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Class	9th	Chapter	01
Subject	Physics	Board	Punjab

CHAPTER 01: PHYSICAL QUANTITIES AND MEASUREMENTS — SOLUTIONS

A. Multiple Choice Questions

- **1.1. The instrument that is most suitable for measuring the thickness of a few sheets of cardboard is a:**
  - **Options:** (a) metre rule | (b) measuring tape | (c) Vernier Callipers | (d) **micrometer screw gauge** *(Correct Answer)*
  - *Explanation:* A micrometer screw gauge has high precision (least count of 0.01 mm or 0.001 mm), making it ideal for very small thicknesses.
- **1.2. One femtometre is equal to:**
  - **Options:** (a) 10^{-9} m| (b) 10^{-15} m*(Correct Answer)* | (c) 10^{9} m| (d) 10^{15} m
  - *Explanation:* The SI prefix 'femto-' stands for 10^{-15}.
- **1.3. A light year is a unit of:**
  - **Options:** (a) light | (b) time | (c) **distance** *(Correct Answer)* | (d) speed
  - *Explanation:* A light year measures the distance light travels in one Earth year.
- **1.4. Which one is a non-physical quantity?**
  - **Options:** (a) distance | (b) density | (c) **colour** *(Correct Answer)* | (d) temperature
  - *Explanation:* Colour is a qualitative perception and cannot be physically quantified or measured.
- **1.5. When using a measuring cylinder, one precaution to take is to:**
  - **Options:** (a) check for the zero error | (b) look at the meniscus from below the level of the water surface | (c) take several readings by looking from more than one direction | (d) **position the eye in line with the bottom of the meniscus** *(Correct Answer)*
  - *Explanation:* Aligning the eye with the bottom of the meniscus prevents parallax error.

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- **1.6. Volume of water consumed by you per day is estimated in:**
  - **Options:** (a) millilitre | (b) **litre** *(Correct Answer)* | (c) kilogram | (d) cubic metre
  - *Explanation:* Daily human water consumption is typically measured in litres.
- **1.7. A displacement can is used to measure:**
  - **Options:** (a) mass of a liquid | (b) mass of a solid | (c) volume of a liquid | (d) **volume of a solid** *(Correct Answer)*
  - *Explanation:* A displacement (Eureka) can is used to find the volume of irregular solid objects via water displacement.
- **1.8. Two rods with lengths 12.321 cm and 10.3 cm are placed side by side, the difference in their lengths is:**
  - **Options:** (a) 2.02 cm| (b) 2.0 cm*(Correct Answer)* | (c) 2 cm| (d) 2.021 cm
  - *Explanation:* $12.321 - 10.3 = 2.021$ cm. Rounded to the least decimal place of the given measurements (one decimal place), it becomes 2.0 cm.
- **1.9. Four students measure the diameter of a cylinder with Vernier Callipers. Which of the following readings is correct?**
  - **Options:** (a) 3.4 cm| (b) 3.475 cm*(Correct Answer)* | (c) 3.47 cm| (d) 3.5 cm
  - *Explanation:* Standard Vernier Callipers provide readings precise to two decimal places in centimeters (and estimated to three, e.g., 3.475 cm).
- **1.10. Which of the following measures are likely to represent the thickness of a sheet of this book?**
  - **Options:** (a) 6×10^{-25} m| (b) 1×10^{-4} m*(Correct Answer)* | (c) 1.2×10^{-15} m| (d) 4×10^{-2} m
  - *Explanation:* 1×10^{-4} m $= 0.1$ mm, which is the realistic thickness of a single sheet of paper.
- **1.11. In a Vernier Callipers ten smallest divisions of the Vernier scale are equal to nine smallest divisions of the main scale. If the smallest division of the main scale is half millimetre, the Vernier constant is equal to:**
  - **Options:** (a) 0.5 mm| (b) 0.1 mm| (c) 0.05 mm*(Correct Answer)* | (d) 0.001 mm
  - *Explanation:* Least Count $= 1$ MSD $- 1$ VSD $= 0.5$ mm $- 0.45$ mm $=$ 0.05 mm.

B. Short Answer Questions

- **1.1. Can a non-physical quantity be measured? If yes, then how?**
  - **Answer:** No, a non-physical quantity (such as feelings, beauty, or colour) cannot be measured because it cannot be quantified using numbers and standard units. Only physical quantities can be measured.
- **1.2. What is measurement? Name its two parts.**
  - **Answer:** Measurement is the process of comparing an unknown physical quantity with a standard quantity (unit). Its two essential parts are:

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1. A numerical value (magnitude).
2. A proper unit.

