# CN A – Error Theory

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## Conteúdo

# 1 Definitions

## Defining errors

Let $Q$ and $\tilde{Q}$ be the true and approximate values of a physical quantity.

$$\varepsilon_Q = \Delta Q = Q - \tilde{Q} \qquad \text{(Error)}$$

$$|\varepsilon_Q| = |\Delta Q| = |Q - \tilde{Q}| \qquad \text{(Abolute Error)}$$

$$\mathrm{r}_Q = \left|\frac{\Delta Q}{Q}\right| = \left|1 - \frac{\tilde{Q}}{Q}\right| \qquad \text{(Relative Error)}$$

$$\varepsilon_Q \begin{cases} < 0 & \text{Approximating by excess} \\ > 0 & \text{Approximating by defect} \end{cases}$$

## Categorizing errors

There are two kinds of errors:

**Random/Precision errors** are caused by unpredictable changes in the environment, can be easily detected and analyzed by statistical methods.

**Systematic errors** are the result of how an experiment is conducted and can be identified by leading to results that are too high or too low.

## 1.1 Intervalo que contem $x$

$$\boldsymbol{I_x = [\hat{x} - \eta_x, \hat{x} + \eta_x] : |x - \hat{x}| \leq \eta_x}$$

$$\boldsymbol{\eta_x \begin{cases} 0.5 * 10^{-i} & : \hat{x} * 10^i \in \mathbb{Z} \\ \eta_x & : \hat{x} \pm \eta_x \\ y * 10^{-i} & : \hat{x}\,(y) \wedge \hat{x} * 10^i \in \mathbb{Z} \end{cases}}$$

12.3

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Resposta

$|x - \hat{x}| \leq 0.5 * 10^{-1} = \eta_x$
$\therefore I_x = [12.3 - 0.05, 12.3 + 0.05] =$
$= [12.25, 12.35]$

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Resposta

$|x - \hat{x}| \leq 0.07 = \eta_x$
$\therefore I_x = |87.9 - 0.07, 87.9 + 0.07| =$
$= |87.83, 87.97|$

$400.32\,(6)$

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Resposta

$|x - \hat{x}| \leq 6 * 10^{-2} = \eta_x$
$\therefore I_x = [400.26, 400.38]$

$87.9 \pm 0.07$

$x = 1/17 \qquad \hat{x} = 0.059$

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Resposta

(i) Erro Absoluto

$|\varepsilon_x| = |x - \hat{x}| = |1/17 - 0.059| = 0.17647\ldots\ \mathrm{E}^{-}3 \leq 0.177\,\mathrm{E}^{-}3$

(ii) Erro relativo

$$r_x = \frac{|x - \hat{x}|}{|x|} = \frac{|1/17 - 0.059|}{|1/17|} = 0.300\,\mathrm{E}^{-}2$$