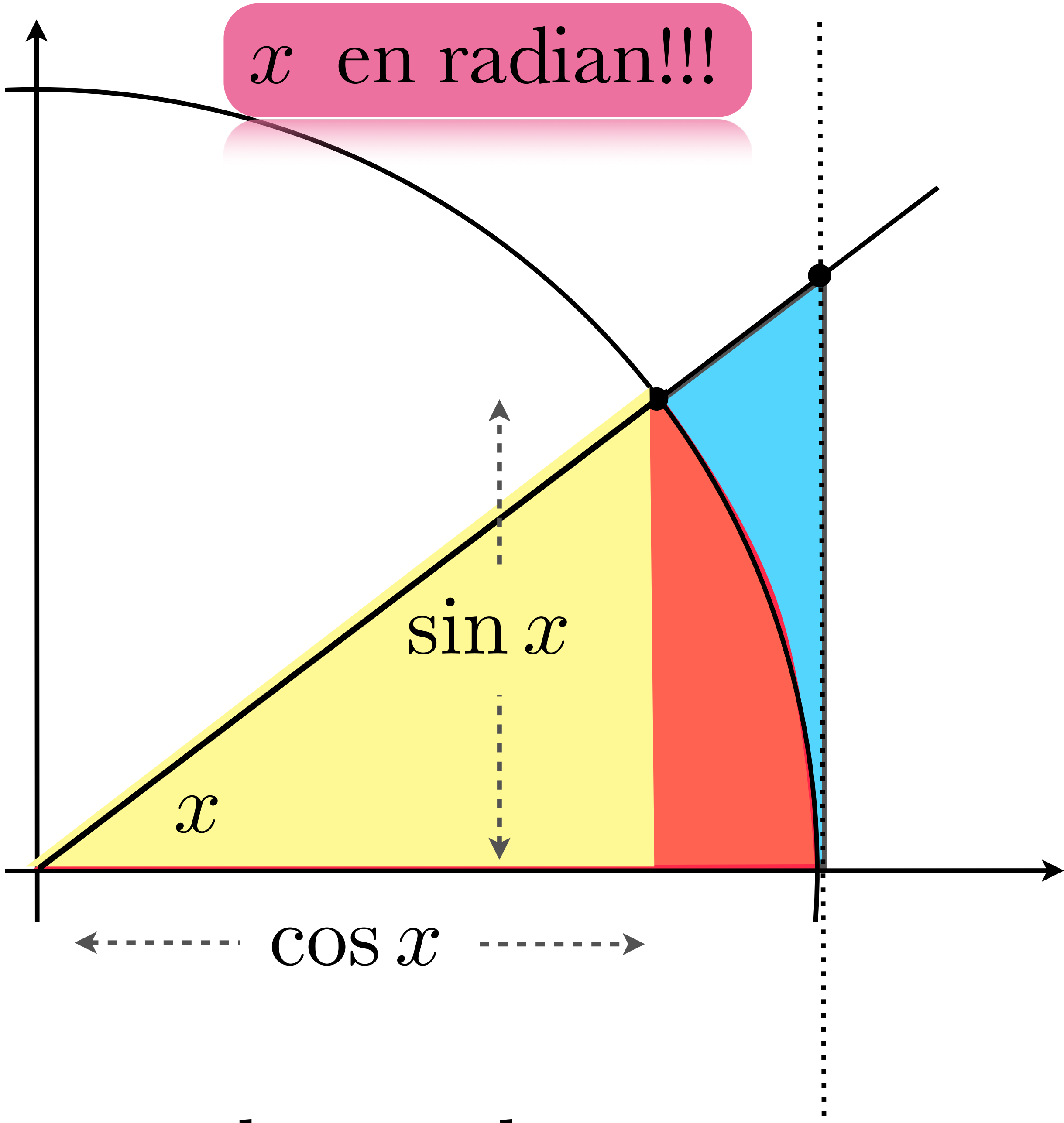

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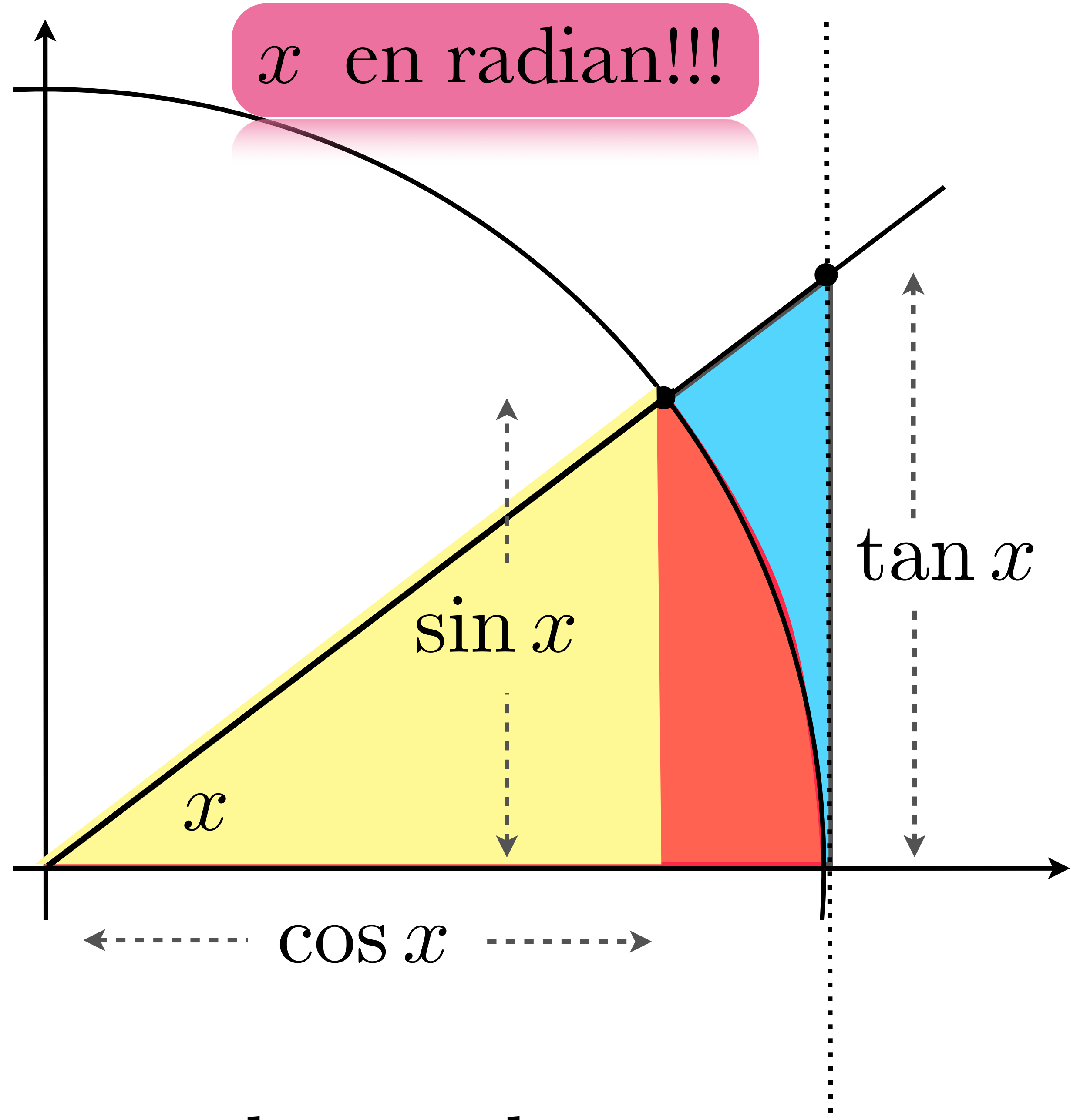

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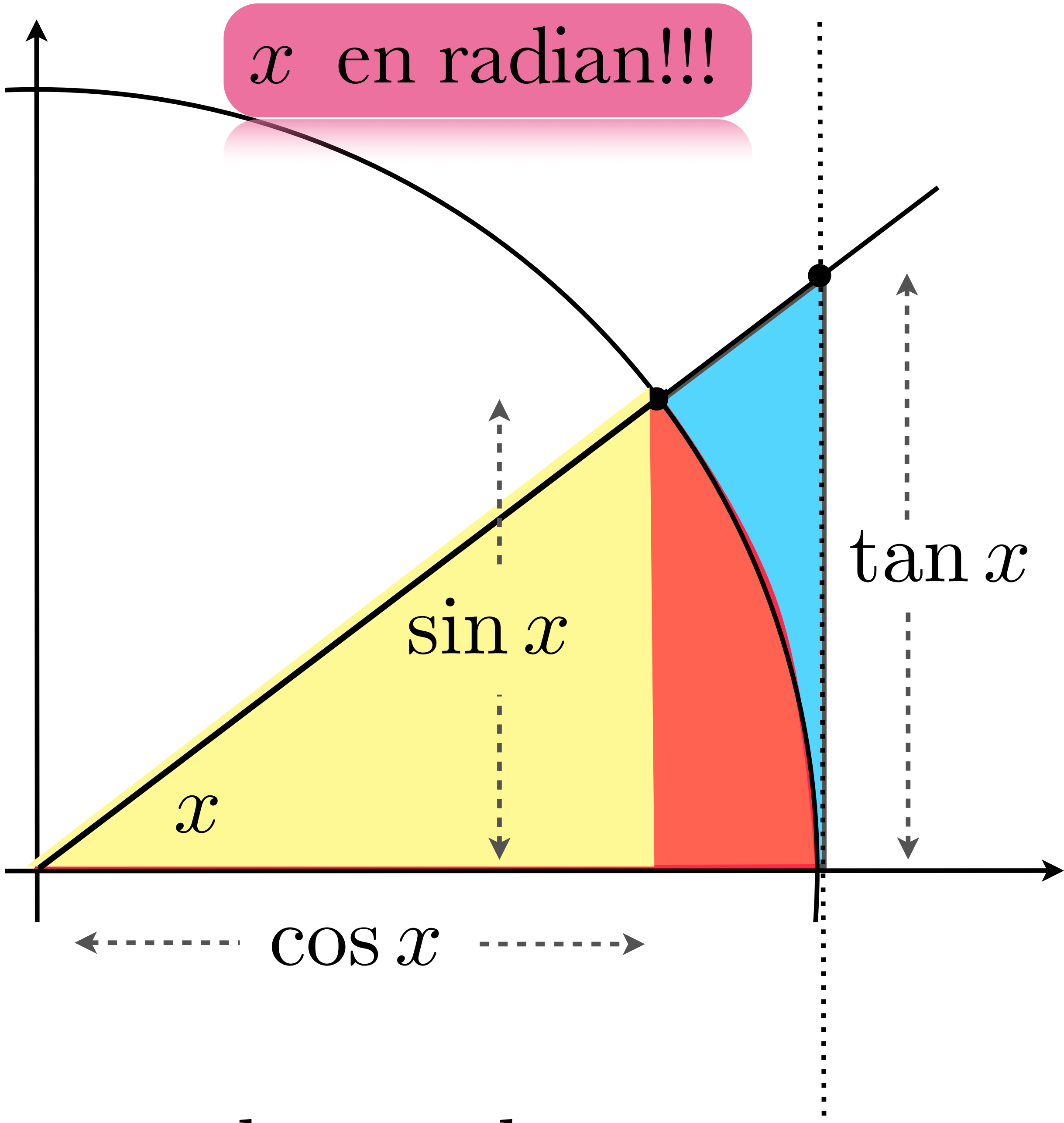

