**Definition of Measurement in Physics**:

Measurement is the process of assigning a numerical value to a physical quantity, such as length, mass, or time, to describe its magnitude or amount.

**Types of Measurement in Physics:**

1. Fundamental Measurements: These are measurements of basic physical quantities like length, mass, time, temperature, and electric current.

2. Derived Measurements: These are measurements of quantities derived from fundamental measurements, such as speed, acceleration, force, and energy.

**Measuring Tools:**

1. Rulers: Used for measuring lengths and distances.

2. Vernier Calipers: Used for precise measurements of lengths and distances.

3. Micrometers: Used for measuring very small lengths and distances.

4. Stopwatches: Used for measuring time intervals.

5. Thermometers: Used for measuring temperature.

6. Ammeters: Used for measuring electric current.

7. Voltmeters: Used for measuring electric potential difference (voltage).

Fundamental Physical Quantities, Units, and Dimensions:

1. Length: Meter (m), dimension [L]

2. Mass: Kilogram (kg), dimension [M]

3. Time: Second (s), dimension [T]

4. Temperature: Kelvin (K), dimension [Θ]

5. Electric Current: Ampere (A), dimension [I]

Measurement Instruments:

1. Rulers: Used for measuring lengths and distances with an accuracy of ±0.1 mm.

2. Vernier Calipers: Used for measuring lengths and distances with an accuracy of ±0.01 mm.

3. Micrometers: Used for measuring lengths and distances with an accuracy of ±0.001 mm.

4. Stopwatches: Used for measuring time intervals with an accuracy of ±0.01 s.

5. Thermometers: Used for measuring temperature with an accuracy of ±0.1°C.

6. Ammeters: Used for measuring electric current with an accuracy of ±0.1 A.

7. Voltmeters: Used for measuring electric potential difference (voltage) with an accuracy of ±0.1 V.

**Ways measurement is done in physics**

1. Conversion: Convert between different units of measurement, such as length (m to cm or inches to feet).

2. Scaling: Scale up or down between different sizes of units, like enlarging or reducing a diagram.

3. Calculation: Perform arithmetic operations (+, -, x, /) with measurements, like finding the total length of several objects.

4. Comparison: Compare measurements to determine which is larger or smaller.

5. Estimation: Estimate a measurement based on a known reference point or approximation.

6. Rounding: Round measurements to the nearest whole number or decimal place.

7. Unit cancellation: Cancel out units when performing calculations, like converting meters to centimeters (m → cm).

8. Dimensional analysis: Use units to guide calculations and ensure correct answers.

9. Proportionality: Use ratios and proportions to solve measurement problems, like finding the scale factor of a map.

10. Measurement formulas: Apply formulas specific to measurement, such as the formula for the area of a rectangle (A = L × W).

**Lets start with Conversion**

**Conversion Factors**

These are conversion factors you should know because they are commonly use in physics contexts.

1. Length:

- 1 meter (m) = 100 centimeters (cm)

- 1 meter (m) = 1000 millimeters (mm)

- 1 kilometer (km) = 1000 meters (m)

- 1 inch (in) = 2.54 centimeters (cm)

- 1 foot (ft) = 12 inches (in)

- 1 yard (yd) = 3 feet (ft)

2. Time:

- 1 minute (min) = 60 seconds (s)

- 1 hour (h) = 60 minutes (min)

- 1 day (d) = 24 hours (h)

3. Speed:

- 1 meter per second (m/s) = 3.6 kilometers per hour (km/h)

- 1 foot per second (ft/s) = 0.3048 meters per second (m/s)

4. Force:

- 1 Newton (N) = 0.2248 pounds (lb)

- 1 dyne (dyn) = 10^(-5) Newtons (N)

5. Energy:

- 1 Joule (J) = 0.239 calories (cal)

- 1 electronvolt (eV) = 1.602 x 10^(-19) Joules (J)

6. Pressure:

- 1 Pascal (Pa) = 1 Newton per square meter (N/m^2)

- 1 atmosphere (atm) = 101,325 Pascals (Pa)

7. Temperature:

- Celsius (°C) to Kelvin (K): T(K) = T(°C) + 273.15

- Fahrenheit (°F) to Celsius (°C): T(°C) = (T(°F) - 32) × 5/9

**Examples and concept explained:**

**Example 1:** Convert 12 inches to feet

- Step 1: Know the conversion factor: 1 foot = 12 inches

- Step 2: Divide the number of inches by the conversion factor: 12 inches ÷ 12 = 1 foot

