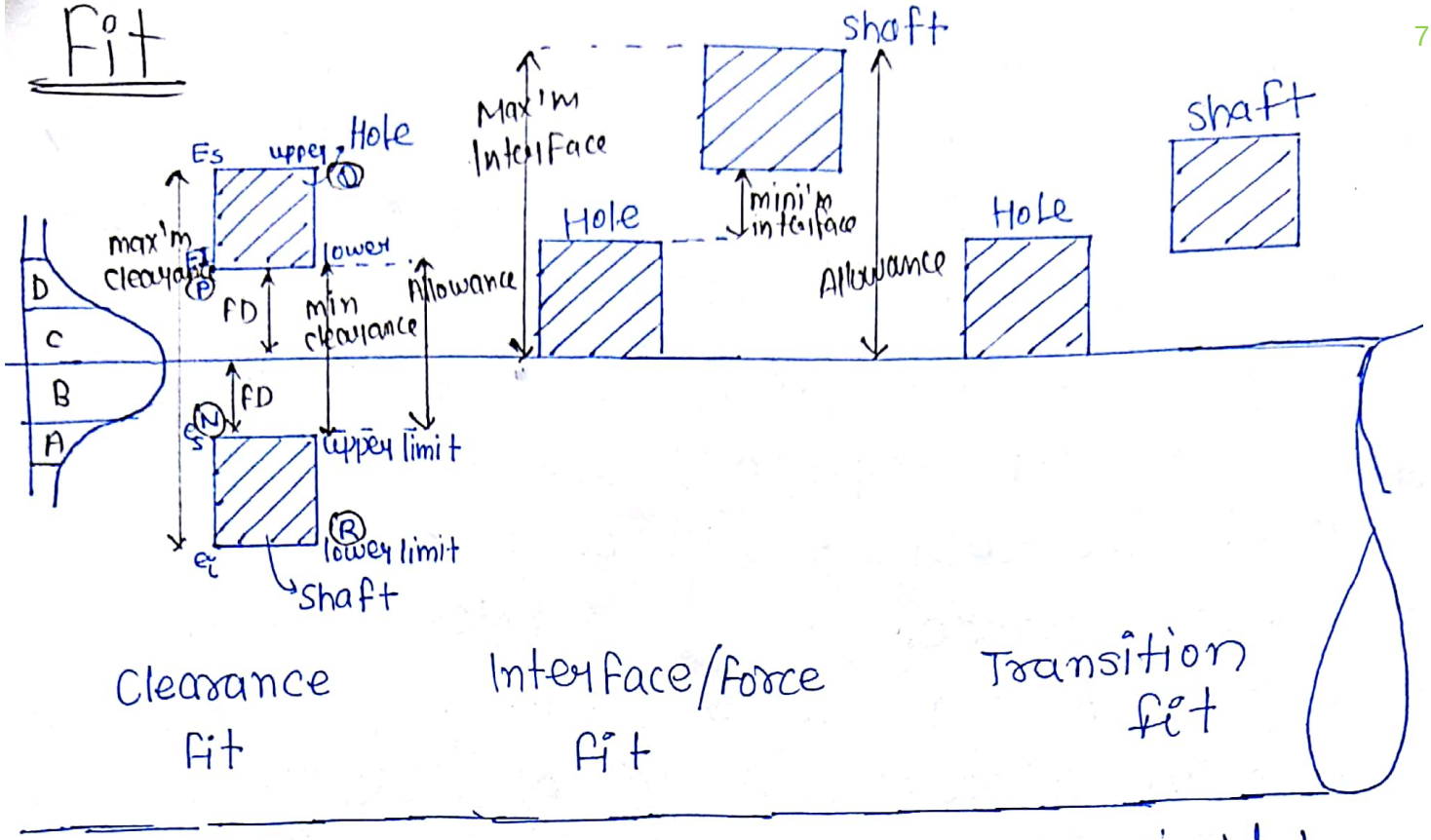
# Fit




Clearance Fit | Interface/Force Fit | Transition fit

{ ES = Eccord superior, EI = Eccord Interior } { PN - max'm material limit, QR - minim material limit }

* Fit is the relationship b/w hole and shaft before assembly.
* Tolerances always refers to a group.