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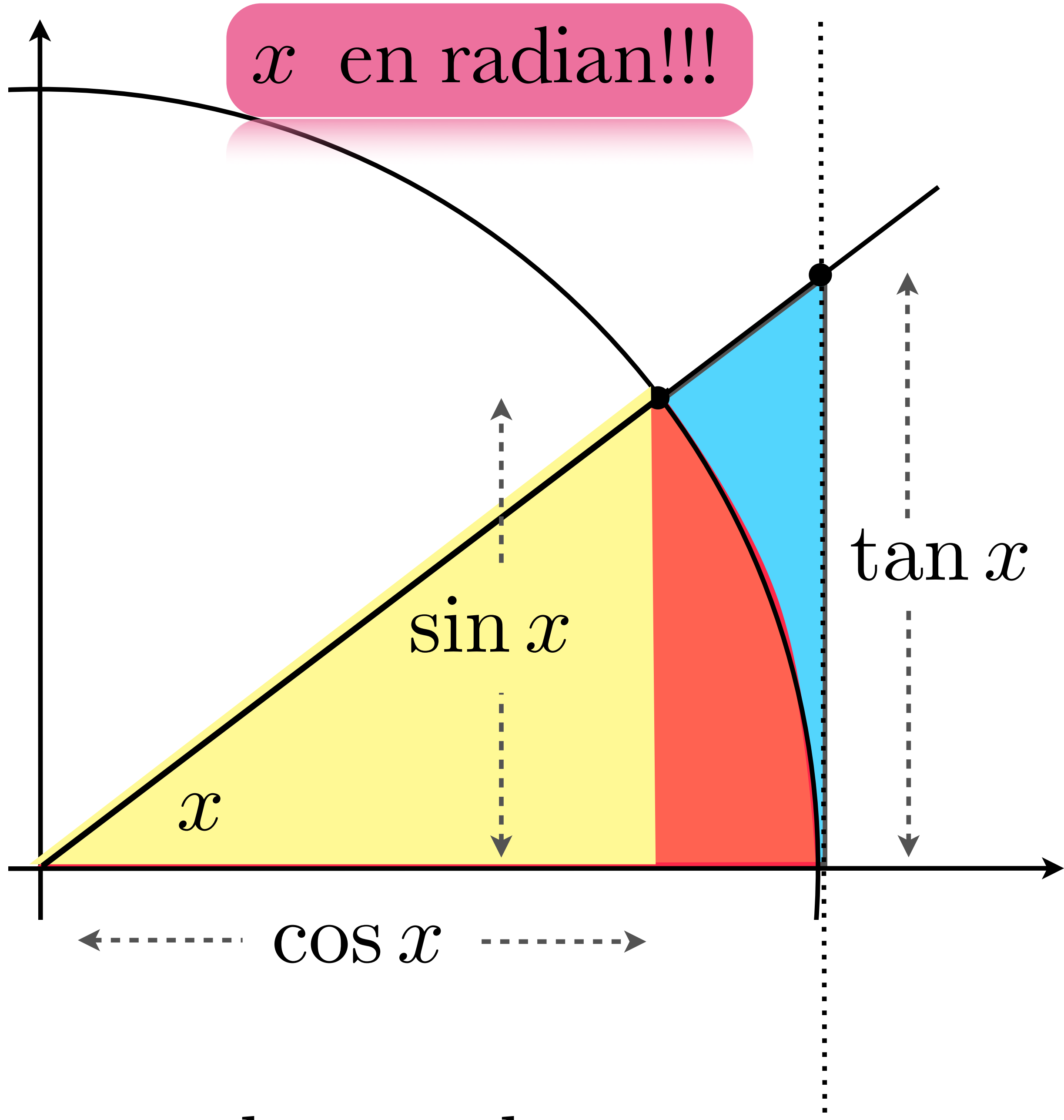

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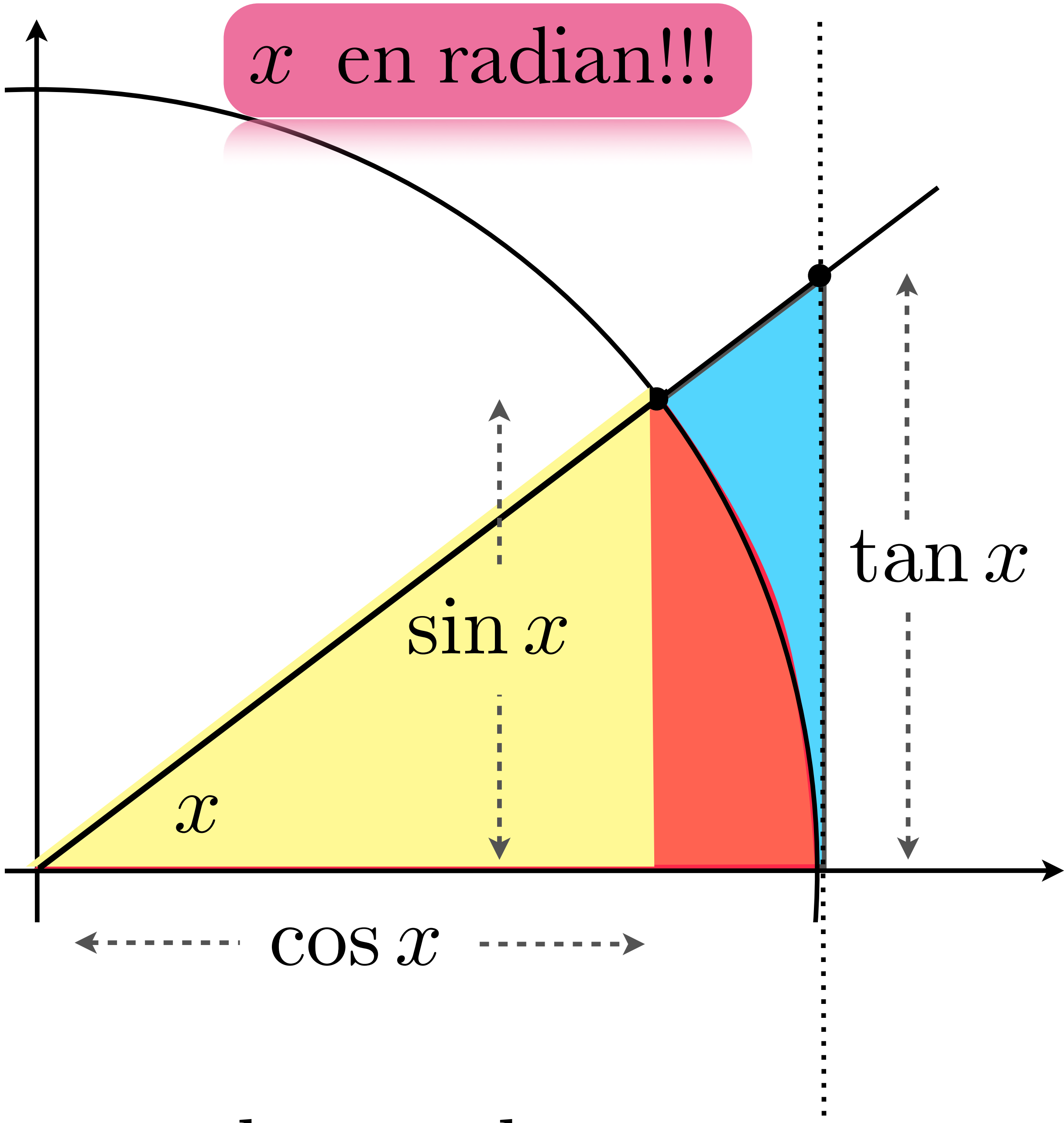

