

## **CHAPTER:01**

### **Physical Quantities and Measurements**

#### **SHORT RESPONSE QUESTIONS**

##### **1. How physics plays an important role in our life?**

Physics plays an important role in our life because it helps us to understand matter, energy and their interaction. All modern technologies such as computers, mobile phones, airplanes, medical instruments and space technology are based on the principles of physics.

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##### **2. Estimate your age in minutes and seconds.**

If age is taken in years, it can be converted into minutes and seconds using:

$$1 \text{ year} = 365 \text{ days}$$

$$1 \text{ day} = 24 \times 60 \times 60 \text{ seconds}$$

$$\text{Age in Minutes: } 15 \times 365 \times 24 \times 60 = 7884000 \text{ mins}$$

$$\text{Thus, age in seconds} = 15 \times 365 \times 24 \times 60 \times 60 = 473040000$$

Age in minutes can be found by dividing seconds by 60.

*(Estimation 15 Years)*

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##### **3. What base quantities are involved in these derived physical quantities: force, pressure, power and charge?**

- **Force** depends on mass, length and time.
  - **Pressure** depends on mass, length and time.
  - **Power** depends on mass, length and time.
  - **Charge** depends on electric current and time.
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##### **4. Show that prefix micro is thousand times smaller than prefix milli.**

$$\text{Milli} = 10^{-3}$$

$$\text{Micro} = 10^{-6}$$

$$\frac{10^{-3}}{10^{-6}} = 10^{-3+6} = 10^3 = 1000$$

Hence, micro is thousand times smaller than milli.

**5. Justify that displacement is a vector quantity while energy is a scalar quantity.**

Displacement is a vector quantity because it requires both magnitude and direction for its complete description.

Energy is a scalar quantity because it is completely described by its magnitude only and does not require direction.

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**6. Screw gauge can give more precise length than vernier calipers. Briefly explain why.**

Screw gauge gives more precise measurement than vernier calipers because its least count is smaller (usually 0.01 mm), therefore it can measure very small lengths more accurately.

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**7. Differentiate between mechanical stopwatch and digital stopwatch.**

<b>Mechanical Stopwatch</b>	<b>Digital Stopwatch</b>
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Has circular dials	Has digital display
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Least count is 1 s	Least count is 0.1 s
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Less precise	More precise
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**8. How measuring cylinder is used to measure volume of an irregular shaped stone?**

The initial volume of water in the measuring cylinder is noted. The stone is completely immersed in water and the new volume is recorded. The volume of the stone is obtained by subtracting the initial reading from the final reading.

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**9. What precaution should be kept in mind while taking measurement using measuring cylinder?**

The eye should be kept at the level of the meniscus while taking the reading to avoid error in measurement.

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**10. Why do we need to consider significant digits in measurements?**

Significant digits are considered because every measurement contains uncertainty. Significant figures indicate the precision of a measurement and help in reporting results correctly.

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### 11. How random error can be reduced?

Random error can be reduced by taking repeated measurements and calculating their mean value.

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### 12. Differentiate between precision and accuracy.

Precision	Accuracy
Degree of agreement between repeated measurements	Closeness of a measurement to the true value
Shows consistency	Shows correctness

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### Long Response Questions:

**Q1. Define Physics. Describe its revolutionary role in technology.**

**(8 Marks)**

**Physics** is the branch of science which deals with the study of matter, energy and their interaction. It explains natural phenomena by using laws and principles based on experimental observations.

Physics has played a revolutionary role in the development of modern technology. Almost all scientific inventions are based on the principles of physics. The invention of electricity has led to the development of electric appliances, computers and communication systems. Medical technologies such as X-rays, ultrasound, CT scan and laser surgery are applications of physics. Transportation systems including automobiles, aeroplanes and rockets work on the laws of mechanics and aerodynamics. Space technology and satellite communication are also the result of advancements in physics. Thus, physics forms the foundation of modern scientific and technological progress.

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**Q2. List with brief description of different branches of physics.****(8 Marks)**

Physics is divided into different branches to study various physical phenomena in an organized way.

**Mechanics** is the branch of physics that deals with the study of motion, force and energy.

**Thermodynamics** deals with heat, temperature and the laws governing the conversion of heat into other forms of energy.

**Waves and Oscillations** is the branch that studies periodic motion, sound waves and wave properties.

**Optics** deals with the study of light and its phenomena such as reflection and refraction.

**Electromagnetism** is concerned with electric charges, electric current and magnetic fields.

**Atomic Physics** deals with the structure and properties of atoms.

**Nuclear Physics** studies the nucleus of atoms and nuclear reactions.

**Solid State Physics** deals with the physical properties of solids.

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**Q3. What are physical quantities? Distinguish between base physical quantities and derived physical quantities. Give at least three examples to show that derived physical quantities are derived from base physical quantities.****(8 Marks)**

Physical quantities are those quantities which can be measured and expressed by a numerical value along with a unit.

**Base physical quantities** are fundamental quantities which are independent and cannot be derived from other quantities. Examples of base physical quantities are length, mass, time, electric current, temperature, amount of substance and luminous intensity.