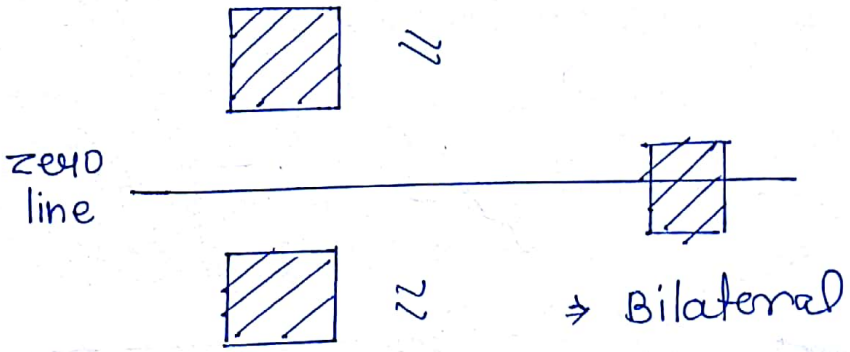
① when the tolerance of hole and shaft are such that max'm size of shaft is less than the mini'm size of hole then randomaly a hole is selected from hole lot and shaft is selected from shaft lot assembly can be made without any difficulty.

For any assembly allowance is differance b/w max. material limil of hole and shaft. In clearance fit allowance is equal to the minimum clearance

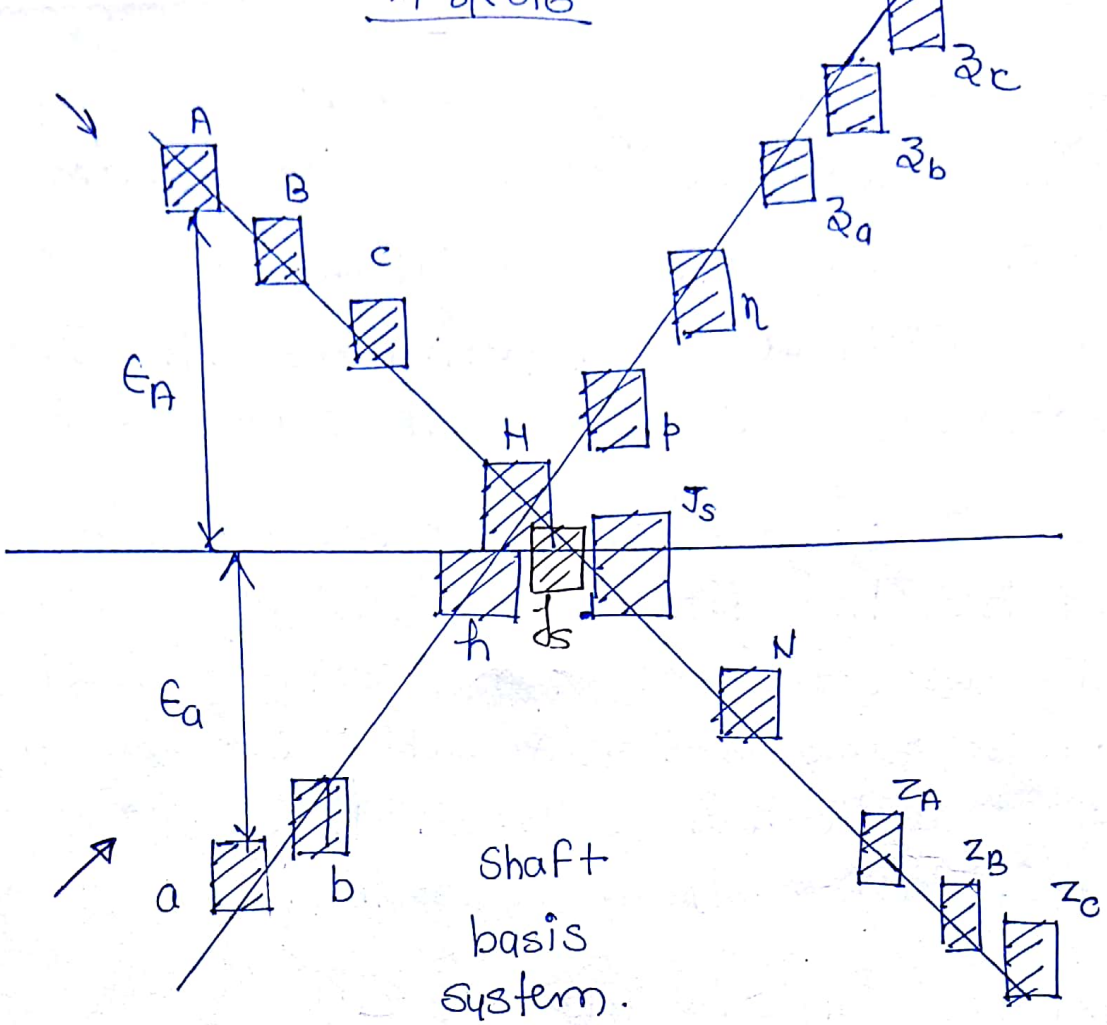
② When the mini size of shaft in subgroup is greater then the max. size of hole, In such a situation force need to be applyied to make such an assembly, called interferance fit. In this case allowance is equal to the max. interface.

