SHORT ANSWER QUESTIONS

1.1 What are base units and derived units? Give some examples of both these units.

Ans.

Base Units:

Base units are the **fundamental units** of measurements defined by the SI system. They are not derived from other units.

Examples:

- Length → (m)
- Mass → (kg)
- Time → (s)

Derived Units:

Derived units are units that are **formed by combining base units** according to the physical relationships between quantities.

Examples:

- Speed → **m s^{-1}**
- Force → **newton (N) = kgm s^{-2}**
- Pressure → **pascal (Pa) = kg$m^{-1}s^{-2}$**

1.2 How many significant figures should be retained in the following?

(i) Multiplying or dividing several numbers

(ii) Adding or subtracting numbers

Ans.

(i) Multiplying or Dividing Numbers:

In multiplication or division, result must have same number of significant figures as the input number with the **least significant figures.**

Example: $4.02 \times 2.234 \times 0.25 = 2.24517$

The least significant figures are two (0.25).

Final result = 2.2 (rounded to 2 sig figs)

(ii) Adding or Subtracting Numbers:

In addition, or subtraction, result must have same number of decimal places as the number with the **least decimal places.**

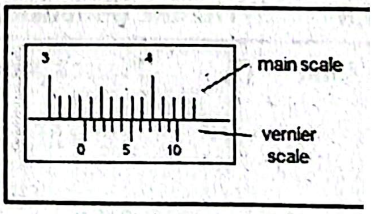
Example: 5.86kg+1.3kg+7.623 kg = 14.723 kg

The minimum no of decimal places is one (1.3 kg).

Final result = 14.7 kg (rounded to one decimal place)

1.3 How is the Vernier scale related to the main Scale of a Vernier Callipers?
What is meant by L.C. of the Vernier Callipers?

Ans. In a Vernier Calipers, the main scale is fixed and marked in millimeters or centimeters, while the Vernier scale slides along it.



RELATIONSHIP:

The Vernier scale is made so that **'N' VSD = (N – 1) MSD,**

Example:

If 10 Vernier scale divisions (VSD) = 9 Main scale divisions (MSD)

This small difference allows for precise measurement of fractions of a main scale division.

Least Count (L.C.):

The least count is the smallest value a Vernier calipers can measure accurately.

$$\textbf{Least Count (L.C.)} = \frac{\text{Main scale division}}{N} = \frac{1}{10} = 0.1\text{mm (or 0.01 cm)}$$

1.4 Write the following numbers in scientific notation. (a) 143.7 (b) 206.4 × 10^2

Ans. Scientific notation expresses numbers using **powers of ten**, with **one non-zero digit left of the decimal.**

(a) **143.7:** In scientific notation it can be written as 1.437×10^2

(b) **206.4 × 10^2:** In scientific notation it can be written as 2.064×10^4

1.5 Write the following numbers using correct prefixes: (a) 580 × 10^2 g (b) 0.45 × 10^{-5} s

Ans. Adjust the number to a standard **power of ten,** then replace it with the **matching SI prefix.**

(a) **580 × 10^2 g:** Using correct prefixes, it can be written as

$580 \times 10^2\text{ g} = 58 \times 10^3\text{ g} = 58\text{ kg}$

(b) **0.45 × 10^{-5} s:** Using correct prefixes, it can be written as

$0.45 \times 10^{-5} = 4.5 \times 10^{-6}\text{ s} = 4.5\ \mu\text{s}$

1.6 Kinetic energy of a body of mass m moving with speed *v* is given by 1/2 mv². What are the dimensions of kinetic energy?

Ans.

$$\text{K.E.} = \frac{1}{2}mv^2$$

Dimensions of Mass $= [M]$

Dimensions of velocity $= [LT^{-1}]$

Dimensions of K.E: **Where :** (½ is dimensionless quantity)

$$[\text{K.E}] = [m][v]^2 = [M][L^2T^{-2}]$$

$$[\text{K.E}] = [ML^2T^{-2}]$$

1.7 How many significant figures are there in the following measurements?
(i) 37 km (ii) 0.002953 m (iii) 7.50034 cm (iv) 200.0 m

Ans.

(i) **37 km:** **Significant Figures = 2**

Reason: Both digits (3 and 7) are non-zero and thus significant.

(ii) **0.002953 m:** **Significant Figures = 4**

Reason: Leading zeros are **not** significant. The digits 2, 9, 5, and 3 are **significant.**

(iii) **7.50034 cm:** **Significant Figures = 6**

Reason: All non-zero digits and zeros **between or after after decimal are counted.**

(iv) **200.0 m:** **Significant Figures = 4**

Reason: The right-side zeros after the decimal point are significant.

