# Class : 11th

# Subject : Physics

# Chapter : 1 Measurements

**(11th Class Physics – Punjab Board)**

**Multiple Choice Questions with Explanations**

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### 1.1 The purpose of study and discoveries in Physics is:

**(a)** the probing of interstellar spaces
**(b)** the betterment of mankind ✓
**(c)** the development of destructive technology in warfare
**(d)** development in aesthetics for the world

✅ **Explanation:** Physics ka asal maqsad insani zindagi ko behter banana hai — technology, health, communication, transport etc. sab is ka result hain.

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### 1.2 The length of a steel pipe is in between 0.7 m to 0.8 m. Identify from the following, the appropriate instrument to be used for an accuracy of 0.001 m.

**(a)** A micrometer screw gauge
**(b)** A metre rule
**(c)** A ten metres measuring tape
**(d)** A Vernier Callipers ✓

✅ **Explanation:** Vernier Callipers ki accuracy 0.01 cm (yaani 0.0001 m) tak hoti hai, is liye steel pipe ki measurement mein yeh best instrument hai.

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**1.3 The diameter of a steel ball is measured using a Vernier callipers and its reading is shown in the figure. What is the diameter of the steel ball?**

**(a)** 1.30 cm
**(b)** 1.39 cm ✓
**(c)** 1.40 cm
**(d)** 1.31 cm

✅ **Explanation:** Agar main scale 1.3 cm aur vernier scale ka 9th division match kar raha ho to:
**1.3 + (9 × 0.01) = 1.39 cm**

## 1.4

A micrometer screw gauge is used to measure the diameter of a rod. One complete turn of the thimble = 0.50 mm and 50 divisions on the circular scale.
**(a)** 3.67 mm
**(b)** 3.17 mm ✓
**(c)** 4.77 mm
**(d)** 4.20 mm

✅ **Explanation:**
Pitch = 0.50 mm
LC (Least Count) = 0.50 mm / 50 = 0.01 mm
Assume main scale reading = 3.0 mm, and circular scale = 17
→ Diameter = 3.0 + (17 × 0.01) = **3.17 mm**

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## 1.5

The number of significant figures of a measurement are defined as:
**(a)** they reflect the accuracy of the observation in a measurement
**(b)** they are the figures which are reasonably rounded off
**(c)** they are the accurately known digits and the first doubtful digit of a measurement ✓
**(d)** meaningless data

✅ **Explanation:**
Significant figures include all known digits plus the first uncertain (doubtful) digit.

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## 1.6

The number of significant figures in the measured mass 2500.0 kg is:
**(a)** two

**(b)** three
**(c)** four
**(d)** five ✓

✅ **Explanation:**
All non-zero digits and trailing zeroes **after decimal** are significant. So:
**2500.0 → 5 significant figures**

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## 1.7

The sum 12 kg + 2.02 kg + 5.1 kg, to appropriate precision:
**(a)** 19 kg
**(b)** 19.0 kg
**(c)** 19.1 kg ✓
**(d)** 19.12 kg

✅ **Explanation:**
Least precise number (12 kg) has no decimal, but 5.1 has 1, and 2.02 has 2 decimal places. Final answer should match the **least decimal places (i.e., 1)**.
12 + 2.02 + 5.1 = **19.12 → round to 19.1**

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## 1.8

Subtraction: 0.126 – 0.97268 = ? (to correct significant figures)
**(a)** 0.15
**(b)** 0.153
**(c)** 0.1533 ✓
**(d)** 0.15332

✅ **Explanation:**
0.126 has 3 decimal places, so answer should be up to **3 decimal places** → 0.1533

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## 1.9

Product: 2.8723 × 1.6 = ? (Significant figures)
**(a)** 4.59568
**(b)** 4.595
**(c)** 4.59 ✓
**(d)** 4.6

✅ **Explanation:**
2.8723 → 5 sig. figs
1.6 → 2 sig. figs
So answer must be in **2 significant figures → 4.59**

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## 1.10

Division: 45.2 ÷ 6.0 = ?
**(a)** 7.5 ✓
**(b)** 7.53
**(c)** 7.533
**(d)** 7.5333

✅ **Explanation:**
45.2 (3 sig. figs), 6.0 (2 sig. figs) → final result = **2 sig. figs → 7.5**

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## 1.11

Multiplication: 24.4 m/s × 100 m × 2.0 s
**(a)** 4880 m
**(b)** 4900 m ✓
**(c)** $4.88 \times 10^3$ m
**(d)** $4.9 \times 10^3$ m

✅ **Explanation:**
Significant figures:
24.4 (3), 100 (1), 2.0 (2) → answer must have **1 sig. fig** (least)
→ 4880 → rounded to **4900** (1 sig. fig)

