1. What are the fundamental quantities and their units in SI system?

   **Answer:**

   The fundamental quantities and their units in SI system are:

| Quantity | Unit |
|---|---|
| Length | meter |
| Mass | kilogram |
| Time | second |
| Temperature | kelvin |
| Luminous intensity | candela |
| Electric current | ampere |
| Amount of substance | mole |
| Angle | radian |
| Solid angle | steradian |

2. Give the order of magnitude of the following:

   (i) 0.0002303

   (ii) 0.3740 $g/cm^3$

   (iii) 6.230 J

   (iv) $7.14 \times 10^{14}$ kg.

   **Answer:**

   (i) -4
   (ii) 0
   (iii) 1
   (iv) 15

3. What do you mean by the least count of a vernier caliper? When does a vernier caliper have positive and negative zero error?

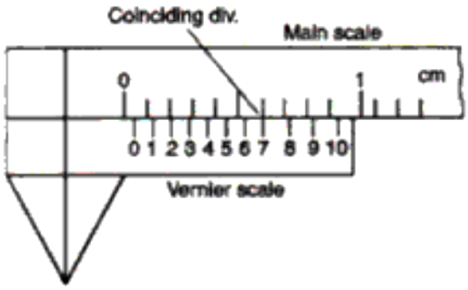
   **Answer:**

   Least count of a vernier caliper is the least distance which can be measured accurately by it. It is also called the vernier constant.

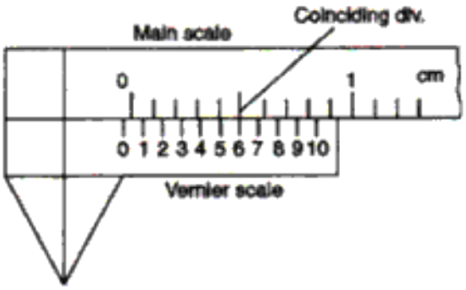
   On bringing the movable jaw in contact with the fixed jaw, if the zero of the main scale coincides with the zero of the vernier scale, then the given vernier is free from zero error, but if zero of the vernier scale does not coincide with the zero of the main scale, the vernier is said to have zero error.

   Zero error is equal to the distance between the zero of the main scale and the zero of the vernier scale. Zero error is of two kinds viz. positive zero error and negative zero error.

The zero error is said to be positive if on bringing both the jaws together, the zero mark of the vernier is on the right hand side of the zero mark of the main scale.
The zero error is said to be negative, if on bringing both the jaws together, the zero mark of the vernier is on the left side of the zero of the main scale.



Positive zero error



Negative zero error

4. In an instrument, there are 25 divisions on the vernier scale which coincide with 24 divisions of the main scale. 1 cm on the main scale is divided in 20 equal parts. Find the least count.

**Answer:**

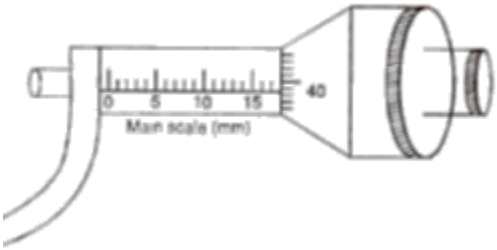
The value of one division on the main scale division,

$$x = \frac{1}{20\text{cm}}$$

Given that the number of divisions on the vernier scale, n = 25

$$\text{LC of vernier} = \frac{x}{n} = \frac{1/20}{25} = 0.002\text{cm}$$

5. Given diagram shows a screw gauge. In one measurement, the final position of the scale is as shown in the diagram. The circular scale has 50 divisions.




(i) What is the least count of the screw gauge?

(ii) If 40th division of the circular scale coincides with the main scale line, what is the final reading?

(iii) What do you mean by back-lash error of a screw gauge?

**Answer:**

(i) The least count of the screw gauge $= \frac{\text{Pitch}}{\text{Total number ofdivisions on circular scale}}$

$$= \frac{1\text{mm}}{50}$$

$$= 0.02\text{mm} = 0.002\text{ cm}$$

(ii) Final reading of measurement = MSR + CSR = 17 mm + 40 × 0.02 mm

= 17 mm + 0.80 = 17.8 mm.

