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MADE EASY
MECHANICAL ENGINEERING
Metrology
BY- Gunjan Sir

- Theory
- Explanation
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- Shortcuts
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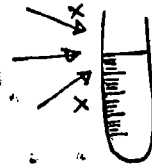
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Metrology: → [Science of Measurement]

Standard is required



Line Standard

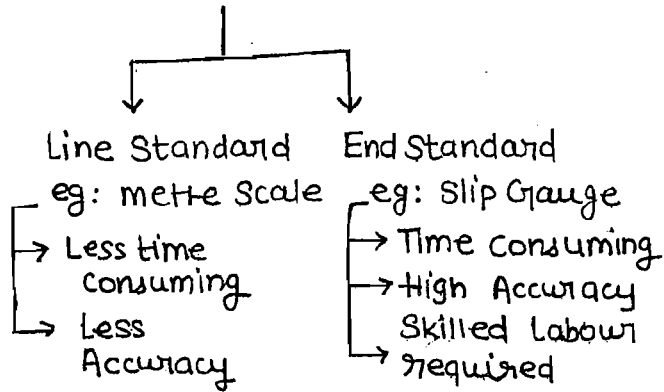


Parallax error

Standard ⇒ It is an authority which is set-up or established to measure Length, Weight, quantity, quality, angle etc.

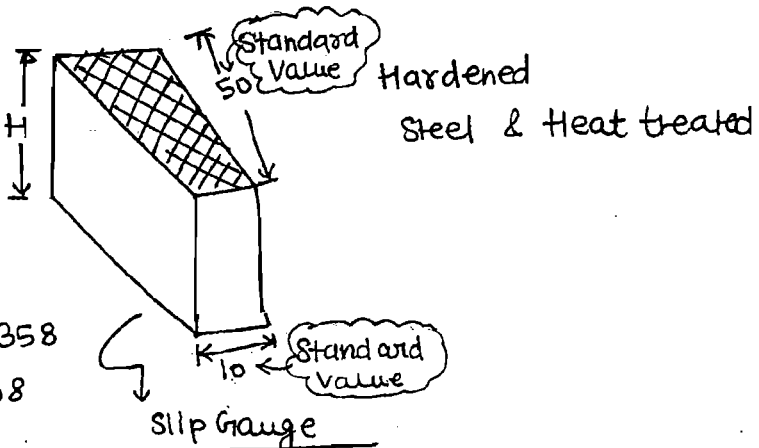
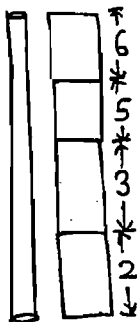
eg: IOML → International organisation for measurement of Length.

LENGTH STANDARD



IS - 919 - 1996

Range	Step size	Number
1.001 - 1.009	0.001	9
1.01 - 1.49	0.01	49
1.5 - 9.5	0.5	19
10 - 100	10	10



eg:
$$\begin{array}{r} 96.999 \\ 1.009 \\ 1.49 \\ 4.5 \\ 90 \\ \hline 96.999 \end{array}$$

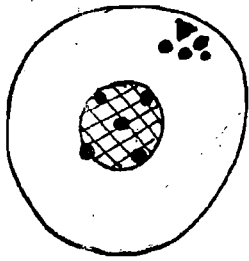
eg:
$$\begin{array}{r} 72.358 \\ 1.008 \\ 1.35 \\ 6.5 \\ 50 \\ \hline 58.975 \end{array}$$

↳ Ground to High Accuracy and Surface finish

eg:
$$\begin{array}{r} 58.975 \\ 1.005 \\ 1.47 \\ 6.5 \\ 50 \\ \hline 58.975 \end{array}$$

Accuracy: →

It is the degree of closeness of a value with respect to true value.