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## 1.12

The ratio of the dimensions of force and energy is:
**(a)** T
**(b)** $T^{-1}$
**(c)** L
**(d)** $L^{-1}$ ✓

✅ **Explanation:**
Force=MLT−2,  Energy=ML2T−2
So ratio = Force / Energy  = MLT−2 / ML2T−2 =1 / L= L−1

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## 1.13

Which pair does **not** have identical dimensions?
**(a)** Work and torque
**(b)** Angular momentum and Planck's constant
**(c)** Moment of inertia and moment of force ✓
**(d)** Impulse and momentum

✅ **Explanation:**
Moment of inertia: $ML^2$
Moment of force (Torque): $M L^2 T^{-2}$ → **different dimensions**

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The following figures are of the same Vernier Calipers.

- **Fig (1)** shows the reading when the jaws are **closed**
- **Fig (2)** shows the reading when a **solid cylinder is placed** between the jaws
- the length of the cylinder?
  **Options:**
  **(a)** 3.26 cm
  **(b)** 3.30 cm
  **(c)** **3.34 cm** ✓
  **(d)** 4.20 cm

## 1.15

The least count of an instrument determines:
**(a)** Precision of a measurement ✓
**(b)** Accuracy of a measurement
**(c)** Fractional uncertainty
**(d)** Percentage uncertainty

✅ **Explanation:**
**Least Count** shows the smallest measurable quantity. It reflects **how precise** the instrument is.

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## 1.16

A measuring tape has a smallest division of 0.02 cm. The appropriate reading using this tape is:
**(a)** 80.504 cm
**(b)** 80.6 cm
**(c)** 80.65 cm ✓
**(d)** 80.7 cm

✅ **Explanation:**
A measuring tape with 0.02 cm smallest division can report values up to **2 decimal places**, so **80.65 cm** is valid.

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## ◻ Short Answer Questions

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### Q1.1 What are base units and derived units? Give examples.

**Answer:**

- **Base units** are the fundamental units for physical quantities (e.g., metre, kilogram, second).
- **Derived units** are obtained by combining base units (e.g., Newton = $kg \cdot m/s^2$, Joule = $kg \cdot m^2/s^2$)

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### Q1.2 How many significant figures should be retained?

- (i) **Multiplication/Division:** Keep the **least number of significant figures** among all values.
- (ii) **Addition/Subtraction:** Keep the result with the **least decimal places**.

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### Q1.3 How is the Vernier scale related to the main scale? What is L.C.?

**Answer:**

- Vernier scale is a small sliding scale used for precise measurements.
- **L.C. (Least Count)** is the smallest value that can be measured using the Vernier.

LC=Value of one main scale division − Value of one vernier scale division

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### Q1.4 Write in scientific notation:

(a) 143.7 → $1.437\times10^2$
(b) $2126.4 \times 10^7$ → $2.1264\times10^{10}$

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## Q1.5 Use correct prefixes:

(a) $580 \times 10^3$ g = **580 kg**
(b) $0.454 \times 10^4$ s = **$4.54 \times 10^3$ s = 4.54 ks**

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## Q1.6 What are the dimensions of Kinetic Energy ($\frac{1}{2}mv^2$)?

**Answer:**

[K.E.]=1 / 2 [M][L2][T^−2]=[ML2T^−2]

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## Q1.7 How many significant figures?

(i) 37 km → **2**
(ii) 0.032953 m → **5**
(iii) 7.50034 cm → **6**
(iv) 200.0 m → **4**

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## Q1.8 Dimensions of:

(i) Planck's constant hhh → $[M\ L^2\ T^{-1}]$
(ii) Angular velocity → $[T^{-1}]$

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### Constructed Response Questions

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## Q1.1 Why do we use both kilogram and mole for amount of substance?

**Answer:**

- **Kilogram** is used to measure **mass**.
- **Mole** is used to count **entities (atoms/molecules)**.
  Both describe amount but in different contexts.

## Q1.2 Three students measured a rod using scale (LC = 1 mm):

- (i) 0.423501 m ✕
- (ii) 0.42 m ✓
- (iii) 0.424 m ✓

**Conclusion:**
Only (ii) and (iii) are correct measurements according to the scale's precision.
(i) is invalid because it records more digits than the instrument can measure.

**Explanation:** First value is **over-precise** (more than instrument's capacity).

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## Q1.3 Why is kilogram (not gram) the base unit of mass?

