CHAPTER 24

Errors

Error

Random	**Syotematic**
(Cann't be removed but minimized)	(Can be removed)
No fixed sign	Ex- zero error, Bench error
	Fixed sign

Absolute Error : Expressed in absolute term ex-least count

Relative/ Fractional Error : $\frac{\text{Absolute error}}{\text{Size of measurement}}$

1. ***Addition and subtraction rule*:**
The absolute random errors add.
Thus if $R = A + B$, $r = a + b$ and if $R = A - B$, $r = a + b$

2. ***Product and quotient rule*:**
The relative random errors add.

Thus if $R = AB$, $\frac{r}{R} = \frac{a}{A} + \frac{b}{B}$

and if $R = \frac{A}{B}$, then also $\frac{r}{R} = \frac{a}{A} + \frac{b}{B}$

3. ***Power rule*:**
When a quantity Q is raised to a power P, the relative error in the result is P times the relative error in Q.

This also holds for negative powers. If $R = Q^P$, $\frac{r}{R} = P \times \frac{q}{Q}$

4. The quotient rule is not applicable if the numerator and denominator are dependent on each other.

e.g if $R = \frac{XY}{X+Y}$. We cannot apply quotient rule to find the error in R. Instead we write the equation as follows $\frac{1}{R} = \frac{1}{X} + \frac{1}{Y}$. Differentiating both the sides, we get $-\frac{dR}{R^2} = -\frac{dX}{X^2} - \frac{dY}{Y^2}$.

Thus $\frac{r}{R^2} = \frac{x}{X^2} + \frac{y}{Y^2}$

Significant Digits

Rules for determining the number of significant digits in number with indicated decimals.

- All nonzero digits (1-9) are to be counted as significant.
- Zeros that have any nonzero digits anywhere to the LEFT of them are considered significant zeros.
- All other zeros not covered in rule (2) above are NOT be considered significant digits.

Determining the number of significant digits in number is not having an indicated decimals.

Express in ecientific notation

Rule for expressing the correct number of significant digits in an addition or substraction :

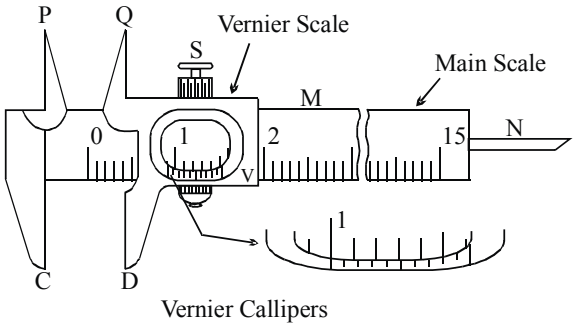
A sum or difference can have no more indicated positions to the right of the decimal as the number involved in the operation with the LEAST indicated positions to the right of its decimal.

Rules for rounding off digits

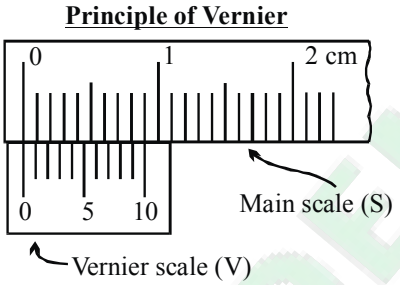
There are a set of conventional rules for rounding off.

- Determine according to the rule what the last reported digit should be.
- Consider the digit to the right of the last reported digit.
- If the digit to the right of the last reported digit is less than 5 round it and all digits to its right off.
- If the digit to the right of the last reported digit is greater than 5 round it and all digits to its right off and increased the last reported digit by one.
- If the digit to the right of the last reported digit is a 5 followed by either no other digits or all zeros, round it and all digits to its right off and if the last reported digit is odd round up to the next even digit. If the last reported digit is even then leave it as is.

Vernier Callipers



Vernier Callipers



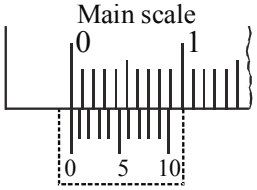
Least count of Vernier Callipers

The least count or Vernier constant (v. c) is the minimum value of correct estimation of length without eye estimation. If N division of vernier coincides with (N-1) division of main scale, then

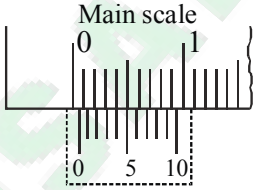
$$N\,(VS) = (N-1)\,ms \;\Rightarrow\; 1VS = \frac{N-1}{N}\,ms$$

Vernier constant $= 1\,ms - 1\,vs = \left(1 - \frac{N-1}{N}\right) ms = \frac{1ms}{N}$, which is equal to the value of the smallest division on the main scale divided by total number of divisions on the vernier scale.

