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Theory of Errors Formulas

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List of 21 Theory of Errors Formulas

Theory of Errors

1) Mean Error given Specified Error of Single Measurement

$$\text{fx } E_m = \frac{E_s}{\sqrt{n_{\text{obs}}}}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$\text{ex } 0.125 = \frac{0.25}{\sqrt{4}}$$

2) Mean Error given Sum of Errors

$$\text{fx } E_m = \frac{\Sigma E}{n_{\text{obs}}}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$\text{ex } 0.6 = \frac{2.40}{4}$$

3) Most Probable Error given Standard Deviation

$$\text{fx } \text{MPE} = 0.6745 \cdot \sigma$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$\text{ex } 0.897085 = 0.6745 \cdot 1.33$$



4) Most Probable Value given Residual Error

$$fx \quad MPV = x - r$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$ex \quad 79 = 159 - 80$$

5) Most Probable Value with Different Weightage

$$fx \quad MPV = \text{add} \frac{w_i \cdot x_i}{\text{add}} (w_i)$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$ex \quad 78 = \text{add} \frac{10 \cdot 78}{\text{add}} (10)$$

6) Most Probable Value with Same Weightage for Observations

$$fx \quad MPV = \frac{\sum x_i}{n_{\text{obs}}}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$ex \quad 200 = \frac{800}{4}$$

7) Observed Value given Relative Error

$$fx \quad x = \frac{\varepsilon_x}{R_x}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$ex \quad 160 = \frac{320}{2}$$



8) Observed Value given Residual Error 

$$fx \quad x = r + MPV$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)


$$ex \quad 159 = 80 + 79$$

9) Observed Value given True Error 

$$fx \quad x = X - \varepsilon_x$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)


$$ex \quad 160 = 480 - 320$$

10) Probable Error of Mean 

$$fx \quad PE_m = \frac{PE_s}{n_{obs}^{0.5}}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$ex \quad 0.005 = \frac{0.01}{(4)^{0.5}}$$


11) Relative Error 

$$fx \quad R_x = \frac{\varepsilon_x}{x}$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$ex \quad 2.012579 = \frac{320}{159}$$



12) Residual Error 

$$fx \quad r = x - MPV$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 80 = 159 - 79$$

13) Residual Variation given Most Probable Value 

$$fx \quad V = m - MPV$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 20.9 = 99.9 - 79$$

14) Standard Deviation of Weighted Observations 

$$fx \quad \sigma_w = \sqrt{\frac{\sum WV^2}{n_{\text{obs}} - 1}}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 22.36068 = \sqrt{\frac{1500}{4 - 1}}$$

15) Standard Deviation used for Survey Errors 

$$fx \quad \sigma = \sqrt{\frac{\sum V^2}{n_{\text{obs}} - 1}}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$ex \quad 40.82483 = \sqrt{\frac{5000}{4 - 1}}$$



16) Standard Error of Function where variables are Subjected to Addition



$$fx \quad e_A = \sqrt{e_x^2 + e_y^2 + e_z^2}$$

[Open Calculator](#)

$$ex \quad 200.4221 = \sqrt{(120)^2 + (115)^2 + (112)^2}$$

17) Standard Error of Mean of Weighted Observations



$$fx \quad \sigma_{nw} = \frac{\sigma_w}{\sqrt{\Sigma W}}$$

[Open Calculator](#)

$$ex \quad 100.1388 = \frac{950}{\sqrt{90}}$$

18) True Error



$$fx \quad \varepsilon_x = X - x$$

[Open Calculator](#)

$$ex \quad 321 = 480 - 159$$

19) True Error given Relative Error



$$fx \quad \varepsilon_x = R_x \cdot x$$

[Open Calculator](#)

$$ex \quad 318 = 2 \cdot 159$$



20) True Value given True Error

$$\text{fx } X = \varepsilon_x + x$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)

$$\text{ex } 479 = 320 + 159$$

21) Variance of Observations

$$\text{fx } \sigma^2 = \frac{\Sigma V^2}{n_{\text{obs}} - 1}$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5_img.jpg\)](#)

$$\text{ex } 1666.667 = \frac{5000}{4 - 1}$$



Variables Used

- e_A Standard Error in Function
- E_m Error of Mean
- E_s Specified Error of a Single Measurement
- e_x Standard Error in x coordinate
- e_y Standard Error in y coordinate
- e_z Standard Error in z coordinate
- m Measured Value
- **MPE** Most Probable Error
- **MPV** Most Probable Value
- n_{obs} Number of Observations
- PE_m Probable Mean of Error
- PE_s Probable Error in Single Measurement
- r Residual Error
- R_x Relative Error
- ΣV^2 Sum of Square of Residual Variation
- ΣW Sum of Weightage
- ΣWV^2 Sum of Weighted Residual Variation
- Σx_i Sum of Observed Values
- V Residual Variation
- w_i Weightage
- x Observed Value



- X True Value
- x_i Measured Quantity
- ϵ_x True Error
- σ Standard Deviation
- σ_{nw} Standard Error of Mean
- σ_w Weighted Standard Deviation
- σ^2 Variance
- ΣE Sum of Errors of Observations



Constants, Functions, Measurements used

- **Function: add**, add
Summation operator $add(a_1, a_2, a_3, \dots, a_n)$
- **Function: sqrt**, sqrt(Number)
Square root function



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