- **1.3. Why do we need a standard unit for measurements?**
  - **Answer:** Standard units are needed to communicate scientific observations and commercial measurements universally and unambiguously across the world without confusion.
- **1.4. Write the name of 3 base quantities and 3 derived quantities.**
  - **Answer:**
    - *Base quantities:* Length, Mass, Time.
    - *Derived quantities:* Area, Volume, Speed.
- **1.5. Which SI unit will you use to express the height of your desk?**
  - **Answer:** The metre (m) or centimetre (cm). In SI units, length is expressed in metres (m).
- **1.6. Write the name and symbols of all SI base units.**
  - **Answer:**
    1. Length: metre (m)
    2. Mass: kilogram (kg)
    3. Time: second (s)
    4. Electric current: ampere (A)
    5. Thermodynamic temperature: kelvin (K)
    6. Amount of substance: mole (mol)
    7. Luminous intensity: candela (cd)
- **1.7. Why prefix is used? Name three sub-multiple and three multiple prefixes with their symbols.**
  - **Answer:** Prefixes are used to express very large or very small quantities conveniently, avoiding the writing of numerous zeros.
    - *Sub-multiple prefixes:* milli- (m), micro- (μ), nano- (n)
    - *Multiple prefixes:* kilo- (k), mega- (M), giga- (G)
- **1.8. What is meant by: (a) 5 pm (b) 15 ns (c) 6 µm (d) 5 fs**
  - **Answer:**
    - (a) $5\ \text{pm} = 5 \times 10^{-12}$ metres (picometres)
    - (b) $15\ \text{ns} = 15 \times 10^{-9}$ seconds (nanoseconds)
    - (c) $6\ \mu\text{m} = 6 \times 10^{-6}$ metres (micrometres)
    - (d) $5\ \text{fs} = 5 \times 10^{-15}$ seconds (femtoseconds)
- **1.9. (a) For what purpose, a Vernier Callipers is used? (b) Name its two main parts. (c) How is least count found? (d) What is meant by zero error?**
  - **Answer:**

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- (a) Vernier Callipers is used to measure small lengths, internal/external diameters, and depths with high precision.
- (b) Its two main parts are the Main Scale and the Vernier Scale.
- (c) Least Count $= \frac{\text{Smallest division on main scale}}{\text{Total number of divisions on vernier scale}} = 1\ \text{MSD} - 1\ \text{VSD}$.
- (d) Zero error is an instrumental error where the zero of the vernier scale does not coincide with the zero of the main scale when the jaws are tightly closed.

- **1.10. State least count and Vernier scale reading as shown in the figure and hence, find the length.**
  - **Answer:**
    - Least Count: 0.01 cm (or 0.1 mm)
    - Main Scale Reading (MSR): 3.1 cm
    - Vernier Coincidence (VC): 4th division
    - Vernier Reading $= 4 \times 0.01\ \text{cm} = 0.04\ \text{cm}$
    - Total Length $= \text{MSR} + (\text{VC} \times \text{LC}) = 3.1\ \text{cm} + 0.04\ \text{cm} = \mathbf{3.14}\ \text{cm}$.
- **1.11. Which reading out of A, B and C shows the correct length and why?**
  - **Answer:** Reading B shows the correct length because the line of sight (eye position) is held perpendicular (vertically above) to the scale mark, preventing parallax error.
- **1.12. Why might a standard system of measurement be helpful to a tailor?**
  - **Answer:** It ensures precision, consistency, and accurate communication of measurements so garments fit correctly without ambiguity.
- **1.13. The minimum main scale reading of a micrometer screw gauge is 1 mm and there are 100 divisions on the circular scale... What is the least count and thickness?**
  - **Answer:**
    - Least Count $= \frac{\text{Pitch of screw gauge}}{\text{Number of divisions on circular scale}} = \frac{1\ \text{mm}}{100} = 0.01\ \text{mm} = 0.001\ \text{cm}$.
    - Thickness of rod $=$ Main scale reading $+$ (Circular scale reading $\times$ Least Count) $= \text{MSR} + (\text{CSR} \times 0.01\ \text{mm})$.
- **1.14. You are provided a metre scale and a bundle of pencils; how can the diameter of a pencil be measured using the metre scale with the same precision as that of Vernier Callipers? Describe briefly.**
  - **Answer:** By placing N identical pencils side-by-side tightly in a bundle, measure the total thickness using a metre scale, and divide the total thickness by N. This averaging method significantly reduces measurement error and increases precision.
- **1.15. The end of a metre scale is worn out. Where will you place a pencil to find the length?**

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- **Answer:** Do not use the worn-out 0 cm mark. Instead, start measuring from a clear, intact mark (e.g., 1.0 cm) and subtract that initial reading from the final reading.