③ If there is an overlap in tolerance zone It is called transition fit. In this case when hole is selected from the hole lot and shaft is selected from shaft lot some of the assembly can be made without application of load and in some the assembly load needs to be applied.

Unilateral & Bilateral Tolerance :-

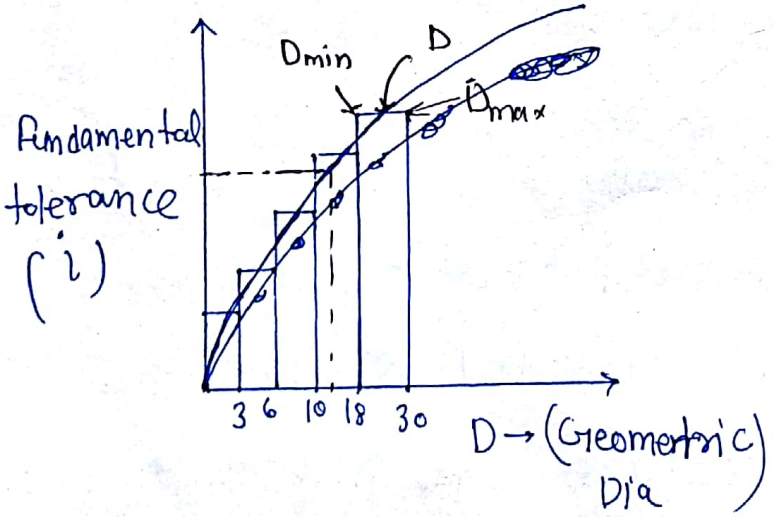



when tolerance are situated only one one side of zero line it is called unilatral tolerance but when tolerance are situated on both the side of zero line are called Bilateral tolerances.




* 25 types of fundamental deviation

## Grade of Tolerance:—




$$i = 0.45\, D^{1/3} + 0.001\, D$$

$$D = \sqrt{D_{max} \times D_{min}}$$

↓

Geometric diameter

IT01 IT0 IT1 IT2 IT3

← Emphesical (i) →

| IT4 | IT5 | IT6 | IT7 | IT8 |
|---|---|---|---|---|
| | $(10)^{4/5}i$ | 10i | $10(10)^{4/5}i$ | $10(10)^{2/5}i$ |
| | $\simeq 7i$ | | $\simeq 16i$ | $\simeq 25i$ |

| IT9 | IT10 | IT11 | IT12 | IT13 |
|---|---|---|---|---|
| $10(10)^{3/5}i$ | $10(10)^{4/5}i$ | 100i | $\simeq 160i$ | $\simeq 250i$ |
| $\simeq 40i$ | $\simeq 64i$ | | | |