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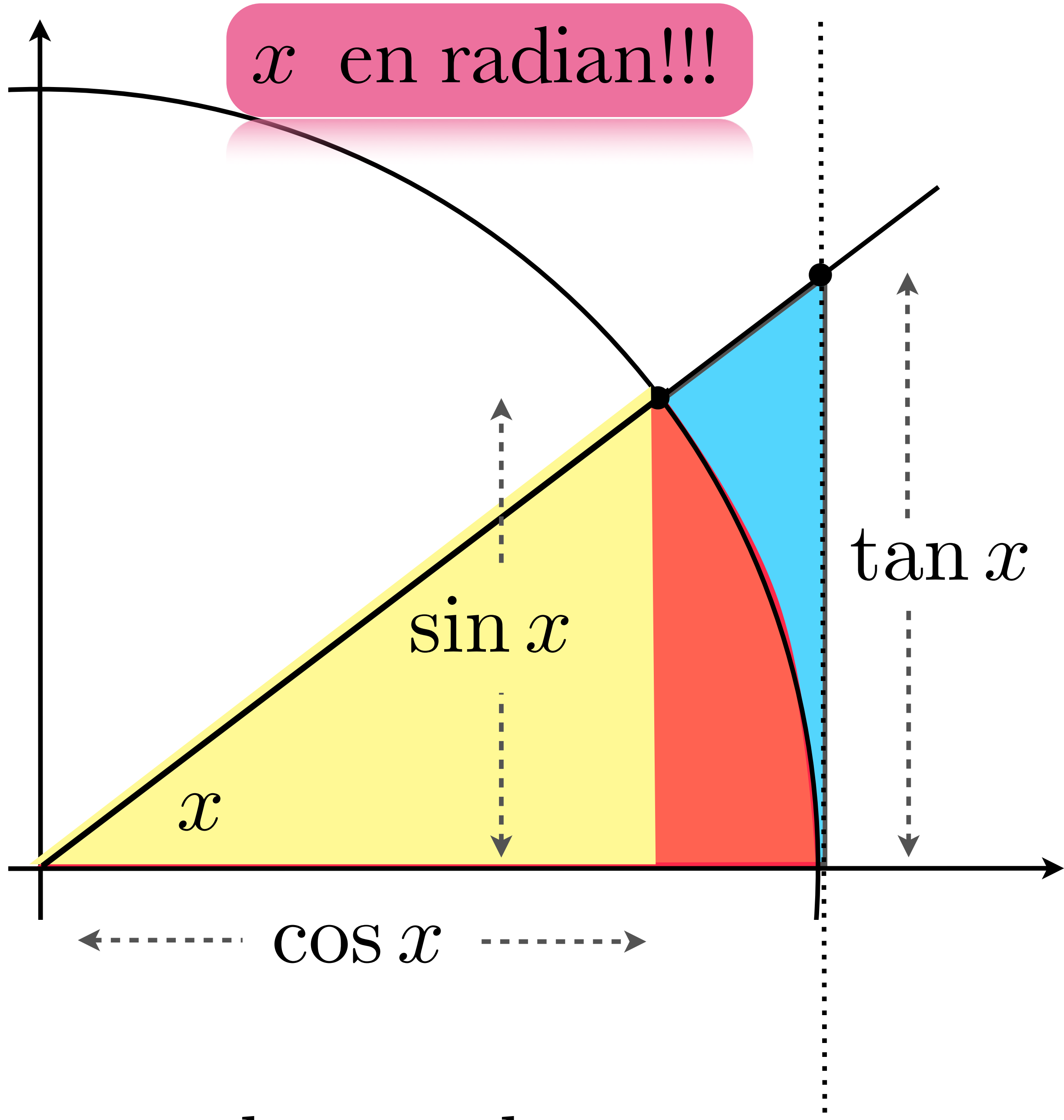

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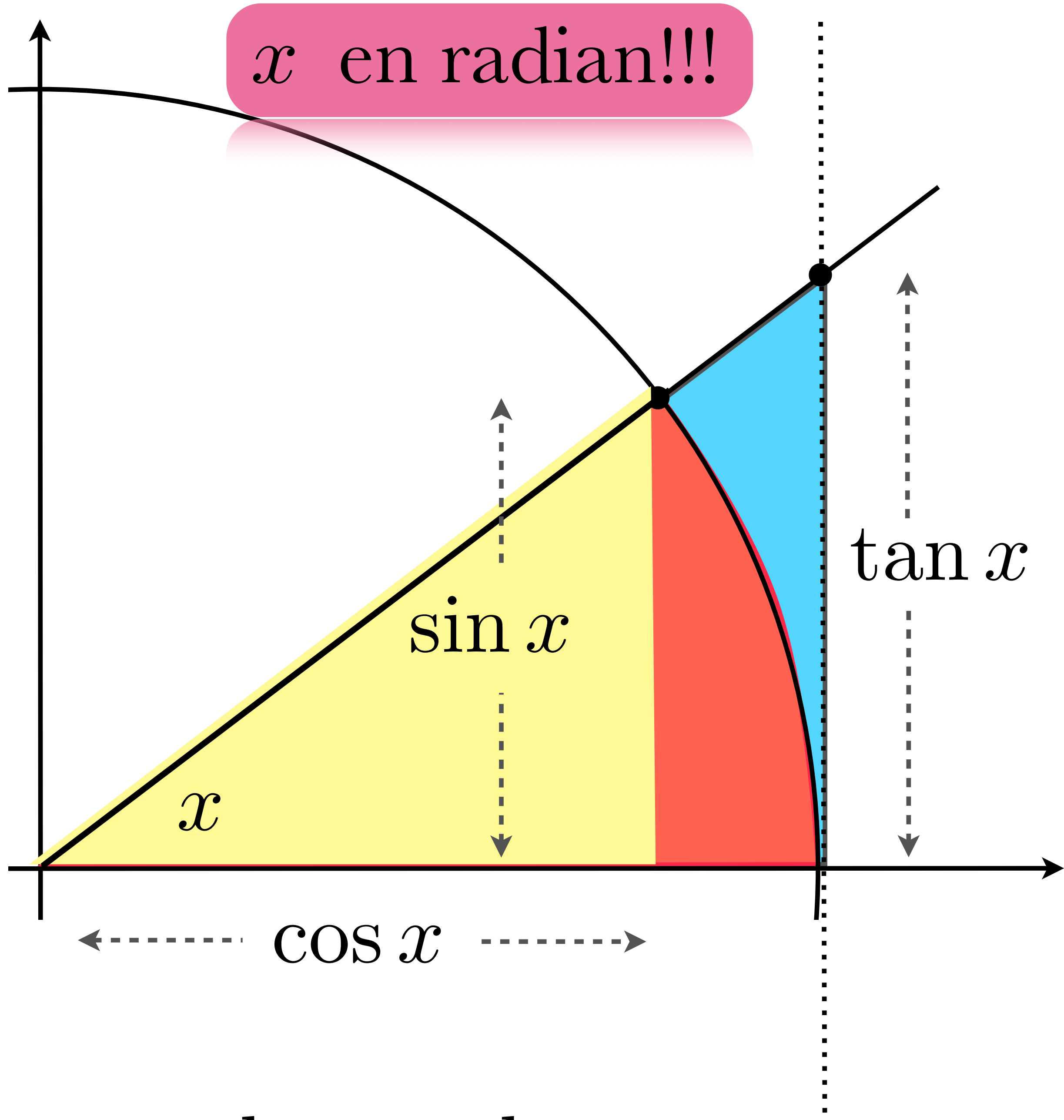

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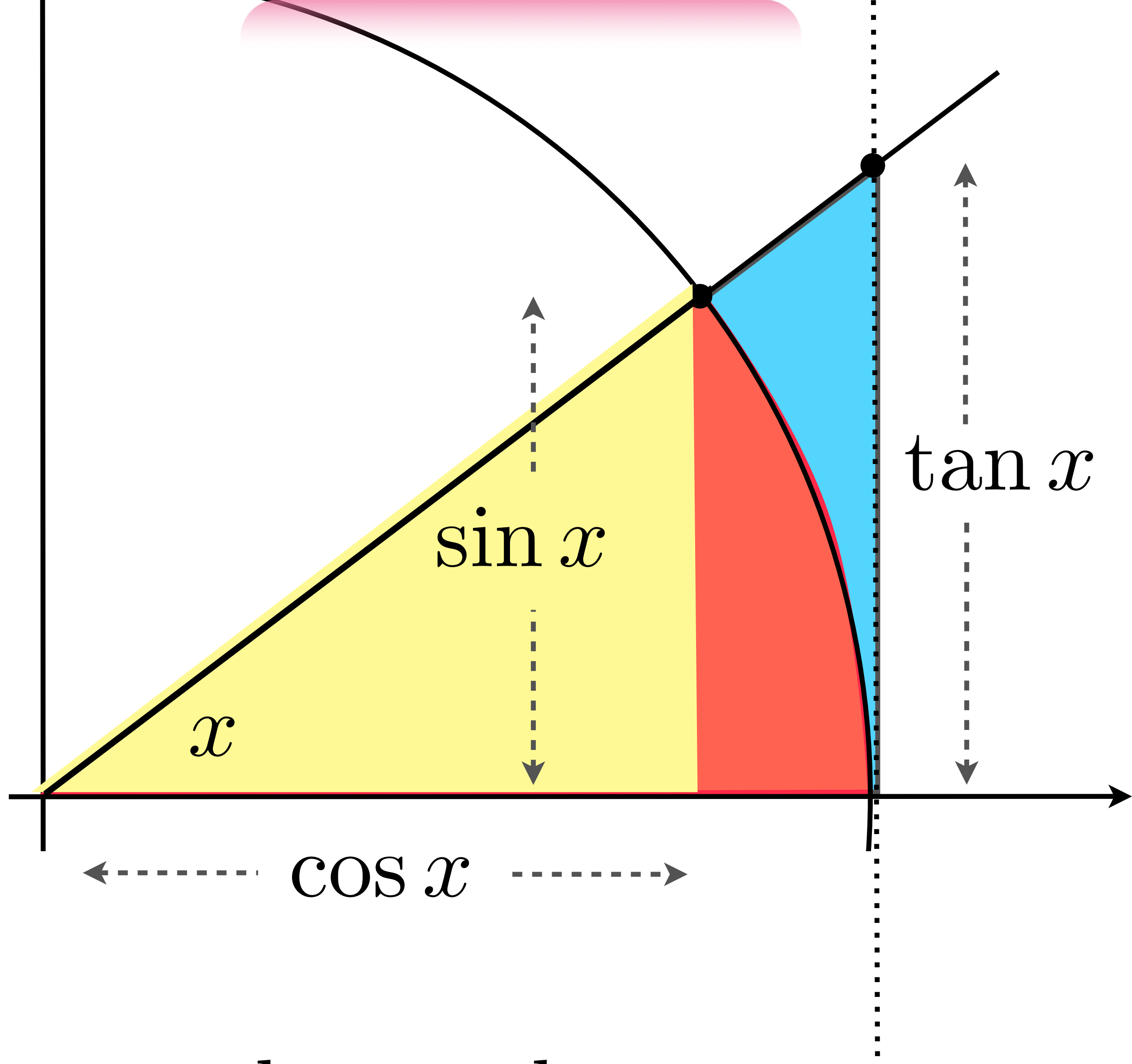
Quand
$x \to 0$

x en radian!!!



$$\text{Aire}_{\triangle} = \frac{\text{base} \times \text{hauteur}}{2}$$

x en radian!!!