- **1.16. Why is it better to place the object close to the metre scale?**
  - **Answer:** Placing the object close to the scale minimizes parallax error that occurs due to the separation between the object and the markings.
- **1.17. Why a standard unit is needed to measure a quantity correctly?**
  - **Answer:** To ensure uniformity, reproducibility, and universal acceptance of scientific and commercial data.
- **1.18. Suggest some natural phenomena that could serve as a reasonably accurate time standard.**
  - **Answer:** Earth's rotation on its axis (day and night), Earth's revolution around the sun (year), or atomic vibrations (cesium-133 atom oscillations).
- **1.19. It is difficult to locate the meniscus in a wider vessel. Why?**
  - **Answer:** In a wider vessel, the surface area of the liquid is large, making the curvature (meniscus) flatter and harder to read accurately.
- **1.20. Which instrument can be used to measure: (i) internal diameter of a test tube (ii) depth of a beaker?**
  - **Answer:**
    - (i) Internal diameter: Vernier Callipers (using internal jaws).
    - (ii) Depth of a beaker: Vernier Callipers (using the depth probe strip).

C. Constructed Response Questions

- **1.1. In what unit will you express each of the following?**
  - **Answer:**
    - (a) Thickness of a five-rupee coin: **millimetre (**mm**)**
    - (b) Length of a book: **centimetre (**cm**) or metre (**m**)**
    - (c) Length of football field: **metre (**m**)**
    - (d) The distance between two cities: **kilometre (**km**)**
    - (e) Mass of five-rupee coin: **gram (**g**)**
    - (f) Mass of your school bag: **kilogram (**kg**)**
    - (g) Duration of your class period: **minute (**min**) or second (**s**)**
    - (h) Volume of petrol filled in the tank of a car: **litre (**L**) or cubic metre (**m^3**)**
    - (i) Time to boil one litre milk: **minute (**min**)**

D. Comprehensive Questions

- **1.1. What is meant by base and derived quantities? Give the names and symbols of SI base units.**
  - **Answer:**

- *Base quantities:* Quantities on the basis of which other quantities are expressed (e.g., length, mass, time).
- *Derived quantities:* Quantities that are expressed in terms of base quantities (e.g., speed, area, volume).
- *SI base units:* metre (m), kilogram (kg), second (s), ampere (A), kelvin (K), mole (mol), candela (cd).

- **1.2. Give three examples of derived unit in SI. How are they derived from base units? Describe briefly.**
  - **Answer:**
    1. Area (m^2): Derived by multiplying length by width (m × m).
    2. Volume (m^3): Derived by multiplying length, width, and height (m × m × m).
    3. Speed (m/s): Derived by dividing distance (m) by time (s).
- **1.3. State the similarities and differences between Vernier Callipers and micrometer screw gauge.**
  - **Answer:**
    - *Similarities:* Both are precision measuring instruments used to measure small lengths/dimensions accurately beyond standard metre scales.
    - *Differences:* Vernier Callipers is used for lengths down to 0.1 mm (or 0.01 cm) and measures internal/external diameters and depths. A micrometer screw gauge uses a screw mechanism for higher precision down to 0.01 mm or 0.001 mm, primarily used for wire diameters or sheet thicknesses.
- **1.4. Identify and explain the reasons for human errors, random errors and systematic errors in experiments.**
  - **Answer:**
    - *Human (Personal) errors:* Caused by poor observation, parallax error, or incorrect reading of instruments.
    - *Random errors:* Caused by unknown, unpredictable variations in experimental conditions (e.g., fluctuating voltage, drafts).
    - *Systematic errors:* Caused by faulty instrument calibration, zero error, or consistent experimental bias in one direction.
- **1.5. Differentiate between precision and accuracy of a measurement with examples.**
  - **Answer:**
    - *Precision* refers to the reproducibility or closeness of multiple measurements to each other (least count limit).
    - *Accuracy* refers to how close a measurement is to the true or accepted value.

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- *Example:* If a true rod length is 10.0 cm and three measurements are 10.5 cm, 10.51 cm, and 10.5 cm, the measurements are precise (close to each other) but inaccurate (far from 10.0 cm).