1.8 Write the dimension of : (i) Planck's constant (ii) Angular velocity

Ans. **(i)** **Planck's constant (h)**

$$E = hf \Rightarrow h = \frac{E}{f}$$

$$\text{Dimension of 'h'} = \frac{[E]}{[f]}$$

$$[h] = \frac{[ML^2T^{-2}]}{[T^{-1}]}$$

(ii) **Angular velocity**

As, $\omega = \dfrac{\Delta\phi}{\Delta t}$

$$\text{Dimension of } \omega = \frac{[\theta]}{[t]}$$

$$[\omega] = \frac{\text{no dimension}}{[T]}$$

$[h] = [ML^2T^{-1}]$	$\because$ Plane angle is dimensionless $[\omega] = [T^{-1}]$

CONSTRUCTED RESPONSE QUESTIONS

1.1 Why do we find it useful to have two units for the amount of a substance, the kilogram and the mole?

Ans. kilogram measures **mass**, while mole measures the **number of particles**.

Kilogram:-

The **kilogram (kg)** is the SI unit of mass. It is used when we measure the **mass** of a substance directly using a balance.

All measurements in physics or engineering laboratories where kilogram is used as unit.

Mole:-

It is used to measure the **number of particles** (atoms, molecules, ions, etc.)

In case of gases, one mole of a substance contains the equal number of particles (i.e., $N_A = 6.022 \times 10^{23}$).

1.2 Three students measured the length of a rod with a scale on which minimum division is 1 mm and recorded as: (i) 0.4235 m (ii) 0.42 m (iii) 0.424 m. Which record is correct and why?

Ans. **Correct measurement is:** 0.424 m

Reason: **Least count (LC) = 1 mm = 0.001 m.**

Thus, length is measured up to three decimal places which are more accurate.

- **0.424 m** is recorded up to **3 decimal places**, matching the precision of the scale.

Therefore, the correct recorded value is 0.424 m.

1.3 Why Is the kilogram (not the gram), the base unit of mass.

Ans. The **kilogram** is the base unit of mass (not the gram) in the **International System of Units (SI)** for **historical and practical reasons:**

Reasons:

- The kilogram is the SI base unit of mass, because it was historically defined by a physical prototype kept in France.
- It is a **more accessible size** for scientific and everyday use but **1 gram is too small** for measurements.
- Using kilograms allows for simpler expressions of physical laws and formulas, such as Newton's second law of motion ($F = ma$) etc

1.4 Consider the equation; $P = Q + R$
If Q and R both have the dimensions of [MLT], what are the dimensions of P? What are the units of P in SI? If the dimensions of Q were different from those of R, could we determine dimensions of P?

Ans. In that equation

$$P = Q + R$$

According to the principle of homogeneity, the dimensions of the quantities on both sides of the equation are same:

$$[P]=[Q]=[R]=[MLT]$$

As dimensions of a quantity only give qualitative nature of the quantity, so

Units of 'P':

As the dimensions of P are [MLT], the SI unit of P is kg m s (kilogram·meter·second).

If dimensions are different:

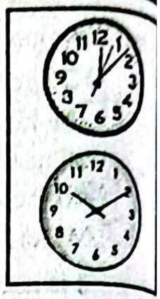
We could not determine the dimensions of P if Q and R had different dimensions. The equation is physically incorrect.

1.5 What is the least count of a clock if it has:

(a) Hour's hand, minute's hand and second's hand

(b) Hour's hand and minute's hand

Ans. The least count of a clock is the **smallest time** interval it can measure.



(a) Hour's hand, minute's hand and second's hand:

The **second hand** shows the smallest measurable time.

∴ **Least count = 1 second**

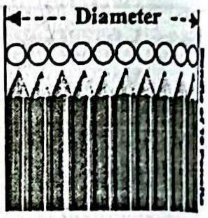
(b) Hour's hand and minute's hand:

The **minute hand** is the smallest time-measuring hand.

∴ **Least count = 1 minute**

.6 How can the diameter of a round pencil be measured using metre rule with the same accuracy as that of Vernier Callipers? Describe.

Ans. If we measure the diameter of pencil with **Vernier Callipers** (L.C = 0.01 cm), then



Uncertainty in diameter = ±0.01cm

A meter rule typically has a least count of **0.1 cm**, which is **less precise** than Vernier callipers.

Steps to Achieve Accuracy:

- **Place multiple pencils side by side** (e.g. 10 pencils) tightly in a straight line.
- Use a **meter rule** to measure the **total diameter** of all the pencils bundle.
- Divide the total width by the number of pencils

$$\text{Diameter of each pencil} = \frac{\text{Diameter of bundle}}{\text{Total no of pencils}}$$

$$\text{Uncertainty in diameter of each} = \frac{\text{L.C of meter rod}}{10} = \frac{0.1}{10} = \pm 0.01\text{cm}$$

- This Uncertainty (±0.01cm) of meter rod match the Uncertainty of Vernier callipers.

7 How would be the readings differ if the screw gauge is used instead of a Vernier Callipers to measure the thickness of a glass plate?

Ans. Reading will be **more precise** with a screw gauge due to its **smaller least count** (0.01 mm).