Precision: → Degree of Repeatability

It is the degree of closeness of a value w.r.t. other measured values

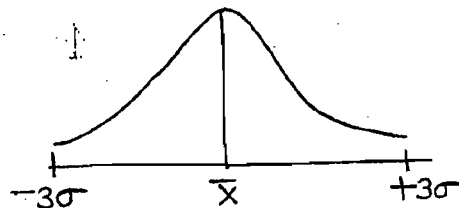
No Dimension is EXACT

↳ Tolerance

Limits And Tolerance: →

Limit → Permissible range within which value must lie

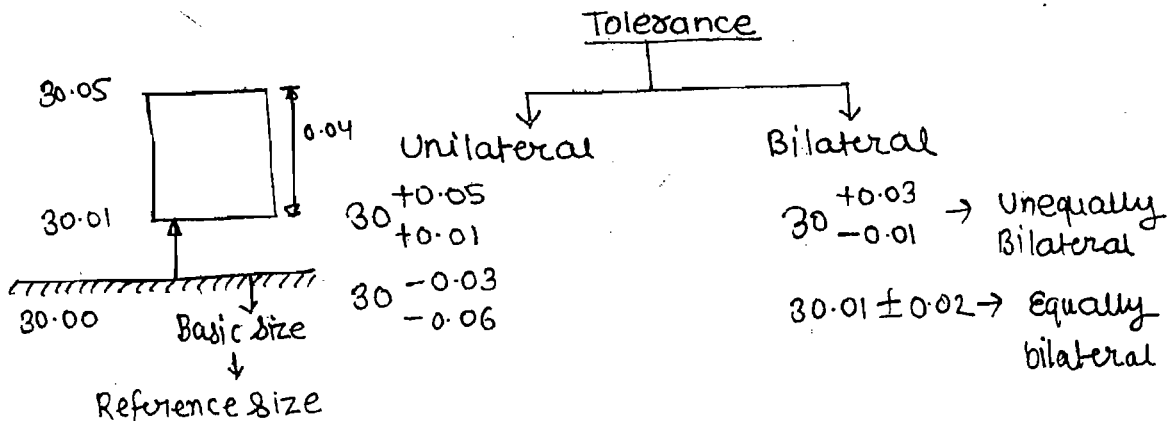
Ecart Supérieur Ecart Inférieur

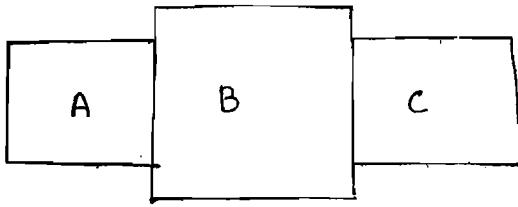


value = $\bar{x} \pm 3\sigma$

Tolerance = ES - EI

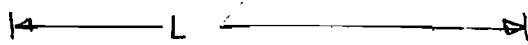
↓
Difference b/w Upper Limit & Lower Limit





$$B = L - (A + C)$$

$$= 30.01 \pm 0.06$$



$$A = 30 \begin{matrix} +0.02 \\ -0.04 \end{matrix} = 29.99 \pm 0.03$$

$$B = ?$$

$$C = 40 \pm 0.02$$

$$L = 100 \pm 0.01$$

$$B = 30 \begin{matrix} +0.07 \\ -0.05 \end{matrix}$$

$$B = 30.01 \pm 0.06$$

$$B_{\max} = L_{\max} - A_{\min} - C_{\min}$$

$$= 100.01 - 29.96 - 39.98$$

$$= 30.07$$

$$B_{\min} = L_{\min} - A_{\max} - C_{\max}$$

$$= 99.99 - 30.02 - 40.02$$

$$= 29.95$$

Steps:

- (i) Convert all tolerance as equal bilateral.
- (ii) Use B.S. only in arithmetic operation.
- (iii) Add all tolerances.

Que → 17/08/20-13

$$R = 13.01 \pm 0.03$$

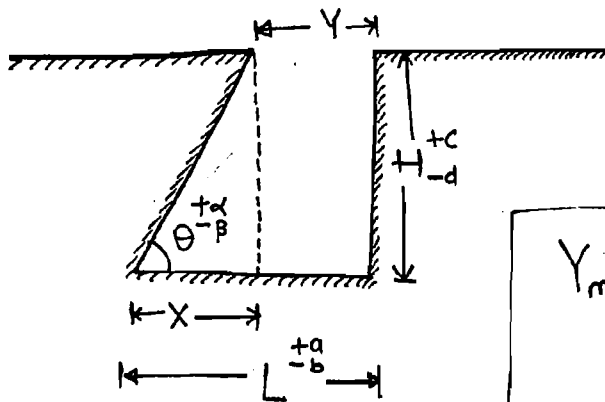
$$W = 35 - 12 - 13.01 = 9.99$$

$$W = 9.99 \pm 0.13$$

$$\begin{array}{r} 0.08 \\ 0.02 \\ 0.03 \\ \hline 0.13 \end{array}$$

→

• Compound Tolerance :→



$$Y = L - X$$

$$Y_{\max} = L_{\max} - X_{\min}$$

$$= L^{+a} - \frac{H^{-d}}{\tan \theta^{+\alpha}}$$

$$Y_{\min} = L_{\min} - X_{\max}$$

$$= L^{-b} - \frac{H^{+c}}{\tan \theta^{-\beta}}$$

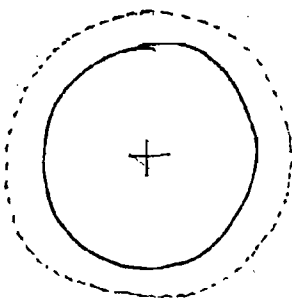
$$\tan \theta = \frac{H}{X}$$

$$X = \frac{H}{\tan \theta}$$

$$X_{\max} = \frac{H_{\max}}{(\tan \theta)_{\min}} = \frac{H^{+c}}{\tan \theta^{-\beta}}$$

$$X_{\min} = \frac{H_{\min}}{(\tan \theta)_{\max}} = \frac{H^{-d}}{\tan \theta^{+\alpha}}$$

• Shaft Plating



t = Plating thickness

Di = diameter before Plating

Df = diameter after Plating

$$D_f = D_i + 2t$$

$$t = 80 \pm 2 \mu\text{m}$$

$$\text{dia after plating} = 20^{+0.05}_{-0.03} \text{ mm}$$

find the diameter of shaft before plating.