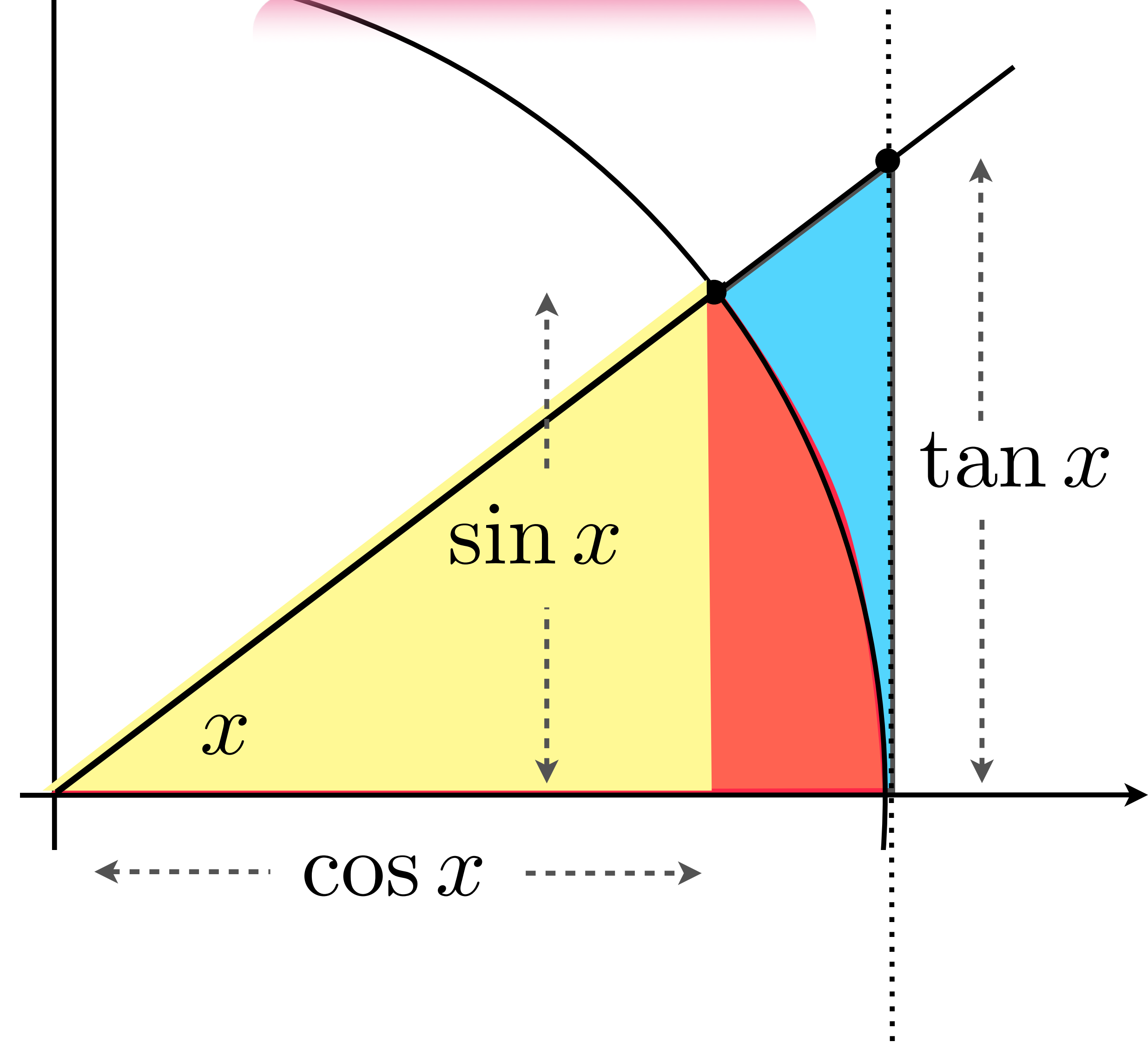
$$\frac{\cos x \sin x}{2} \leq \frac{x}{2} \leq \frac{\sin x}{2 \cos x}$$

$$\sin x \cos x \leq x \leq \frac{\sin x}{\cos x}$$

$$\cos x \leq \frac{x}{\sin x} \leq \frac{1}{\cos x}$$

Quand $x \to 0$ ↓

$$1$$



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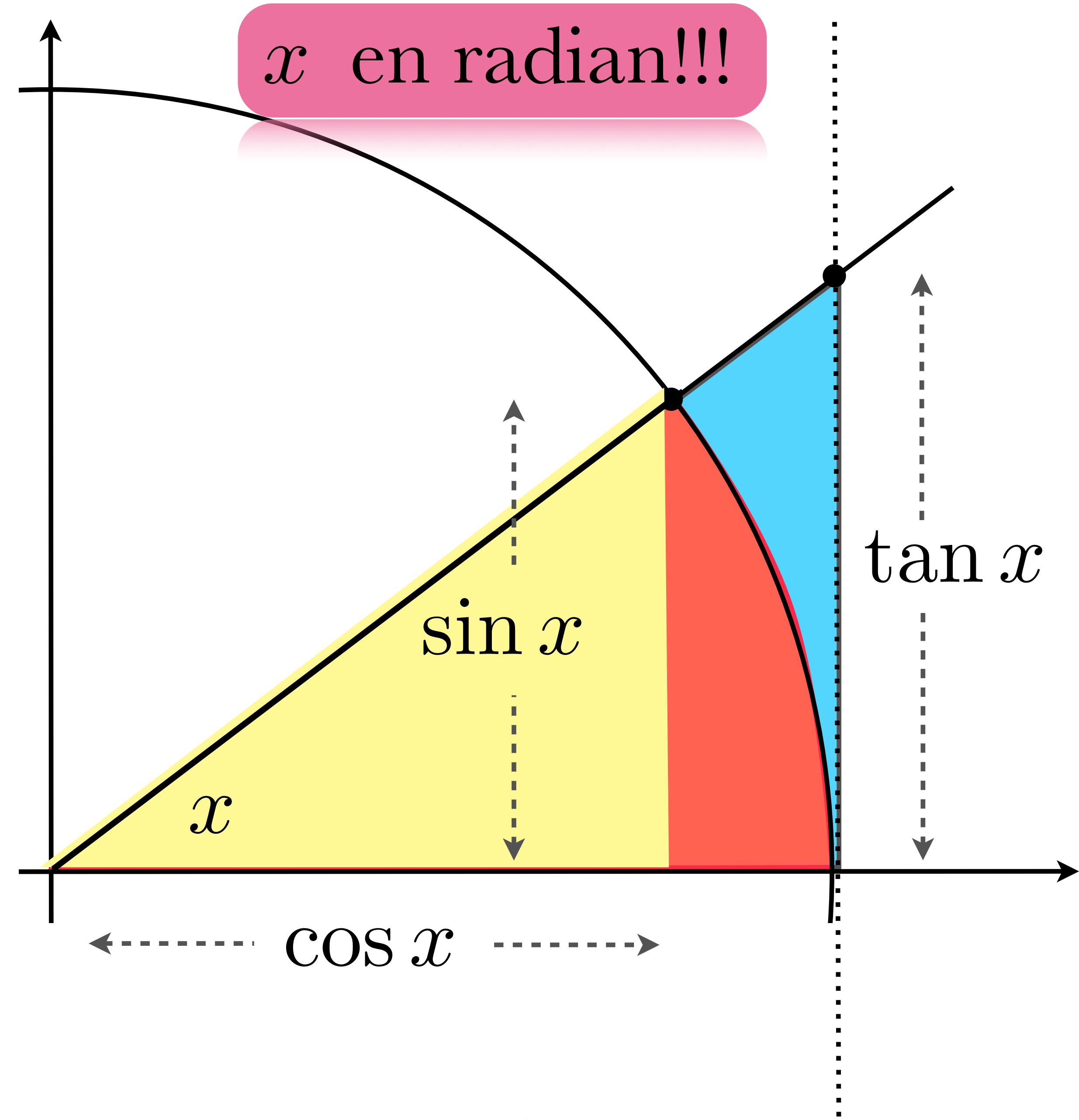
Quand $x \to 0$: $\cos x \to 1$ and $\frac{1}{\cos x} \to 1$



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Quand $x \to 0$

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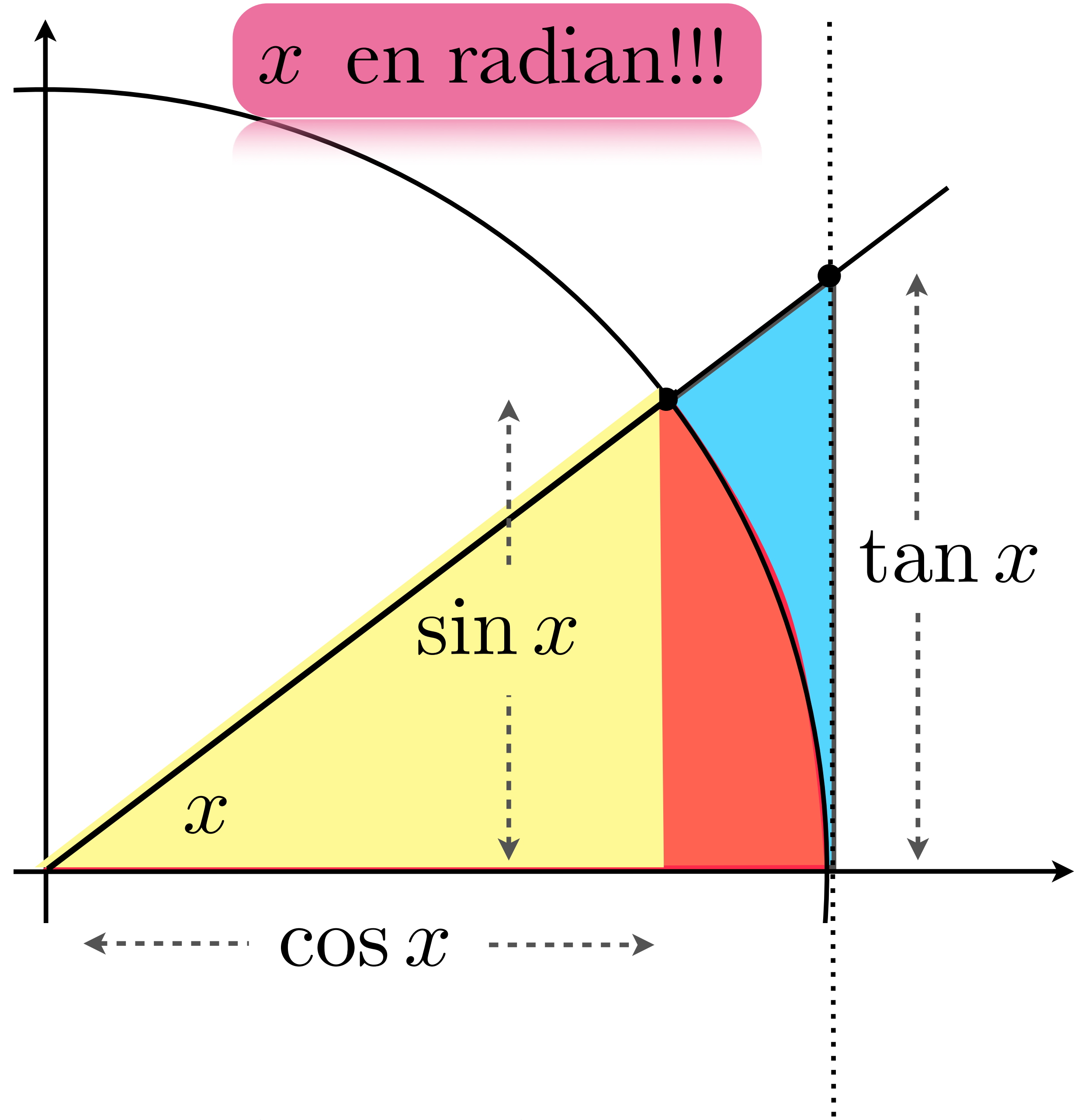