Zero error:

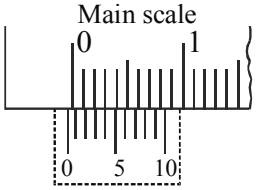


Vernier scale
without zero error



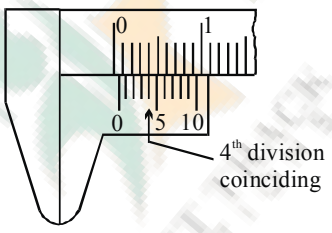
Vernier scale
with positive zero error

(i)

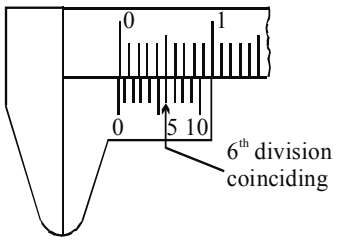


Vernier scale
with negative zero error

(ii)



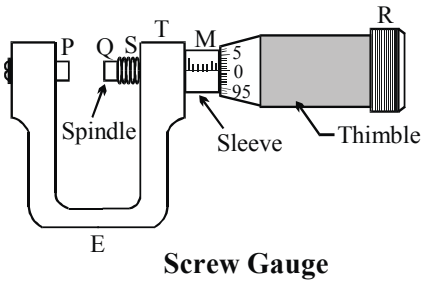
Positive zero error (+0.04 cm)
and its correction



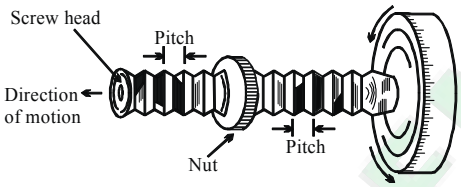
Negative zero error = (–0.04 cm)
and its correction

Negative zero error = – [Total no. of vsd – vsd coinciding] ×L.C.

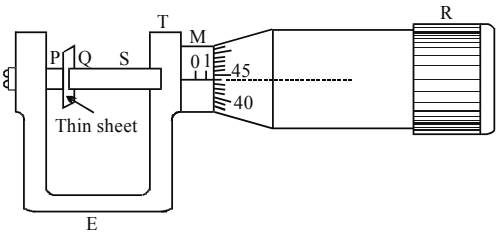
Screw Gauge

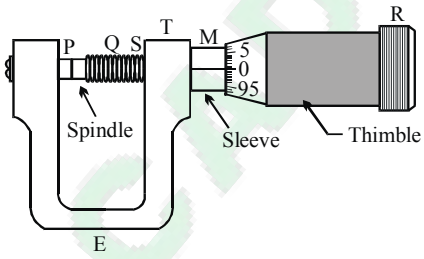


Screw Gauge

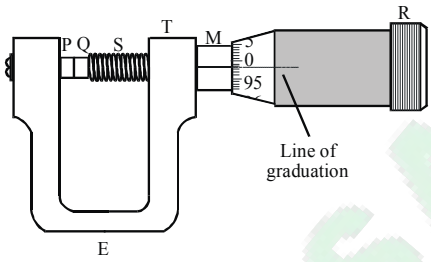


Principle of a micrometer

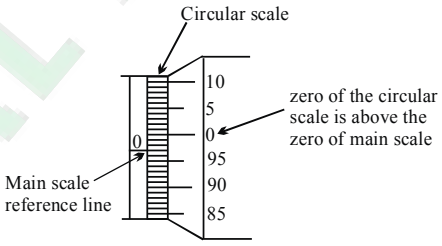


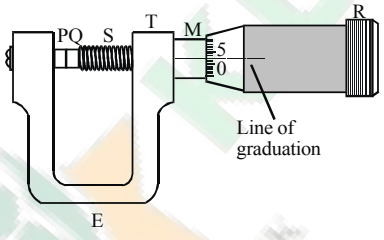


Screw gauge with no zero error

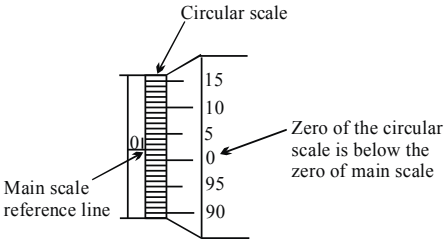


Negative zero error
(3 division error) i.e., - 0.003 cm





Positive zero error
(2 division error) i.e., + 0.002 cm



Constants of the Screw Gauge

(a) Pitch
(b) Least count
(c) Measurement of length by screw gauage