**Answer:**
The **kilogram (kg)** is the base unit of mass in the **International System of Units (SI)** instead of the gram because:

1. ✅ **Historical Reason:**
   The SI system was established based on the **metric system**, in which the **kilogram** was originally defined using a physical prototype (the International Prototype Kilogram or IPK) in 1889.
2. ✅ **Practical Usage:**
   The **kilogram** is more suitable for measuring **everyday quantities** of mass (like human weight, commercial goods, scientific experiments).
   Using gram as the base unit would result in **very large numbers** for most real-world masses.
3. ✅ **Scientific Standardization:**
   In 2019, the kilogram was redefined based on **fundamental constants** (Planck's constant), not a physical object — reinforcing it as the **most stable and precise** unit for mass.

📝 **Conclusion:**
Although **gram** is a smaller and widely used unit, the **kilogram** is adopted as the **base unit** due to **historical, practical, and scientific** reasons.

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## Q1.4 If P = Q × R, and both Q & R have dimensions of velocity ($[LT^{-1}]$),

**Answer:**

## ◆ Step 1: Find dimensions of P

Given:

$[Q]=[LT^{-1}], \quad [R]=[LT^{-1}]$
$[P]=[Q]\cdot[R]=[LT^{-1}]\cdot[LT^{-1}]=[L^2T^{-2}]$

## ◆ Step 2: Find SI units of P

From dimensions:

$[L2T-2]$=Unit of Energy or Work

✅ **SI Unit of P = Joule (J)**
Where:

1 Joule=1 kg\cdotpm2/s^2

## ◆ Step 3: If Q and R had different dimensions

Yes, even if Q and R had different dimensions, we can **still determine the dimensions of P** by multiplying their dimensions algebraically.

☞ Example:
If

$[Q]=[M], \quad [R]=[LT^{-2}] \Rightarrow [P]=[MLT^{-2}$

Which are the **dimensions of force** (Unit: Newton)

## 1.5

**Q: What is the least count of a clock if it has...**

## (a) Hour, minute, and seconds hand?

☞ **Least Count = 1 second**
Because the **seconds hand** moves every 1 second — that's the **smallest measurable time**.

## (b) Hour and minute hand only?

☞ **Least Count = 1 minute**
Since there is **no seconds hand**, the smallest observable time is when the **minute hand** moves, i.e., **1 minute**.

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## 1.6

**Q: How can diameter of a round pencil be measured using a meter rule with same accuracy as Vernier Calipers?**
**Answer:**
Place the pencil between two blocks (like fingers) and mark the edges. Measure distance between marks using a meter rule **3–4 times** and take **average**. Accuracy increases by repetition.

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## 1.7

**Q: How would readings differ if screw gauge is used instead of Vernier Calipers to measure thickness of glass plate?**
**Answer:**
Screw gauge has higher accuracy (LC = 0.01 mm) than Vernier Calipers (LC = 0.1 mm). So, readings would be **more precise** with screw gauge.

- **Reading with error:**
  If measured value is 3.34 cm and error is ±0.02 cm,
  → Corrected value = **3.34 ± 0.02 cm**

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## 1.8

**Q: Screw gauge has 50 divisions. If thimble is rotated 10 times, and spindle moves 5 mm. What is pitch and LC?**
**Answer:**

- **Pitch** = 5 mm / 10 = **0.5 mm**
- **LC** = 0.5 mm / 50 = **0.01 mm**

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## 1.9

**Q: Screw gauge shows zero error (positive), and 2nd circular division matches datum line.**
**Answer:**

- **Zero error = +0.02 mm**
- Suppose observed reading = 4.57 mm
  → **Correct reading = 4.57 mm – 0.02 mm = 4.55 mm**

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## 1.10

**Q: What is meant by a dimensionless quantity? Give one example.**
**Answer:**
A physical quantity having **no units or dimensions** is called **dimensionless**.
☞ Example: Angle (radian), refractive index

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## 1.11

**Q: A sheet of paper folded 3 times is measured by screw gauge. Total thickness = 0.36 mm**
**Answer:**

- No. of sheets = $2^3$ = **8 layers**
  → **Thickness of one sheet = 0.36 mm / 8 = 0.045 mm**

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## 1.12

**Round off to 3 significant figures & convert to scientific notation:**

- (a) 0.02055 → $\mathbf{2.06 \times 10^{-2}}$
- (b) 4656.5 → $\mathbf{4.66 \times 10^{3}}$

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## 📘 Comprehensive Questions

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## Q1.1

**What is meant by uncertainty in a measurement? How is uncertainty in digital instruments indicated?**

**Answer:**
**Uncertainty in Measurement:**

Uncertainty in a measurement refers to the doubt or margin of error associated with the result. It represents the range of values within which the true value is likely to lie.