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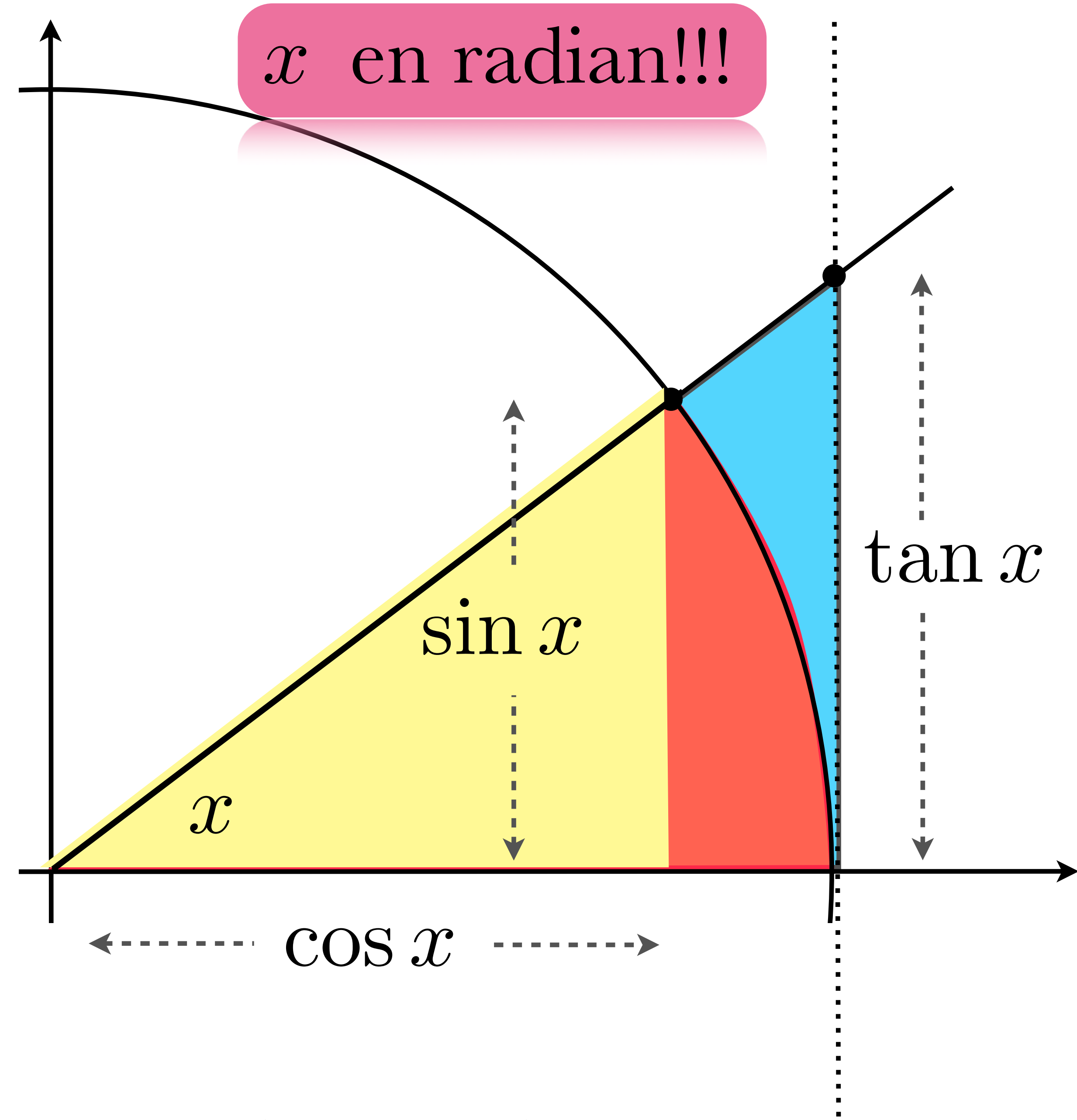

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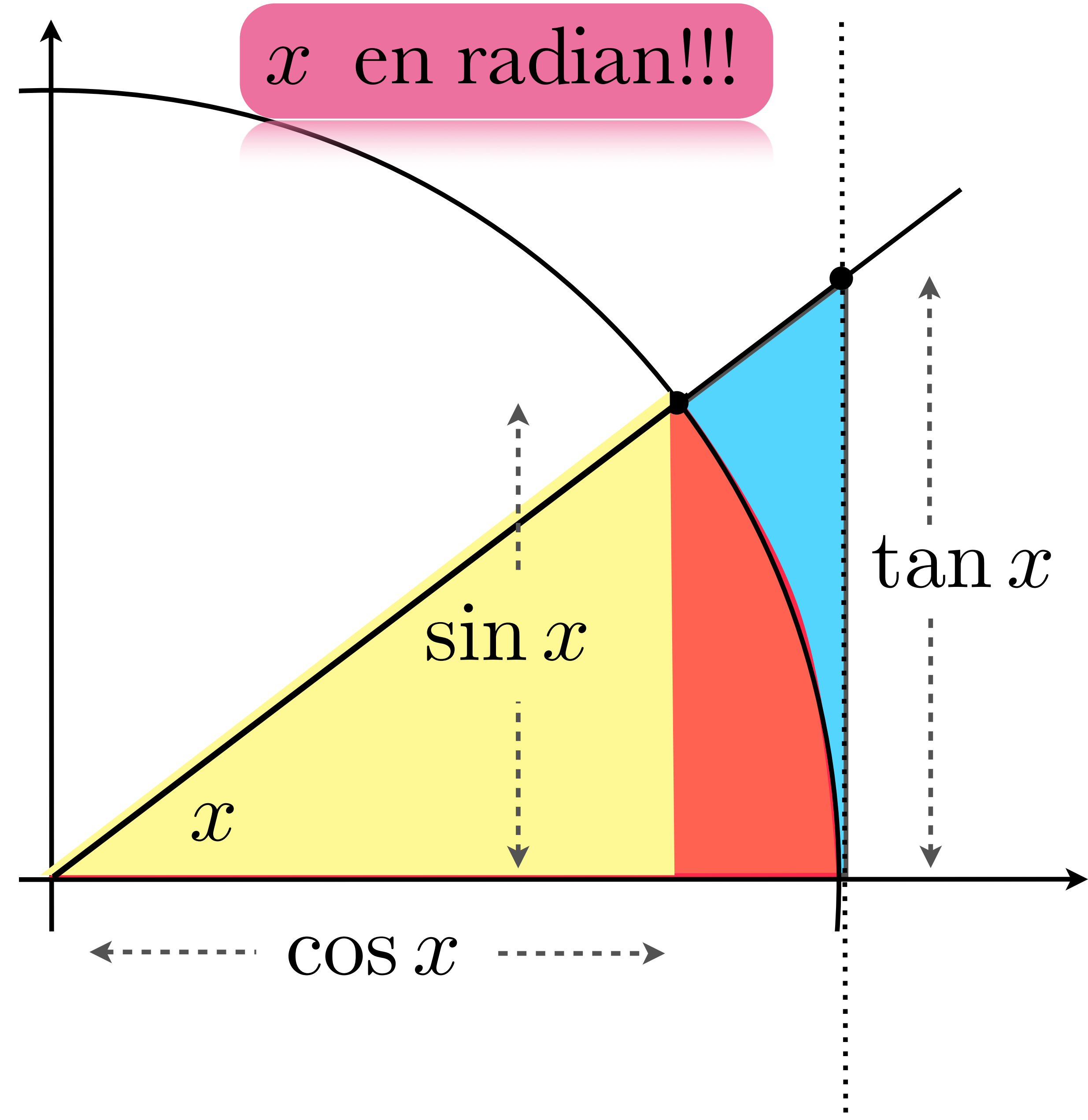