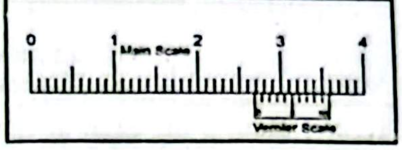
Explanation:

- Screw gauge has a L.C = 0.001 cm, while Vernier calipers usually have a L.C = 0.01 cm.
- Screw gauge provides more precise measurement due small least count.
- Screw gauge suitable for measuring very thin objects

  e.g. (Thickness of **glass plate**, Diameter of wire and Thickness of **sheet metal**)

1.8 Write the correct reading of the length of a solid cylinder as shown in the figure if there is an error of +0.02 cm in the Vernier Callipers.

Ans. **In figure:**



Main scale reading (MSR) = 2.6 cm

Vernier scale division (VSR) = n × L.C. (cm)

= 9 × 0.01 = 0.09 cm

Measured reading = R = 2.6 + 0.09 = 2.69 cm

Corrected reading = R ± Z.C.

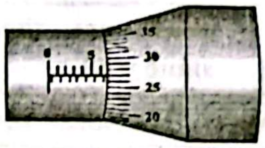
L.C = MSD / no of VSD
L.C = 0.1 / 10 = 0.01 cm

As zero error is positive, so zero correction will be negative

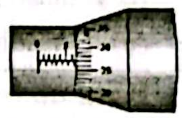
Corrected reading = 2.69 – 0.02

$\boxed{\text{Corrected reading} = 2.67 \text{ cm}}$

1.9 There are 50 divisions on the circular scale of a Screw gauge. If the head (thimble) of the screw is given 10 revolutions, then the spindle advances by 5 mm. There is also zero error as the 2nd division of the circular scale coincides with the datum line and zero of circular scale is below the datum line. What is the thickness of a glass slab as measured by the described screw gauge shown in the figure?



Ans. **In figure:**



Main scale reading (MSR) = 6.5 mm

Circular scale reading (CSR) = n × L.C. = 27 × 0.01 = 0.27 mm

Measured reading = 6.5 + 0.27 = 6.77 mm

Zero Error:

Zero of the circular scale is 2 divisions below the datum line.

L.C = Pitch / no of CSD
L.C = 0.5 / 50 = 0.01 mm

- Zero error = 2 × 0.01 mm = + 0.02 mm
- Zero correction = – 0.02 mm

Corrected reading (R) = 6.77 – 0.02

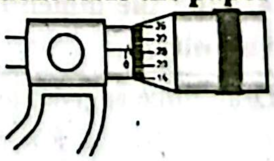
$\boxed{\text{Corrected reading (R)} = 6.75 \text{ mm}}$

1.10 What is meant by a dimensionless quantity? Give one example,

Ans. **Dimensionless Quantity:** A quantity that has no physical dimensions. It is pure number or any supplementary quantity, resulting from the ratio of two quantities with the same dimension,

Examples: (i) Angle $\left(\theta = \frac{s}{r}\right)$ (ii) Refractive index $\left(n = \frac{C}{V}\right)$

1.11 A student uses a screw gauge to determine the thickness of a sheet of paper. The student folds the paper three times and measures the total thickness of the folded sheet. Assume that there is no zero error in the screw gauge. The reading of screw gauge is shown in the figure. Find the thickness of the sheet.

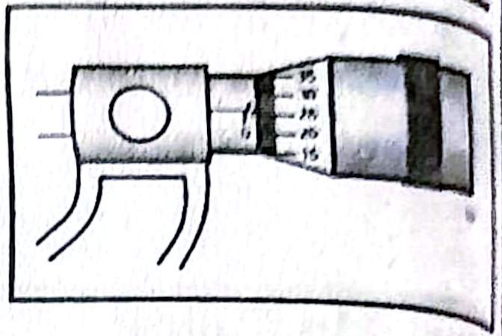


Ans. Main scale reading (MSR) $= 1.0$ mm

Circular scale reading (CSR) $= n \times L.C = 26 \times 0.01 = 0.26$ mm

Observed reading (R) $= 1.0 + 0.26$

$= 1.26$ mm



As there is no zero error, so corrected reading $= 1.26$ mm

❖ **1-fold = 2 layers, 2-fold = 4 layers and 3-folds = 8 layers of sheet**

$$\boxed{\text{Thickness of single sheet} = \frac{1.26}{8} = 0.16 \text{ mm}}$$

1.12 Round off each of the following numbers to 3 significant figures and write your answer in scientific notation. (a) 0.02055 (b) 4656.5

Ans. Round off each of the following numbers to 3 significant figures and write standard form.

(a) 0.02055

After rounding 3 significant figures and writing in scientific notation (power of 10)

$\boxed{0.02055 \rightarrow 2.06 \times 10^{-2}}$

(b) 4656.5

After rounding 3 significant figures and writing in scientific notation (power of 10)

$\boxed{4656.5 \rightarrow 4.66 \times 10^{3}}$