| IT14 | IT15 | IT16 |
|---|---|---|
| $\simeq 400i$ | $\simeq 640i$ | 1000i |

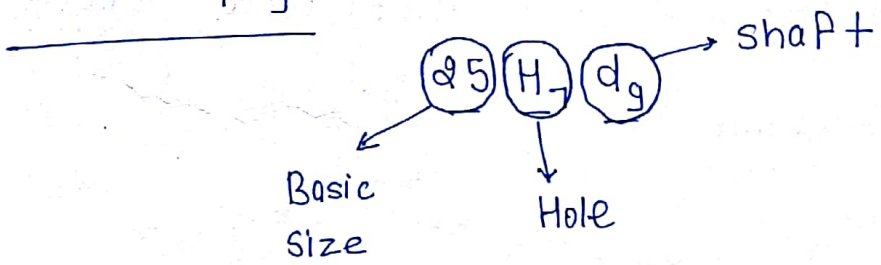
Ratio = $(10)^{1/5}$

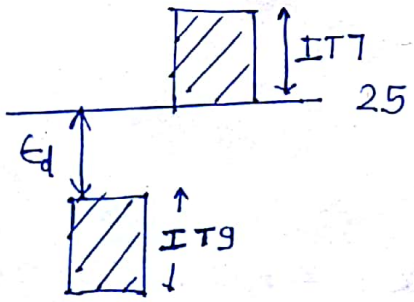
IT01 - IT1 - emphesical

IT1 - IT5 - Geometric ⇒ Every 5th term Multiple of 10

IT5 - IT16 - Preferred series ⇒ 5-step preferred series.

Eg $\phi 25 H_7 d_9$



In exam following point must be remebey

① In the formula ($i = 0.45 D^{1/3} + 0.001 D$) of fundamental tolerance and fundamental deviation. 'D' is geometric diameter, not basic size.

② Input to these formula will be in milimeter but output will be in microns.

③ keep the answer correct upto 3 (three) decimal place do not round off.

**Problem**

A hole and shaft have basic size 30 mm and are to have clearance fit with max. clearance is 0.04 and min. clearance is 0.02. The Hole tolerance is 1.5 times of shaft tolerance Determine the limit of both hole and shaft. using Hole - base system & Shaft base system.