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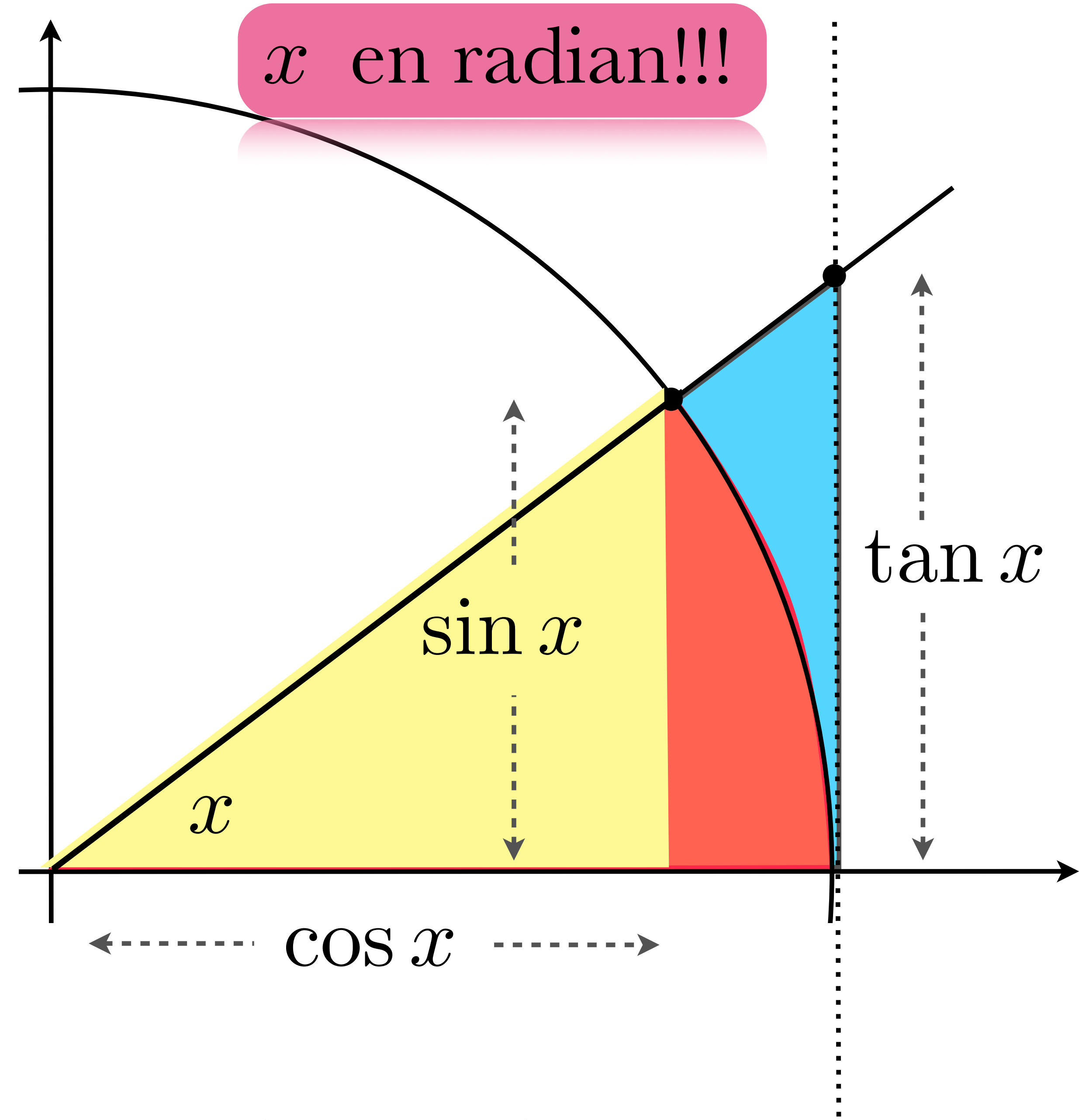

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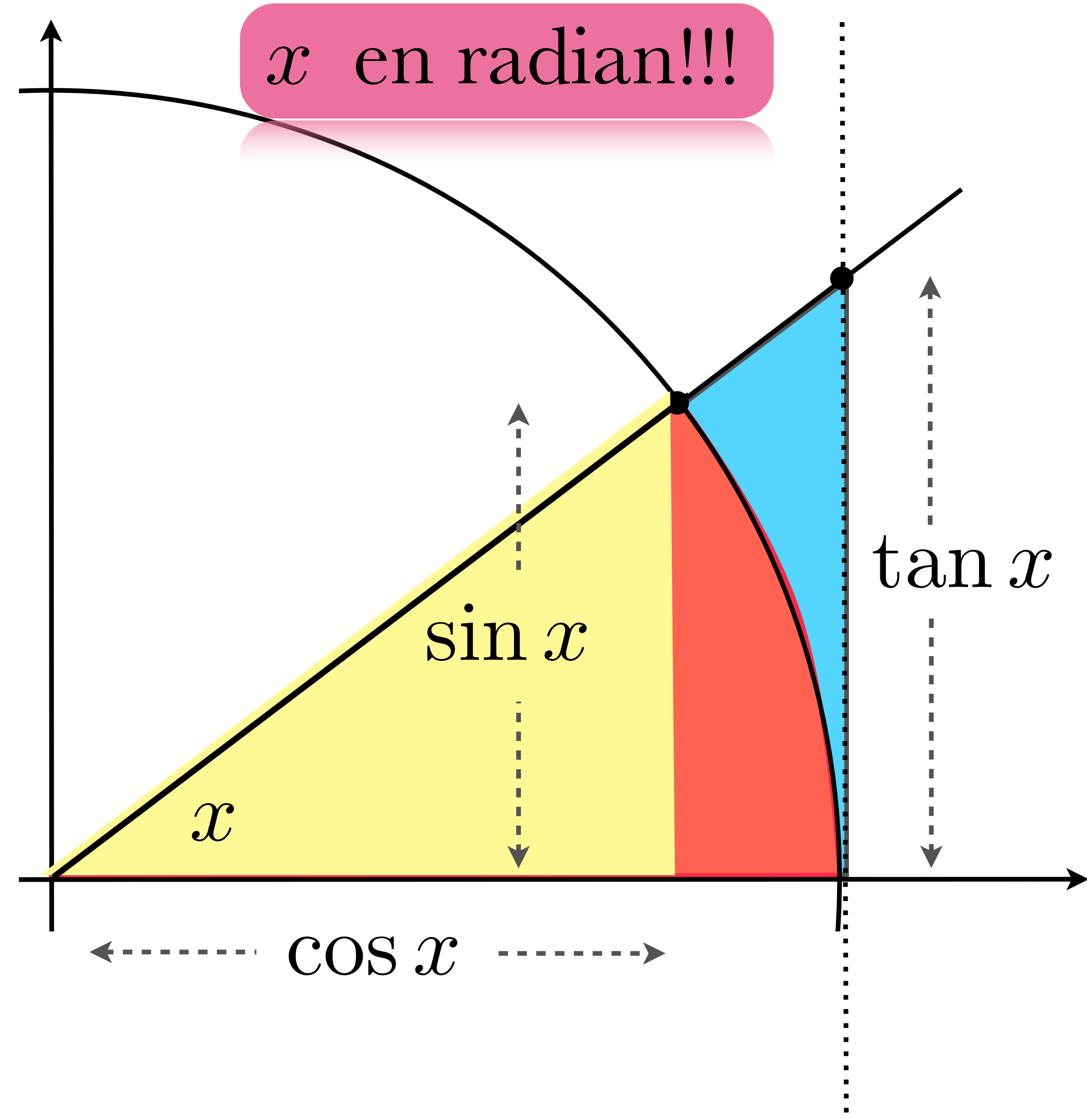

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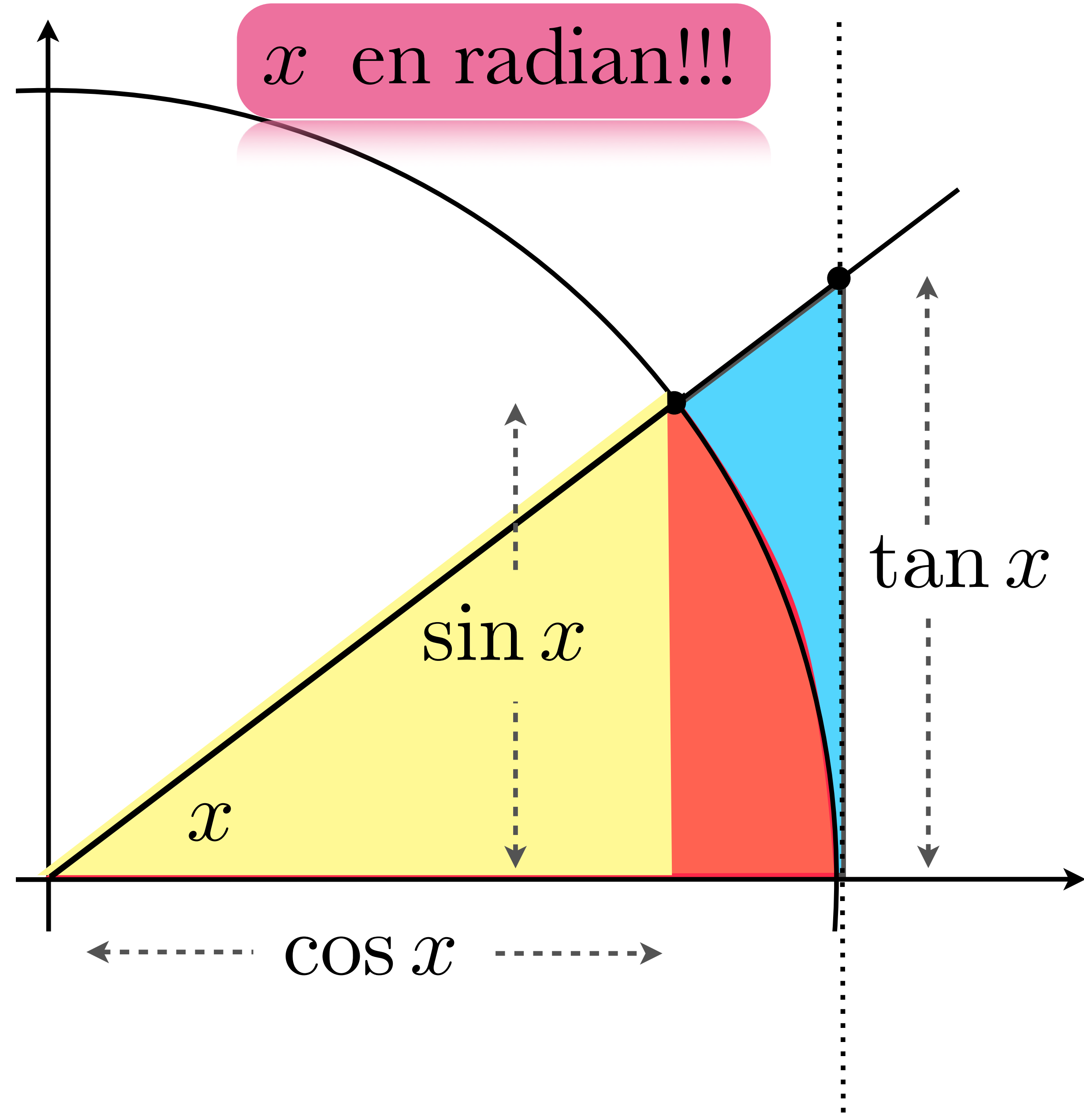