- Answer: 12 inches = 1 foot

**Example 2**: Convert 3 miles to yards

- Step 1: Know the conversion factor: 1 mile = 1760 yards

- Step 2: Multiply the number of miles by the conversion factor: 3 miles × 1760 yards/mile = 5280 yards

- Answer: 3 miles = 5280 yards

Example 3: Convert 4 cups to pints

- Step 1: Know the conversion factor: 1 pint = 2 cups

- Step 2: Divide the number of cups by the conversion factor: 4 cups ÷ 2 = 2 pints

- Answer: 4 cups = 2 pints

Example 4: Convert 2 liters to milliliters

- Step 1: Know the conversion factor: 1 liter = 1000 milliliters

- Step 2: Multiply the number of liters by the conversion factor: 2 liters × 1000 mL/L = 2000 mL

- Answer: 2 liters = 2000 milliliters

Example 5: Convert 5 kilometers to meters

- Step 1: Know the conversion factor: 1 kilometer = 1000 meters

- Step 2: Multiply the number of kilometers by the conversion factor: 5 kilometers × 1000 meters/km = 5000 meters

- Answer: 5 kilometers = 5000 meters

**NB:** you may be wondering when are you expected to multiply or divide on the conversion

“In conversion factors, we are essentially multiplying by a special kind of fraction called a "conversion fraction".

When we multiply by a conversion fraction, we are essentially scaling the original value by a certain amount.

The reason we sometimes divide and sometimes multiply is because of the way the conversion fractions are set up.

- When the conversion fraction has a value greater than 1 (like 1000 mm/m), we multiply to scale up the value.

- When the conversion fraction has a value less than 1 (like 0.01 m/cm), we divide to scale down the value.

Think of it like this:

- Multiplying by a large value (greater than 1) stretches the value, like zooming in on a map.

- Dividing by a small value (less than 1) shrinks the value, like zooming out on a map.

By multiplying or dividing by the appropriate conversion fraction, we can change the units of our value without changing its physical meaning. This allows us to convert between different units of measurement!”

With this knowledge, now solve the following

**Basic Questions**

Convert the following:

1. 5 cm to mm ( Answers to be hidden = 50 mm)

2. 2 m to cm = 200 cm

3. 3 km to m = 3000 m

4. 4 in to cm = 10.16 cm

5. 1 ft to in = 12 in

6. 2 yd to ft = 6 ft

7. 5 ml to L = 0.005 L

8. 3 hr to min = 180 min

9. 2 s to ms = 2000 ms

10. 1 lb to kg = 0.453592 kgIntermediate (20)

**Intermediate Questions**

1. 12 mi to km = 19.312 km

2. 50°F to °C = 10°C

3. 1000 ms to s = 1 s

4. 25 ft/s to m/s = 7.62 m/s

5. 3000 Pa to atm = 0.02995 atm

6. 500 J to cal = 119.26 cal

7. 25 N to lb = 5.61 lb

8. 1000 km/h to m/s = 277.78 m/s

9. 50 kW to hp = 67.11 hp

10. 200 mm to in = 7.87 in

11. 12 in to ft = 1 ft

12. 1000 cm to m = 10 m

13. 25 m/s to km/h = 90 km/h

14. 500 V to kV = 0.5 kV

15. 200 A to mA = 200,000 mA

16. 1000 W to kW = 1 kW

17. 50 kPa to psi = 7.25 psi

18. 2000 lb to kg = 907.185 kg

19. 12 hr to s = 43,200 s

20. 500 ms to min = 0.08333 min

**Hard Questions**

1. 0.05 N/m to dyn/cm = 500 dyn/cm

2. 25,000 atm to Pa = 2,500,000 Pa

3. 100,000 J to eV = 6.241509e17 eV

4. 500,000 km to AU = 0.003335 AU

5. 25,000 lb to N = 111,035.23 N

6. 100,000 cal to J = 418,400 J

7. 50,000 kW to MW = 50 MW

8. 25,000 in to km = 0.635 km

9. 100,000 s to hr = 27.7778 hr

10. 500,000 psi to Pa = 3,447,387 Pa

11. 25,000 ft/s to km/h = 8,941.18 km/h

12. 100,000 V to MV = 0.1 MV

13. 50,000 A to kA = 50 kA

14. 25,000 W to MW = 0.025 MW

15. 100,000 kPa to atm = 993.665 atm

16. 500,000 lb to Mg = 226.796 Mg

17. 25,000 ms to hr = 0.06944 hr

18. 100,000 km/h to mi/h = 62,137.12 mi/h

19. 50,000 hp to kW = 37,284.96 kW

20. 25,000 in to m = 635.0 m