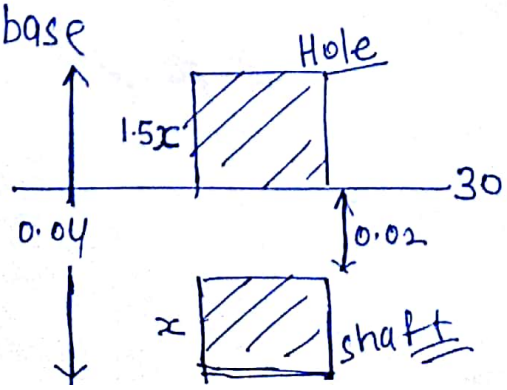
**Soln** Basic size = 30 mm

max'm clearance = 0.04

min " " = 0.02

$(\text{Hole})_t = 1.5\,(\text{shaft})_t$

① Hole base




$1.5x + x + 0.02 = 0.04$

$2.5x = 0.02$

$x = 0.008$

$1.5x = 0.012$

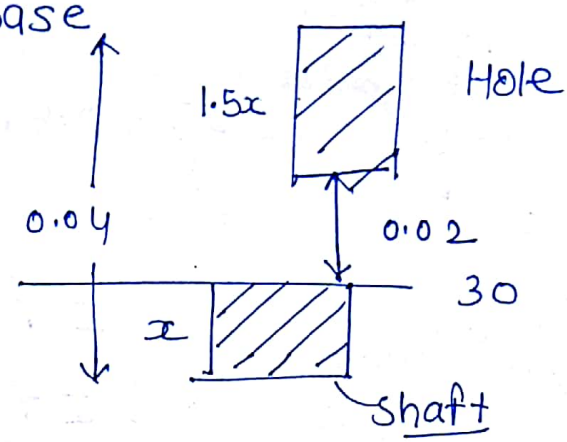
Hole { max = 30.012
min = 30

$30^{+0.012}_{+0}$

shaft { max = 29.980
min = 29.972

$30^{-0.02}_{-0.028}$

(2) Shaft base




$x + 0.02 + 1.5x = 0.04$

$x = 0.008$

$1.5x = 0.012$

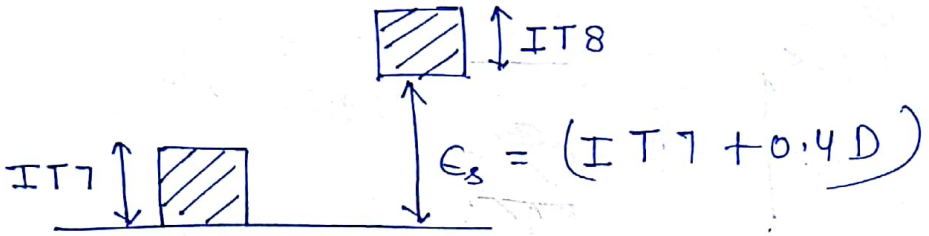
Hole { max = 30.032
min = ~~29~~ 30.02

Shaft { ~~max~~ min = 29.992
~~min~~ max = 30

Quest

Det. Limit tolerance and allowand for $75H_7s_8$ the basic size in ranze of 50-80. F D of s type of shaft $\epsilon_s = (IT7 + 0.4D)$ Hs.

Soln




$$D = \sqrt{D_{max} \times D_{min}}$$

$IT7 = 16i$

$IT8 = 25i$

$$D = \sqrt{50 \times 80}$$

$$D = \sqrt{4000}$$

$D = 63.245$ mm $= 0.063$ Hm

$$i = 0.45(D)^{1/3} + 0.001D \quad \text{Hm}$$

$i = 1.856$ Hm

$IT7 = 29.696 = 0.029$ Hm

Now devide/1000

$IT8 = 46.4 = 0.046$ Hm

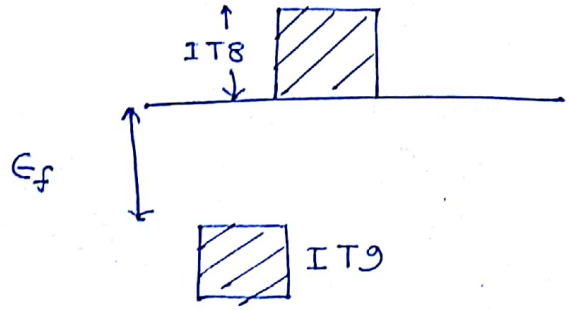
$$\epsilon_s = (0.029 + 0.4 \times 0.063) = 0.054$$

Hole — max = 75.029
Hole — min = 75.0

Shaft — max = 75.10
Shaft — min = 75.054

**Ques** Cal. limit fit and tolerance for $25 H_8 f_9$
Basic size falles in 18-30 and FD of f type shaft $\epsilon_f = -5.5 D^{0.4}$.

**Soln**




$IT8 = 25 i$

$IT9 = 40 i$

$D = \sqrt{18 \times 30} = 23.237 mm$

~~$D = 0.023418$~~

$i = 0.45(D)^{1/3} + 0.001(D)$

$i = 0.45\left(\frac{0.023}{23.237}\right)^{1/3} + 0.001 \times \left(\frac{23.237}{0.023}\right) = 1.307 \mu m$

~~$i = 0.001318 mm$~~

$IT8 = 0.032$

$IT9 = 0.052$

$\epsilon_f = -5.5 (23.237)^{0.4}$

$\epsilon_f = 19.357 mm$

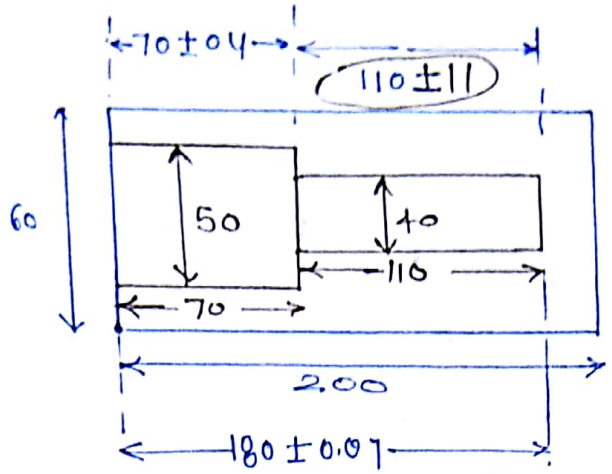
$\epsilon_f = 0.019 mm$

Hole — max = 25.032
Hole — min = 25

Shaft — max = 24.981
Shaft — min = 24.929

# Tolerance Sink :-

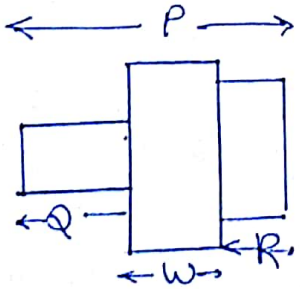
Eg




"like minded"

