PHYSICS

HSSC-I

MEASUREMENTS

SHORT QUESTIONS

QUESTION # 1

Length (m)	Mass (kg)	Time (s)
Diameter of proton = 10^{-15}	Mass of electron = 10^{-30}	Mean lifetime of unstable nucleus = 10^{-23}
Diameter of large nucleus = 10^{-14}	Mass of proton = 10^{-27}	Time for single floating-point operation = 10^{-16}
Diameter of H-atom = 10^{-10}	Mass of bacterium = 10^{-15}	Time period of visible light = 10^{-15}
Diameter of typical virus = 10^{-7}	Mass of mosquito = 10^{-6}	Time period of atom in solid = 10^{-13}
Width of pinky fingernail = 10^{-2}	Mass of hummingbird = 10^{-2}	Time period of nerve impulse = 10^{-3}
Height of 4-year-old child = 10^{0}	Mass of 1 liter of water = 10^{0}	Time for 1 heartbeat = 10^{0}
Length of football ground = 10^{2}	Mass of a Motorcycle = 10^{2}	One day = 10^{5}
Diameter of Earth = 10^{7}	Mass of atmosphere = 10^{18}	One year = 10^{7}
Diameter of solar system = 10^{13}	Mass of Moon = 10^{22}	Human lifetime = 10^{9}
1 light-year = 10^{16}	Mass of Earth = 10^{24}	Recorded human history = 10^{11}
Diameter of Milky Way = 10^{21}	Mass of Sun = 10^{30}	Age of Earth = 10^{17}
Distance across observable universe = 10^{26}	Mass of known universe = 10^{53}	Age of universe = 10^{18}

QUESTION # 2

Q2: Express the units of the following derived quantities in terms of base units.

(a) Force

Formula: Force = mass × acceleration

$$\text{Force} = \text{mass} \times \frac{\textit{change in velocity}}{\textit{time}}$$

$$\text{Force} = \text{mass} \times \left(\frac{\textit{change in displacement}}{\textit{time}}\right) \frac{1}{\textit{time}}$$

$$\text{Force} = \text{mass} \times \frac{\textit{change in displacement}}{\textit{time}^2}$$

SI base unit: $\text{kg m/s}^2 = \text{kg m s}^{-2}$

(b) Work

Formula: Work = Force × displacement

Work = mass × acceleration × displacement

$$\text{Work} = \text{mass} \times \frac{\textit{change in velocity}}{\textit{time}} \times \text{displacement}$$

$$\text{Work} = \text{mass} \times \frac{\textit{change in velocity}}{\textit{time}^2} \times \text{displacement}$$

$$\text{Work} = \text{mass} \times \frac{\textit{Displacement}^2}{\textit{time}^2}$$

QUESTION # 2

SI base unit: $kg\ m^2/s^2 = kg\ m^2\ s^{-2}$

(c) Power

Formula: Power = $\frac{Work}{Time}$

Power = $\left(\text{mass} \times \frac{Displacement^2}{time^2}\right)\frac{1}{time}$

Power = $\text{mass} \times \frac{Displacement^2}{time^2}$

SI base unit: $kg\ m^2/s^3 = kg\ m^2\ s^{-3}$

(d) Pressure

Formula: Pressure = $\frac{Force}{Area}$

Pressure = $\frac{\text{mass} \times \frac{change\ in\ displacement}{time^2}}{length^2}$