(iii) Back-lash error is the error due to the wear and tear of the threads of the screw. Owing to which, on reversing the direction of rotation of the thimble, the tip of the screw does not move in the opposite direction immediately but remains stationary for a part of the rotation.

6. What temperature Fahrenheit is equivalent to:

(i) $0^oC$

(ii) $100^oC$

**Answer:**

The Fahrenheit to Celsius conversion formula is:

$$F = \frac{9}{5}C + 32$$

(i) $F = \frac{9}{5}C + 32$

$= \frac{9}{5} \times 0 + 32 = 32°F$

(ii) $F = \frac{9}{5}C + 32$

$= \frac{9}{5} \times 100 + 32 = 212°F$

7. A vernier scale has 10 divisions and on its main scale, 1 cm is divided into ten parts. The number of divisions on the left side of the zero of the vernier scale is 56 and the 8th vernier scale division coincides with the main scale. If the instrument has 0.09 cm of negative zero error, calculate the corrected length.

**Answer:**

$$\text{Least count of vernier callipers} = \frac{\text{Value of one main scale division (s)}}{\text{Total number of divisions on vernier (n)}}$$

$$= \frac{0.1\text{cm}}{10} = 0.01 \text{ cm}$$

Measured length= MSR + VSD ×LC

= 56 cm× 0.1cm+ 8×0.01cm

= 5.6 cm+ 0.08 cm = 5.68 cm

Corrected length= Measured length - Correction

= 5.68 – (-0.09) cm = 5.77cm

8. Express the smallest possible value measured accurately using the following instruments:

(i) Meter rule (in mm)

(ii) Vernier calipers (Least count 0.1 mm)

(iii) Screw gauge (Least count 0.001 cm)

(iv) Thermometer ($0.1^oC$)

(v) Protractor (in degrees)

(vi) Spring balance (Least count 5 g).

**Answer:**

(i) 1 mm
(ii) 0.1 mm
(iii) 0.001 cm
(iv) 0.1oC
(v) 1 degree
(vi) 5 g

9. Distinguish between fundamental units and derived units.

**Answer:**

Fundamental units are independent units while derived units are obtained by the combination of fundamental units.

10. State the essential properties of a unit.

**Answer:**

i. Easily accessible
ii. Invariable
iii. Easily reproducible

11. A Vernier scale has 40 divisions and its main scale is divided in millimeters. It has an error of +0.0125 cm. While measuring the length of a cylinder, the reading on the main scale is 75 mm and the 12th Vernier scale division coincides with the main scale. Calculate the corrected length.

**Answer:**

No. of divisions on the vernier scale, n = 40

Value of one main scale division, x = 1 mm

Least count, $LC = \frac{x}{n} = \frac{1}{40} = 0.025mm$

Main scale reading, MSR = 75 mm

Since 12th vernier scale division coincides with the main scale division, p = 12

Vernier reading = p × LC = 12 × 0.025 = 0.3 mm

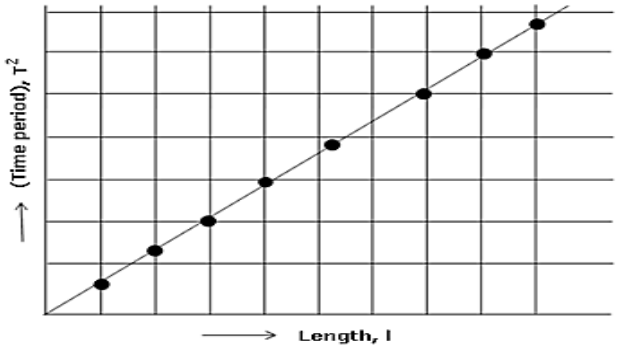
Total reading = MSR + Vernier reading = 75 + 0.3 = 75.3 mm

Corrected reading = 75.3 mm - 0.125 mm = 75.175 mm

12. Draw a graph between effective length 'l' and square of time period '$(T)^2$' of a simple pendulum. How will you obtain the value of acceleration due to gravity from the graph?

The graph between the effective length and $(time\ period)^2$ of a simple pendulum is shown in the figure given below:

**Answer:**




The value of acceleration due to gravity can be calculated by using the following relation:

$$g = \frac{4\pi^2}{\text{Slope of } T^2 \text{ vs I graph}}$$

13. An athlete runs around a circular track of circumference 360 m in (1/60) h and reaches the starting point. Calculate,

(i) The distance covered by athlete

(ii) The displacement

(iii) The average speed and

(iv) The average velocity.