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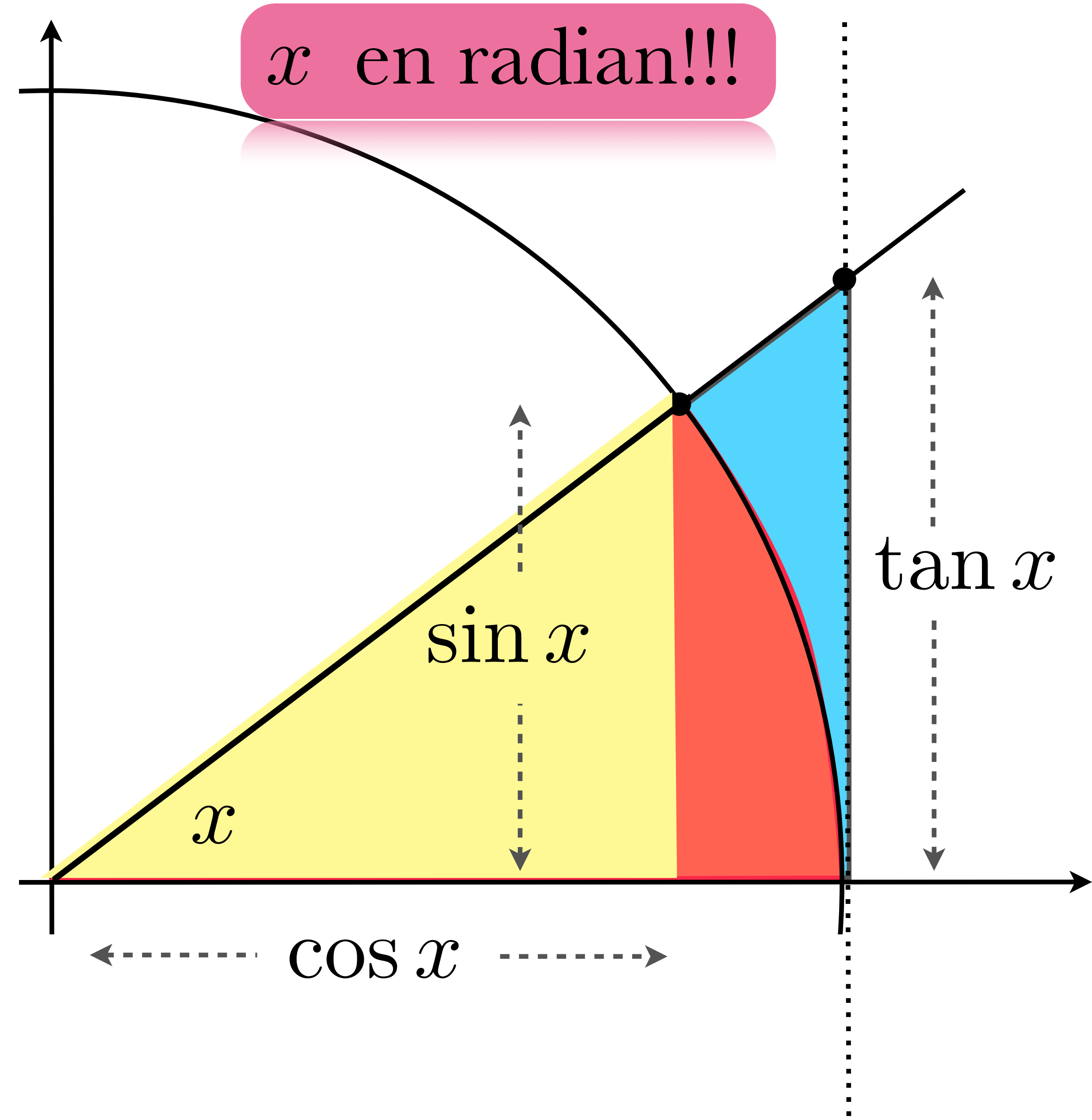

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L'autre limite maintenant…

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$$\lim_{x \to 0} \frac{\cos x - 1}{x}$$

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Calculons la dérivée de la fonction

$$f(x) = \sin x$$

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$$\frac{d}{dx}(\sin x) = \lim_{h\to 0} \frac{\sin(x)(\cos(h)-1)}{h} + \frac{\sin(h)\cos(x)}{h}$$

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$$= \sin(x)\lim_{h\to 0} \frac{\cos(h)-1}{h} + \cos(x)\lim_{h\to 0} \frac{\sin(h)}{h}$$

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$$\frac{d}{dx}(\sin x) = \lim_{h \to 0} \frac{\sin(x)(\cos(h) - 1)}{h} + \frac{\sin(h)\cos(x)}{h}$$

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$$= \sin(x) \lim_{h \to 0} \frac{\cos(h) - 1}{h} + \cos(x) \lim_{h \to 0} \frac{\sin(h)}{h}$$

$$= \sin(x)0 + \cos(x)1$$

$$\frac{d}{dx}(\sin x) = \lim_{h\to 0} \frac{\sin(x)(\cos(h)-1)}{h} + \frac{\sin(h)\cos(x)}{h}$$

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$$= \sin(x)0 + \cos(x)1$$

$$= \cos(x)$$

Calculons maintenant la dérivée de $f(x) = \cos x$

Calculons maintenant la dérivée de $f(x) = \cos x$

$$(\cos x)'$$

Calculons maintenant la dérivée de $f(x) = \cos x$

$$(\cos x)' = \lim_{h \to 0} \frac{\cos(x+h) - \cos(x)}{h}$$

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$$= \lim_{h\to 0} \frac{\cos x(\cos h - 1) - \sin x \sin h}{h}$$

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$$= \lim_{h \to 0} \frac{\cos x (\cos h - 1)}{h} - \lim_{h \to 0} \frac{\sin x \sin h}{h}$$

$$= \cos x \lim_{h \to 0} \frac{\cos h - 1}{h} - \sin x \lim_{h \to 0} \frac{\sin h}{h}$$

Calculons maintenant la dérivée de $f(x) = \cos x$

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Calculons maintenant la dérivée de $f(x) = \cos x$

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$$= \lim_{h \to 0} \frac{\cos x (\cos h - 1) - \sin x \sin h}{h}$$

$$= \lim_{h \to 0} \frac{\cos x (\cos h - 1)}{h} - \lim_{h \to 0} \frac{\sin x \sin h}{h}$$

$$= \cos x \lim_{h \to 0} \frac{\cos h - 1}{h} - \sin x \lim_{h \to 0} \frac{\sin h}{h}$$

$$= 0 \cos x - 1 \sin x$$

Calculons maintenant la dérivée de $f(x) = \cos x$

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$$= \cos x \lim_{h \to 0} \frac{\cos h - 1}{h} - \sin x \lim_{h \to 0} \frac{\sin h}{h}$$

$$= 0 \cos x - 1 \sin x$$

Calculons maintenant la dérivée de $f(x) = \cos x$

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$$= \cos x \lim_{h\to 0} \frac{\cos h - 1}{h} - \sin x \lim_{h\to 0} \frac{\sin h}{h}$$

$$= 0 \cos x - 1 \sin x \quad = -\sin x$$

Faites les exercices suivants

Calculer la dérivée des fonctions suivante

a) $f(x) = \tan x$

b) $f(x) = \sec x$

c) $f(x) = \cot x$

d) $f(x) = \csc x$

Exemple $(\tan x)'$

Exemple

$$(\tan x)' = \left(\frac{\sin x}{\cos x}\right)'$$

Exemple

$$(\tan x)' = \left(\frac{\sin x}{\cos x}\right)' = \frac{\sin x' \cos x - \sin x \cos x'}{\cos^2 x}$$

Exemple

$$(\tan x)' = \left(\frac{\sin x}{\cos x}\right)' = \frac{\sin x' \cos x - \sin x \cos x'}{\cos^2 x}$$

$$= \frac{\cos x \cos x - \sin x(-\sin x)}{\cos^2 x}$$

Exemple

$$(\tan x)' = \left(\frac{\sin x}{\cos x}\right)' = \frac{\sin x' \cos x - \sin x \cos x'}{\cos^2 x}$$

$$= \frac{\cos x \cos x - \sin x(-\sin x)}{\cos^2 x} = \frac{\cos^2 x + \sin^2 x}{\cos^2 x}$$

Exemple

$$(\tan x)' = \left(\frac{\sin x}{\cos x}\right)' = \frac{\sin x' \cos x - \sin x \cos x'}{\cos^2 x}$$

$$= \frac{\cos x \cos x - \sin x(-\sin x)}{\cos^2 x} = \frac{\cos^2 x + \sin^2 x}{\cos^2 x} = \frac{1}{\cos^2 x}$$

Exemple

$$(\tan x)' = \left(\frac{\sin x}{\cos x}\right)' = \frac{\sin x' \cos x - \sin x \cos x'}{\cos^2 x}$$

$$= \frac{\cos x \cos x - \sin x(-\sin x)}{\cos^2 x} = \frac{\cos^2 x + \sin^2 x}{\cos^2 x} = \frac{1}{\cos^2 x} = \sec^2 x$$

Exemple

$$(\tan x)' = \left(\frac{\sin x}{\cos x}\right)' = \frac{\sin x' \cos x - \sin x \cos x'}{\cos^2 x}$$

$$= \frac{\cos x \cos x - \sin x(-\sin x)}{\cos^2 x} = \frac{\cos^2 x + \sin^2 x}{\cos^2 x} = \frac{1}{\cos^2 x} = \sec^2 x$$

Exemple

Exemple $$(\tan x)' = \left(\frac{\sin x}{\cos x}\right)' = \frac{\sin x' \cos x - \sin x \cos x'}{\cos^2 x}$$

$$= \frac{\cos x \cos x - \sin x(-\sin x)}{\cos^2 x} = \frac{\cos^2 x + \sin^2 x}{\cos^2 x} = \frac{1}{\cos^2 x} = \sec^2 x$$

Exemple $(\sec x)'$

Exemple $$(\tan x)' = \left(\frac{\sin x}{\cos x}\right)' = \frac{\sin x' \cos x - \sin x \cos x'}{\cos^2 x}$$

$$= \frac{\cos x \cos x - \sin x(-\sin x)}{\cos^2 x} = \frac{\cos^2 x + \sin^2 x}{\cos^2 x} = \frac{1}{\cos^2 x} = \sec^2 x$$

Exemple $$(\sec x)' = \left(\frac{1}{\cos x}\right)'$$

Exemple $$(\tan x)' = \left(\frac{\sin x}{\cos x}\right)' = \frac{\sin x' \cos x - \sin x \cos x'}{\cos^2 x}$$

$$= \frac{\cos x \cos x - \sin x(-\sin x)}{\cos^2 x} = \frac{\cos^2 x + \sin^2 x}{\cos^2 x} = \frac{1}{\cos^2 x} = \sec^2 x$$