SI base unit: $kg\ m^{-1}\ s^{-2}$

(e) Electric Charge

Formula: Charge = current × time => $(ampere)(second)$

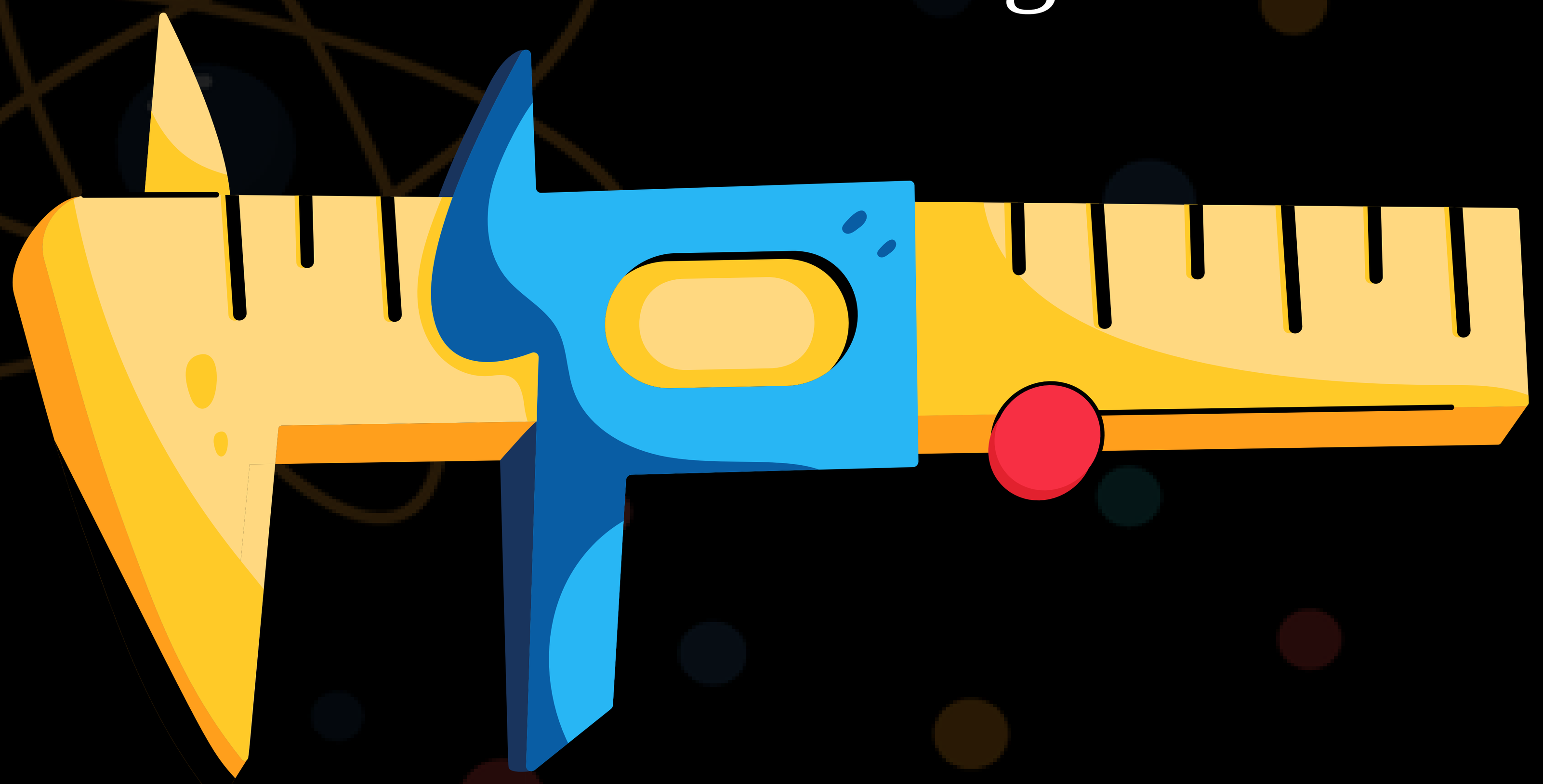
SI base unit: A s

QUESTION # 3

Q.3 Why is it important to use an instrument of the smallest resolution?

Ans. The smallest value that can be measured by the measuring instrument is called its least count. Using an instrument with the smallest resolution:

- Provides more precise and accurate measurements.
- Increases reliability and effectiveness.
- Helps detect small changes in data.