When any Design Engineer submit design to production engineer, one section of the design he must leave blank, without any tolerance so that, production engineer dumped all the tolerance that section and this section called sink. Tolerance of sink is Algebric sumation of all the tolerances and this section become least accurate section, only like minded tolerance will be added

Ex.1
WOB.



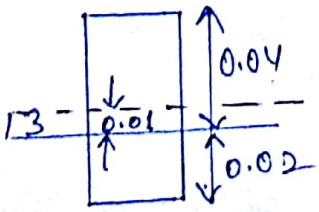

✓ P = 35 ± 0.08

✓ Q = 12.00 ± 0.02

✓ R = $13^{+0.04}_{-0.02}$

Sol$^n$

R




$\Rightarrow \frac{0.06}{2} = 0.030$

R = 13.01 ± 0.3

$$W = P - (Q + R)$$

Basic Size $= 35 - (12 + 13.01)$

Basic Size $= 9.99$

Tolerance $= 0.08 + 0.02 + 0.03$

Tol $= 0.13$

$W = 9.99 \pm 0.13$

$$W = 10^{+0.12}_{-0.14}$$

Short-Cut For objective

$$W = P - (Q + R)$$

$$= 35^{+0.08}_{-0.08} - \left(12^{+0.02}_{-0.02} + 13^{+0.04}_{-0.02}\right)$$

$$= 35^{+0.08}_{-0.08} - 25^{0.06}_{-0.04}$$

$$= 10^{+0.12}_{-0.14}$$

Q.22 $S = P + Q + R + T$

$72.35 + X = (18.75 + 25 + 28.125) \pm 0.3 + 0.125$

$72.35 + X = 72 \pm 0.3$

$72.35 + X = 72 + 0.3$

$X = 72.3 - 72.35 = -0.05$

Q.23 $L_4 = L_1 - (L_2 + L_3)$

B.S. = 22 − (10 + 10)

B.S. = 2

$L_4 = 2 \pm 0.020$

$T = 0.01 + 0.005 + 0.005$

$T = 0.020$

Q. 25 After plating $30^{+0.050}_{+0.010}$ mm

thickness 10 − 15 microns = 5 µ's

both side = 20 − 30 µ's = 10 µ's

initio $30^{+0.050}_{+0.010} \Rightarrow 0.040$

$-0.010$

diff = 0.030

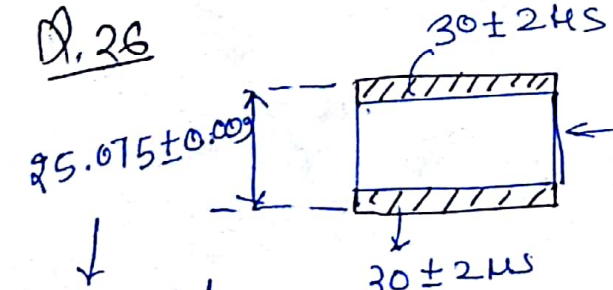
$\Rightarrow$ 20 − 30 µ's

$\Rightarrow 0.02 - 0.03$

$30^{+0.050+(0.02)}_{+0.040+(0.03)}$

$\Rightarrow 30^{+0.070}_{+0.040}$

Q.26




$\Rightarrow 25.015 \pm 0.050$

Basic size = 25.015 + 2(0.03)