E. Numerical Problems

- **1.1. Calculate the number of seconds in a (a) day (b) week (c) month and state your answers using SI prefixes.**
  - **Answer:**
    - (a) Day: 1 day $= 24 \times 60 \times 60 = 86{,}400$ s $= 86.4 \times 10^3$ s $= \mathbf{86.4}$ ks
    - (b) Week: 7 days $= 7 \times 86{,}400 = 604{,}800$ s $= 604.8 \times 10^3$ s $= \mathbf{604.8}$ ks
    - (c) Month (30 days): $30 \times 86{,}400 = 2{,}592{,}000$ s $= 2.592 \times 10^6$ s $= \mathbf{2.592}$ Ms
- **1.2. State the answers of problem 1.1 in scientific notation.**
  - **Answer:**
    - (a) Day: $\mathbf{8.64 \times 10^4}$ s
    - (b) Week: $\mathbf{6.048 \times 10^5}$ s
    - (c) Month: $\mathbf{2.592 \times 10^6}$ s
- **1.3. Solve the following addition or subtraction. State your answers in scientific notation.**
  - **Answer:**
    - (a) 4×10^{-4} kg $+ 3 \times 10^{-5}$ kg $= 4 \times 10^{-4}$ kg $+ 0.3 \times 10^{-4}$ kg $= \mathbf{4.3 \times 10^{-4}}$ kg
    - (b) 5.4×10^{-6} m $- 3.2 \times 10^{-5}$ m $= 0.54 \times 10^{-5}$ m $- 3.2 \times 10^{-5}$ m $= \mathbf{-2.66 \times 10^{-5}}$ m
- **1.4. Solve the following multiplication or division. State your answers in scientific notation.**
  - **Answer:**
    - (a) $(5 \times 10^4$ m$) \times (3 \times 10^{-2}$ m$) = (5 \times 3) \times (10^4 \times 10^{-2}) = 15 \times 10^2$ m$^2 = \mathbf{1.5 \times 10^3}$ m$^{\mathbf{2}}$
    - (b) $\frac{6 \times 10^8 \text{ kg}}{3 \times 10^4 \text{ m}^3} = \left(\frac{6}{3}\right) \times 10^{8-4} = \mathbf{2.0 \times 10^4}$ kg m$^{\mathbf{-3}}$
- **1.5. Calculate the following and state your answer in scientific notation:** $\frac{(3 \times 10^2 \text{ kg}) \times (4.0 \text{ km})}{5 \times 10^2 \text{ s}^2}$
  - **Answer:**
    - Convert 4.0 km to metres: 4.0 km $= 4{,}000$ m $= 4 \times 10^3$ m
    - Numerator $= (3 \times 10^2 \text{ kg}) \times (4 \times 10^3 \text{ m}) = 12 \times 10^5 \text{ kg} \cdot \text{m}$

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- Denominator $= 5 \times 10^2\ s^2$
- Result $= \frac{12}{5} \times 10^{5-2} = \mathbf{2.4 \times 10^3}$ kg · m/s$^{\mathbf{2}}$ (or N)

- **1.6. State the number of significant digits in each measurement.**
  - **Answer:**
    - (a) 0.0045 m → **2** significant digits (leading zeros are not significant)
    - (b) 2.047 m → **4** significant digits (zeros between non-zero digits are significant)
    - (c) 3.40 m → **3** significant digits (trailing zeros after decimal are significant)
    - (d) 3.420×10^4 m → **4** significant digits
- **1.7. Write in scientific notation:**
  - **Answer:**
    - (a) 0.0035 m $= \mathbf{3.5 \times 10^{-3}}$ m
    - (b) 206.4×10^2 m $= \mathbf{2.064 \times 10^4}$ m
- **1.8. Write using correct prefixes:**
  - **Answer:**
    - (a) 5.0×10^4 cm $= 5.0 \times 10^2$ m $= 500$ m $= \mathbf{0.5}$ km
    - (b) 580×10^2 g $= 58{,}000$ g $= \mathbf{58}$ kg
    - (c) 45×10^{-4} s $= 4.5 \times 10^{-3}$ s $= \mathbf{4.5}$ ms
- **1.9. Light year is a unit of distance used in Astronomy... Taking the speed of light as 3.0×10^8 m s^{-1}, calculate the distance.**
  - **Answer:**
    - Distance = Speed × Time
    - Time for 1 year $= 365 \times 24 \times 3600$ s $= 3.1536 \times 10^7$ s
    - Distance $= (3.0 \times 10^8$ m/s$) \times (3.1536 \times 10^7$ s$) = 9.4608 \times 10^{15}$ m $\approx \mathbf{9.46 \times 10^{15}}$ m
- **1.10. Express the density of mercury given as 13.6 g cm^{-3} in kg m^{-3}.**
  - **Answer:**
    - Density $= 13.6$ g/cm$^3 = \frac{13.6 \times 10^{-3}\ \text{kg}}{(10^{-2}\ \text{m})^3} = \frac{13.6 \times 10^{-3}\ \text{kg}}{10^{-6}\ \text{m}^3} = 13.6 \times 10^3$ kg/m$^3 = \mathbf{1.36 \times 10^4}$ kg/m$^{\mathbf{3}}$

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