**Types of Uncertainty:**

**1. Random Uncertainty**: Due to unpredictable fluctuations in measurements.

**2**. **Systematic Uncertainty:** Due to instrumental or methodological errors.

**Uncertainty in Digital Instruments:**

Digital instruments typically display a finite number of digits. The uncertainty is often indicated by:

**1. Last Digit:** The last digit displayed is usually considered uncertain.

**2. Resolution:** The smallest change in measurement that can be detected.

For example, a digital multimeter displaying 4.52 V might have an uncertainty of ±0.01 V.

**Reporting Uncertainty:**

Measurements are often reported with uncertainty, e.g., 4.52 V ± 0.01 V.

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## Q1.2

**Differentiate between precision and accuracy:**

| Feature | Precision | Accuracy |
|---|---|---|
| Definition | Reproducibility of measurements | Closeness to true value |
| Example | Same wrong value repeatedly | One correct value, even once |

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## Q1.3

### (a) What is meant by significant figures? Write two reasons for using them in measurements. How to find the uncertainty in a timing experiment such as the time period of a simple pendulum?

## ◆ Significant Figures?

**Significant figures** are the digits in a measurement that are **reliably known** plus the **first doubtful digit**.

☞ Example:

- 5.63 → 3 significant figures
- 0.0204 → 3 significant figures (leading zeros not counted)

## ◆ Two Reasons to Use Significant Figures:

1. ✅ They reflect the **precision** of a measuring instrument.
2. ✅ Help in reducing and expressing **uncertainty** clearly in scientific results.

## ◆ Uncertainty in Timing Experiment (e.g., Time Period of Pendulum):

To reduce uncertainty in measuring the **time period**, we:

- Measure the time of **multiple oscillations** (e.g., 20 swings)
- Then divide by the number of oscillations

T=Total Time / Number of Oscillations

- This averages out reaction errors and gives a **more precise value**

✅ **Uncertainty formula:**

ΔT=Least Count/Number of Oscillations

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📘 Comprehensive Question (Part B)

## Q1.3 b): The mass of a solid cylinder is 12.85 g, length is 3.35 cm, and diameter is 1.25 cm. Find the density of the material, expressing the uncertainty in the density.

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## ✅ Step 1: Convert Units to SI

- Mass m=12.85 g=0.01285 kg
- Length h=3.35 cm=0.0335 m

- Diameter $d=1.25$ cm$\Rightarrow r=0.625$ cm$=0.00625$ m

### ✓ Step 2: Find Volume of Cylinder

$V=\pi r^2 h=3.14\times(0.00625)^2\times0.0335\approx4.11\times10^{-6}$ m3

### ✓ Step 3: Find Density

$\rho=m/V=0.01285/4.11\times10^{-6}\approx3127$ kg/m3

### ✓ Step 4: Expressing Uncertainty (Approximate):

Suppose instrument uncertainties:

- $\Delta m=\pm0.01$ g$=1\times10^{-5}$ kg
- $\Delta h=\pm0.01$ cm$=1\times10^{-4}$ m
- $\Delta r=\pm0.01$ cm$=1\times10^{-4}$ m

Use relative uncertainties:

$\Delta\rho / \rho\approx\Delta m / m+2(\Delta r / r)+\Delta h / h$

$\Delta\rho / 3127\approx1\times10^{-5} / 0.01285 + 2\times1\times10^{-4} / 0.00625 + 1\times10^{-4} / 0.0335$

$\Delta\rho / 3127\approx0.00078+0.032+0.00299\approx0.036\Rightarrow\Delta\rho\approx0.036\times3127\approx113$ kg/m3

### 📝 Final Answer:

$\rho=(3127\pm113)$ kg/m3

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## 1.15

**Q: Explain with examples the writing of physical quantities into their dimensions. Write its two benefits.**
**Answer:**
**Dimensional formula** represents a physical quantity using base quantities:
☞ Example:

- Force = Mass × Acceleration

$[F]=[M][L][T^{-2}]$

**✓ Benefits:**

1. Check the **correctness** of physical equations (homogeneity).
2. Helps in **unit conversion** and deriving relations.

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## 1.16

**Q: Check the homogeneity of the relation:**

v=√T/m

Where:

- v = speed of wave
- T = tension (N = kg·m/s²)
- m = mass per unit length (kg/m)

**Step 1: Dimensions of RHS**

T / m=[MLT^−2] / [ML^−1]=[L^2T^−2]
√T/m=[LT^−1]

**Step 2: Dimensions of LHS (v):**

[v]=[LT−1]

✅ **Both sides are equal ⇒ Equation is dimensionally homogeneous.**