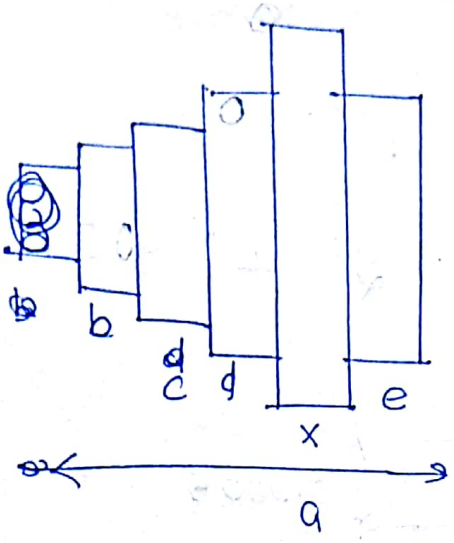
= 25.075

Tol = 0.050 + 2(0.009)

Tot = 0.009

upper limit = 25.084 Ans

Q7




$a \; {}^{+0.005}_{-0.001}$

$b \pm 0.01$

$c \; {}^{-0.002}_{-0.003}$

$d \; {}^{-0.0}_{-0.001}$

$e \; {}^{+0.005}_{+0.0}$

$X = ?$

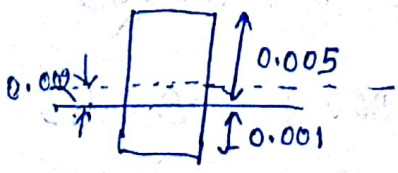
$$X = a - (b + c + d + e)$$

$$\text{Tol} = {}^{0.005}_{-0.001} - \left( {}^{0.013}_{-0.014} \right)$$

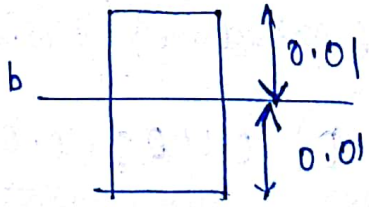
$$X = a \; {}^{0.005 \;\to\; 0.013}_{-0.001 \;\to\; -0.014}$$

$$\Rightarrow X \; {}^{0.019}_{-0.014}$$

for convention

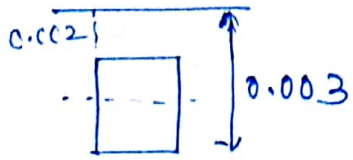



$(a + 0.002) \pm 0.003$

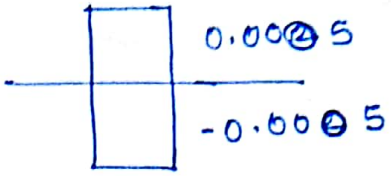



$b \pm 0.01$

C

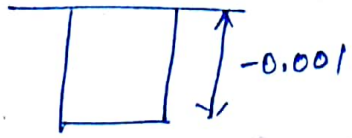



$C^{-0.002}_{-0.003}$

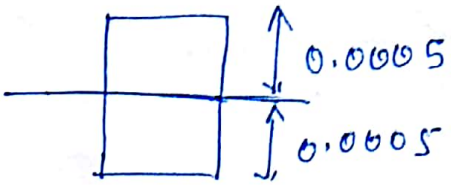



$(C - 0.0025) \pm 0.0025$

D

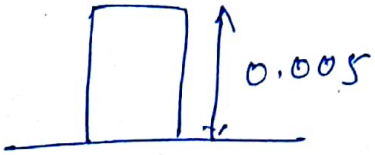



$D^{-0.0}_{-0.001}$

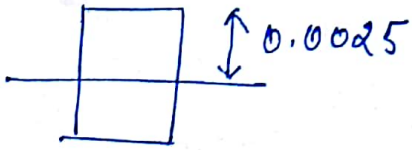



$(D - 0.0005) \pm 0.0005$

e




$e^{+0.005}_{+0.0}$




$(e + 0.0025) \pm (0.0025)$

$X = a - (b + c + d + e)$

$B.S. = (a + 0.002) - (b + c - 0.0025 + D - 0.0005 + e + 0.0025)$

$B.S = (a + 0.002) - (b + C + D + e + 0.0005)$

$B.S. = \{a - (b + c + d + e)\} + 0.0005 = X + 0.0025$

$Tol = (0.003 + 0.01 + 0.0005 + 0.0005 + 0.0025) = 0.0165$

$(X + 0.0025) \pm (0.0165) \Rightarrow X^{+0.019}_{-0.014}$