**Answer:**

(i) Distance covered = 360 m = 0.36 km.

(ii) Displacement = 0 m; because the athlete has returned to his initial position.

(iii) Average speed $= \frac{\text{Total distance}}{\text{time}} = \frac{0.36}{\frac{1}{60}} = 21.6 \frac{\text{km}}{\text{hr}}$.

(iv) Average velocity = Total displacement/time $= \frac{0}{1/60} = 0$ km/hr.

14. The table shows the velocity of a two-wheeler at various intervals of time. [2]

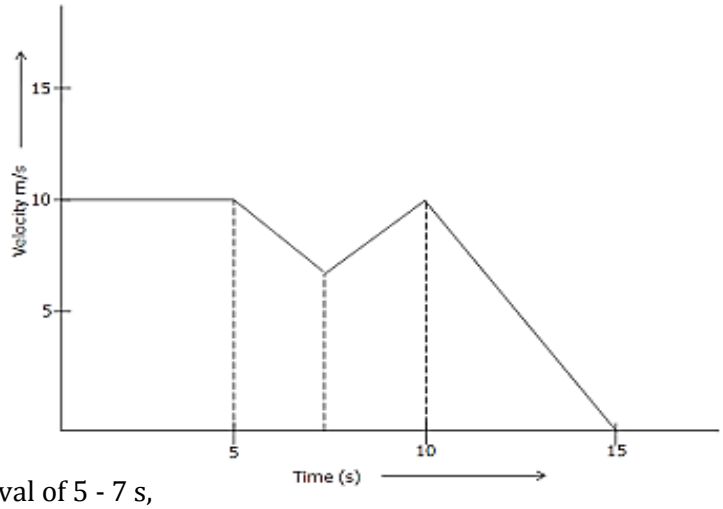
| t(s) | 0 | 5 | 7 | 10 | 15 |
|---|---|---|---|---|---|
| V(m/s) | 10 | 10 | 7 | 10 | 0 |

(i) Plot the velocity-time graph.

(ii) Calculate the rate of change of velocity between 5s - 7s, 7s - 10 s and 10s - 15 s.

**Answer:**

(i) Velocity-time graph is shown in the figure below.




(ii) For time interval of 5 - 7 s,

Change in velocity = 7 - 10 = -3m/s

Time = 7 - 5 = 2 s

Rate in change of velocity = -3/2 = -1.5 m/ $s^2$

For time interval 7 - 10 s,

Change in velocity = 10 - 7 = 3 m/s

Time = 10 - 7 = 3 s

Rate of change in velocity = 3/3 = 1 $m/s^2$

For time interval of 10 - 15 s,

Change in velocity = 0 - 10 = -10 m/s

Time = 15 - 10 = 5 s

Rate of change of velocity = -10/5 = -2$m/s^2$

15. What is the function of ratchet in a screw gauge? A screw gauge has positive error of 7 divisions such that its main scale is marked in half mm and circular scale has 100 divisions. The spindle of the screw advances by 1 division on one complete revolution. If the screw gauge reading is 9 divisions on the main scale and 67 divisions on the circular scale for the diameter of a wire, calculate

(i) Pitch

(ii) Least count and

**Answer:**

Corrected diameter.

Ratchet is attached to the screw by a spring. Its function is to save the stud from the excess pressure exerted by the flat end of the screw when the flat end of the screw is brought in contact with the stud i.e. further rotation given to the ratchet does not press the flat end against the stud.

(i) Pitch $= \frac{0.5\text{mm}}{1} = 0.5\text{mm} = 0.05\text{cm}$

(ii) Least count of the screw gauge $= \frac{0.05\text{cm}}{100} = 0.0005\text{cm}$

Diameter of the wire = 9 × 0.05 cm + 67 × 0.0005 cm
= (0.45 cm + 0.0335 cm)
= 0.4835 cm

(iii) Correct diameter = Observed diameter - correction
= 0.48535 cm – (7 × 0.0005 cm)
= 0.4835 cm – 0.0035 cm
= 0.4800 cm