Exemple $$(\sec x)' = \left(\frac{1}{\cos x}\right)' = \frac{-(-\sin x)}{\cos^2 x}$$

Exemple $$(\tan x)' = \left(\frac{\sin x}{\cos x}\right)' = \frac{\sin x' \cos x - \sin x \cos x'}{\cos^2 x}$$

$$= \frac{\cos x \cos x - \sin x(-\sin x)}{\cos^2 x} = \frac{\cos^2 x + \sin^2 x}{\cos^2 x} = \frac{1}{\cos^2 x} = \sec^2 x$$

Exemple $$(\sec x)' = \left(\frac{1}{\cos x}\right)' = \frac{-(-\sin x)}{\cos^2 x} = \frac{\sin x}{\cos^2 x}$$

Exemple

$$(\tan x)' = \left(\frac{\sin x}{\cos x}\right)' = \frac{\sin x' \cos x - \sin x \cos x'}{\cos^2 x}$$

$$= \frac{\cos x \cos x - \sin x(-\sin x)}{\cos^2 x} = \frac{\cos^2 x + \sin^2 x}{\cos^2 x} = \frac{1}{\cos^2 x} = \sec^2 x$$

Exemple

$$(\sec x)' = \left(\frac{1}{\cos x}\right)' = \frac{-(-\sin x)}{\cos^2 x} = \frac{\sin x}{\cos^2 x}$$

$$= \frac{1}{\cos x}\frac{\sin x}{\cos x}$$

Exemple

$$(\tan x)' = \left(\frac{\sin x}{\cos x}\right)' = \frac{\sin x' \cos x - \sin x \cos x'}{\cos^2 x}$$

$$= \frac{\cos x \cos x - \sin x(-\sin x)}{\cos^2 x} = \frac{\cos^2 x + \sin^2 x}{\cos^2 x} = \frac{1}{\cos^2 x} = \sec^2 x$$

Exemple

$$(\sec x)' = \left(\frac{1}{\cos x}\right)' = \frac{-(-\sin x)}{\cos^2 x} = \frac{\sin x}{\cos^2 x}$$

$$= \frac{1}{\cos x}\frac{\sin x}{\cos x} = \sec x \tan x$$

Exemple $(\cot x)'$

Exemple $(\cot x)' = \left(\dfrac{\cos x}{\sin x}\right)'$

Exemple

$$(\cot x)' = \left(\frac{\cos x}{\sin x}\right)' = \frac{-\sin^2 x - \cos^2 x}{\sin^2 x}$$

Exemple

$$(\cot x)' = \left(\frac{\cos x}{\sin x}\right)' = \frac{-\sin^2 x - \cos^2 x}{\sin^2 x}$$

$$= \frac{-1}{\sin^2 x}$$

Exemple $(\cot x)' = \left(\frac{\cos x}{\sin x}\right)' = \frac{-\sin^2 x - \cos^2 x}{\sin^2 x}$

$$= \frac{-1}{\sin^2 x} = -\csc^2 x$$

Exemple

$$(\cot x)' = \left(\frac{\cos x}{\sin x}\right)' = \frac{-\sin^2 x - \cos^2 x}{\sin^2 x}$$

$$= \frac{-1}{\sin^2 x} = -\csc^2 x$$

Exemple

Exemple $(\cot x)' = \left(\frac{\cos x}{\sin x}\right)' = \frac{-\sin^2 x - \cos^2 x}{\sin^2 x}$

$$= \frac{-1}{\sin^2 x} = -\csc^2 x$$

Exemple $(\csc x)'$

Exemple $$(\cot x)' = \left(\frac{\cos x}{\sin x}\right)' = \frac{-\sin^2 x - \cos^2 x}{\sin^2 x}$$

$$= \frac{-1}{\sin^2 x} = -\csc^2 x$$

Exemple $$(\csc x)' = \left(\frac{1}{\sin x}\right)'$$

Exemple $(\cot x)' = \left(\frac{\cos x}{\sin x}\right)' = \frac{-\sin^2 x - \cos^2 x}{\sin^2 x}$

$$= \frac{-1}{\sin^2 x} = -\csc^2 x$$

Exemple $(\csc x)' = \left(\frac{1}{\sin x}\right)' = \frac{-(\cos x)}{\sin^2 x}$

Exemple $(\cot x)' = \left(\frac{\cos x}{\sin x}\right)' = \frac{-\sin^2 x - \cos^2 x}{\sin^2 x}$

$$= \frac{-1}{\sin^2 x} = -\csc^2 x$$

Exemple $(\csc x)' = \left(\frac{1}{\sin x}\right)' = \frac{-(\cos x)}{\sin^2 x}$

$$= -\frac{1}{\sin x}\frac{\cos x}{\sin x}$$

Exemple

$$(\cot x)' = \left(\frac{\cos x}{\sin x}\right)' = \frac{-\sin^2 x - \cos^2 x}{\sin^2 x}$$

$$= \frac{-1}{\sin^2 x} = -\csc^2 x$$

Exemple

$$(\csc x)' = \left(\frac{1}{\sin x}\right)' = \frac{-(\cos x)}{\sin^2 x}$$

$$= -\frac{1}{\sin x}\frac{\cos x}{\sin x} = -\csc x \cot x$$

Exemple

Exemple $\left(\sin(4x^2 + 7x)\right)'$

Exemple

$$\big(\sin(4x^2 + 7x)\big)' = \cos(4x^2 + 7x)(8x + 7)$$

Exemple

$$\left(\sin(4x^2 + 7x)\right)' = \cos(4x^2 + 7x)(8x + 7)$$

Exemple

Exemple $\left(\sin(4x^2+7x)\right)' = \cos(4x^2+7x)(8x+7)$

Exemple $(\sec(x^4+5))'$

Exemple $\left(\sin(4x^2+7x)\right)' = \cos(4x^2+7x)(8x+7)$

Exemple $(\sec(x^4+5))' = \sec(x^4+5)\tan(x^4+5)(x^4+5)'$

Exemple $\left(\sin(4x^2 + 7x)\right)' = \cos(4x^2 + 7x)(8x + 7)$

Exemple

$$
\begin{aligned}
(\sec(x^4 + 5))' &= \sec(x^4 + 5)\tan(x^4 + 5)(x^4 + 5)' \\
&= \sec(x^4 + 5)\tan(x^4 + 5)(4x^3)
\end{aligned}
$$

Exemple $(\sin(4x^2+7x))' = \cos(4x^2+7x)(8x+7)$

Exemple

$$\begin{aligned}(\sec(x^4+5))' &= \sec(x^4+5)\tan(x^4+5)(x^4+5)' \\ &= \sec(x^4+5)\tan(x^4+5)(4x^3)\end{aligned}$$

Exemple

Exemple

$$\left(\sin(4x^2 + 7x)\right)' = \cos(4x^2 + 7x)(8x + 7)$$

Exemple

$$\begin{aligned}(\sec(x^4 + 5))' &= \sec(x^4 + 5)\tan(x^4 + 5)(x^4 + 5)' \\ &= \sec(x^4 + 5)\tan(x^4 + 5)(4x^3)\end{aligned}$$

Exemple

$$(\sqrt{x\tan(x^3)})'$$

Exemple $$(\sin(4x^2+7x))' = \cos(4x^2+7x)(8x+7)$$

Exemple $$\begin{aligned}(\sec(x^4+5))' &= \sec(x^4+5)\tan(x^4+5)(x^4+5)' \\ &= \sec(x^4+5)\tan(x^4+5)(4x^3)\end{aligned}$$

Exemple $$(\sqrt{x\tan(x^3)})' = \frac{1}{2\sqrt{x\tan(x^3)}}(x\tan(x^3))'$$

Exemple $\left(\sin(4x^2+7x)\right)' = \cos(4x^2+7x)(8x+7)$

Exemple

$$\begin{aligned}(\sec(x^4+5))' &= \sec(x^4+5)\tan(x^4+5)(x^4+5)' \\ &= \sec(x^4+5)\tan(x^4+5)(4x^3)\end{aligned}$$

Exemple

$$(\sqrt{x\tan(x^3)})' = \frac{1}{2\sqrt{x\tan(x^3)}}(x\tan(x^3))'$$

$$= \frac{1}{2\sqrt{x\tan(x^3)}}(\tan(x^3) + x\sec^2(x^3)(3x^2))$$

Exemple $$\left(\sin(4x^2+7x)\right)' = \cos(4x^2+7x)(8x+7)$$

Exemple
$$\begin{aligned}(\sec(x^4+5))' &= \sec(x^4+5)\tan(x^4+5)(x^4+5)' \\ &= \sec(x^4+5)\tan(x^4+5)(4x^3)\end{aligned}$$

Exemple $$(\sqrt{x\tan(x^3)})' = \frac{1}{2\sqrt{x\tan(x^3)}}(x\tan(x^3))'$$

$$= \frac{1}{2\sqrt{x\tan(x^3)}}(\tan(x^3)+x\sec^2(x^3)(3x^2))$$

$$= \frac{\tan(x^3)+3x^3\sec^2(x^3)}{2\sqrt{x\tan(x^3)}}$$

Faites les exercices suivants

6 à 8

Aujourd’hui, nous avons vu

Aujourd'hui, nous avons vu

$$(\sin x)' = \cos x$$

Aujourd'hui, nous avons vu

$$(\sin x)' = \cos x \qquad\qquad (\cos x)' = -\sin x$$

Aujourd'hui, nous avons vu

$$(\sin x)' = \cos x$$

$$(\cos x)' = -\sin x$$

$$(\tan x)' = \sec^2 x$$

Aujourd'hui, nous avons vu

$$(\sin x)' = \cos x$$

$$(\cos x)' = -\sin x$$

$$(\tan x)' = \sec^2 x$$

$$(\cot x)' = -\csc^2 x$$

Aujourd'hui, nous avons vu

$$(\sin x)' = \cos x \qquad (\cos x)' = -\sin x$$

$$(\tan x)' = \sec^2 x \qquad (\cot x)' = -\csc^2 x$$

$$(\sec x)' = \sec x \tan x$$

Aujourd'hui, nous avons vu

$$(\sin x)' = \cos x \qquad (\cos x)' = -\sin x$$

$$(\tan x)' = \sec^2 x \qquad (\cot x)' = -\csc^2 x$$

$$(\sec x)' = \sec x \tan x \qquad (\csc x)' = -\csc x \cot x$$

Devoir: Section 4, # 6 à 13