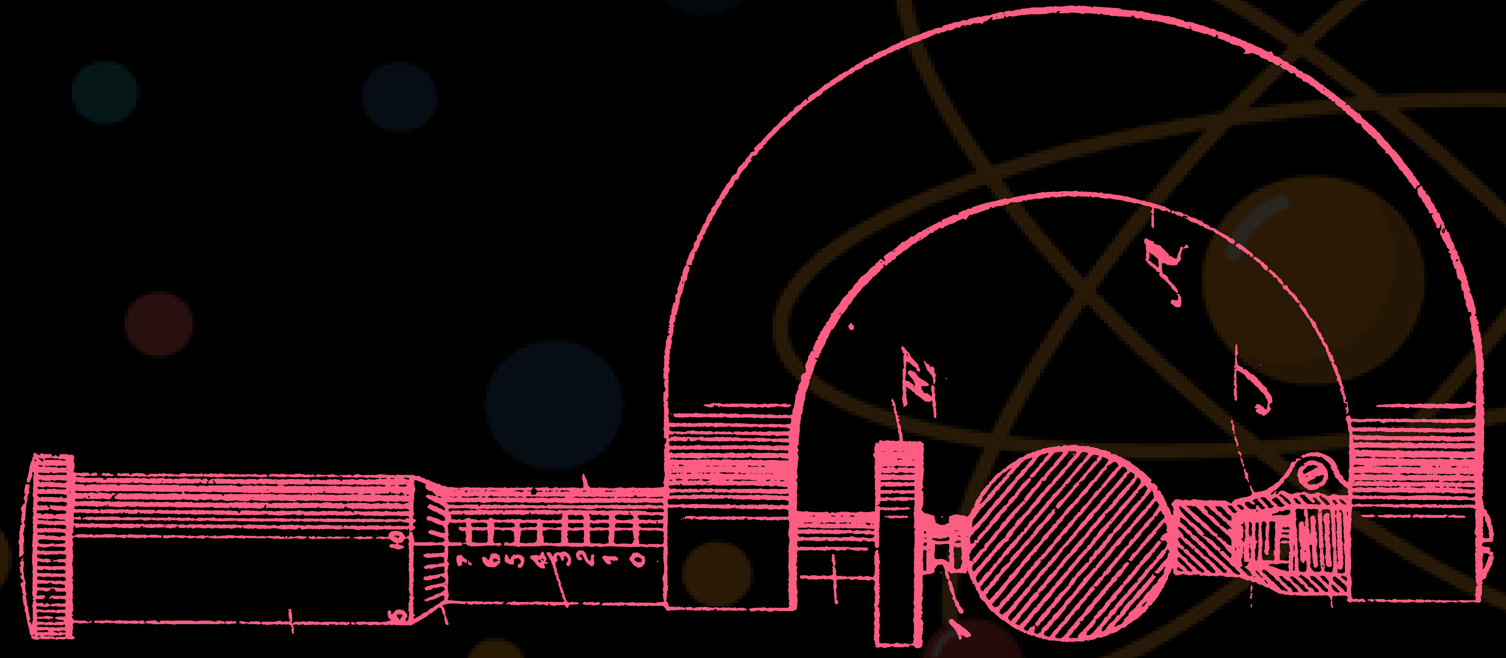
QUESTION # 4

Q.4 What is the importance of increasing the number of readings in an experiment?

Ans. Increasing the number of readings:

- Reduces standard deviation and increases accuracy.
- Minimizes random errors by averaging values.

Enhances reliability and confidence in results.



QUESTION # 5

Accuracy	Precision
Closeness to the true value.	Measure of reproducibility
Can be accurate without being precise.	Can be precise without being accurate
Determined with a single measurement.	Requires multiple measurements.
Affected by systematic error.	Affected by random error
Usually precise values are accurate.	Precise values may not be accurate.
Degree of conformity	Degree of reproducibility

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QUESTION # 6

Q.6 What is the principle of homogeneity of dimensions?

Ans. The principle states that the dimensions of each term in a dimensional equation must be the same on both sides.

- Example: vf=vi+at $\rightarrow$ Dimensions of vi and at must match those of vf.

  Ensures correctness of equations and unit conversion.

QUESTION # 8

The energy of a photon is given by E=hf. Find the dimensions of Planck's constant h, where f is frequency.

Given:

$[E] = [ML^2T^{-2}]$, $[F]=[T^{-1}]$

Solution:

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

The final answer is

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

QUESTION # 7

A ball is thrown in the air, and 5 students measure the time it takes to fall using stopwatches. Their results: 6.2 s, 6.0 s, 6.4 s, 6.1 s, 5.8 s.What is the uncertainty? How should the time be expressed?

Solution:

To find the mean time t, sum all the measurements and divide by the number of measurements:

$$t = \frac{6.2+6.0+6.4+6.1+5.85}{5}$$

$$t = \frac{30.5}{5} \Rightarrow 6.1 \text{ sec}$$

Step 1: Deviation of each measurement from the mean time:

$6.2-6.1=0.1$

$6.0-6.1=-0.1$

$6.4-6.1=0.3$

$6.1-6.1=0$

$5.8-6.1=-0.3$

Step 2: Average of the absolute deviations:

$$\text{Average deviation}=\frac{|0.1|+|-0.1|+|0.3|+|0|+|-0.3|}{5}$$

$$= \frac{0.1+0.1+0.3+0+0.3}{5}$$

Uncertainty = 0.2 s (rounded to 1 significant figure)

Resulting time = (6.1 ± 0.2) s

THANK YOU VERY MUCH!