**Derived physical quantities** are those quantities which are obtained by combining base physical quantities through mathematical relations.

For example, **velocity** is derived from length and time, **force** is derived from mass, length and time, and **pressure** is derived from force and area. This shows that derived physical quantities depend upon base physical quantities.

**Q4. What do you mean by unit of a physical quantity? Define base units and derived units.**

**(4–8 Marks)**

A **unit of a physical quantity** is a standard quantity used to measure and compare physical quantities of the same kind. Without a unit, the measurement of a physical quantity has no meaning.

**Base units** are the units of base physical quantities. These units are independent and cannot be derived from other units. Examples of base units are metre for length, kilogram for mass and second for time.

**Derived units** are the units of derived physical quantities. These units are obtained by combining base units according to the relation of the derived quantity. For example, the unit of force is newton, which is derived from kilogram, metre and second. Similarly, the unit of pressure is pascal and the unit of velocity is metre per second.

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**Q5. What are prefixes? What is their use in measurements?****(4–8 Marks)**

Prefixes are special symbols or words used with units to express very large or very small quantities in a convenient form. They represent multiples or submultiples of units based on powers of ten.

Prefixes are used in measurements to avoid writing very large or very small numbers. They make measurements easy to read, write and understand. For example, kilometre is used instead of writing 1000 metres and millimetre is used instead of writing 0.001 metre. Common prefixes include kilo, milli, micro and mega. Thus, prefixes help in simplifying measurements and calculations.

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**Q6. What is scientific notation or standard form of noting down a measurement? Give at least five examples.****(4–8 Marks)**

Scientific notation, also called standard form, is a method of expressing very large or very small numbers in the form of a number between 1 and 10 multiplied by a power of 10.

This method is used to make calculations easier and to express measurements in a compact form. It also helps in avoiding errors while writing very large or very small values.

Examples of scientific notation are:

- $3000 \text{ m} = 3 \times 10^3 \text{ m}$

- $0.005 \text{ s} = 5 \times 10^{-3} \text{ s}$
  - $45000 \text{ N} = 4.5 \times 10^4 \text{ N}$
  - $0.000002 \text{ m} = 2 \times 10^{-6} \text{ m}$
  - $6000000 \text{ J} = 6 \times 10^6 \text{ J}$
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**Q7. Describe construction and working of vernier calipers in detail.**

**(8 Marks)**

Vernier calipers is a measuring instrument used to measure small lengths, internal and external diameters and depths accurately.

**Construction:**

It consists of a main scale and a vernier scale. The main scale is a fixed scale marked in centimetres and millimetres. The vernier scale slides along the main scale and is used to measure fractions of a main scale division. The instrument has two jaws: the lower jaws are used to measure external diameter, while the upper jaws are used to measure internal diameter. A depth rod is also attached to measure depth.

**Working:**

When an object is placed between the jaws, the vernier scale moves along the main scale. The reading is taken by noting the main scale reading just before the zero of the vernier scale and adding it to the vernier scale reading that coincides with a main scale division. The total reading gives the length of the object.

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**Q8. What is screw gauge? What is its pitch and least count? How is it used to measure thickness of a thin copper wire?**

**(8 Marks)**

A **screw gauge** is a precise instrument used to measure very small lengths such as the diameter of a wire or thickness of a sheet.

**Pitch of screw gauge** is the distance moved by the screw in one complete rotation.

**Least count** is the smallest length that can be measured by a screw gauge and is calculated by dividing the pitch by the number of divisions on the circular scale.

To measure the thickness of a thin copper wire, the wire is placed between the anvil and the spindle. The screw is rotated until the wire is gently held between them. The main scale reading and circular scale reading are noted. The thickness of the wire is obtained by adding the main scale reading to the product of circular scale reading and least count.

**Q9. Define error. Differentiate between random and systematic error. How can these errors be reduced?**

**(8 Marks)**

An **error** is the difference between the measured value of a physical quantity and its true or accepted value. Errors occur due to limitations of measuring instruments and human observation.

**Random errors** are irregular errors that occur due to unpredictable variations in measurement conditions. These errors cause readings to fluctuate above or below the true value. Random errors may arise due to changes in observer's reaction time or environmental conditions. These errors can be reduced by taking repeated measurements and calculating their mean value.

**Systematic errors** are consistent errors that occur in the same direction every time a measurement is taken. These errors are caused by faulty instruments, zero error or incorrect calibration. Systematic errors can be reduced by proper calibration of instruments, correcting zero error and using accurate measuring devices.

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**Q10. Differentiate between scalars and vectors. Justify that distance, speed, mass and energy are scalars while displacement, velocity, acceleration and force are vectors.**

**(8 Marks)**

**Scalar quantities** are physical quantities that are completely described by their magnitude only and do not require direction.

**Vector quantities** are physical quantities that require both magnitude and direction for their complete description.

Distance, speed, mass and energy are scalar quantities because they only tell how much of a quantity is present and do not involve direction. For example, distance tells how much path is covered, and speed tells how fast an object is moving, without indicating direction.

Displacement, velocity, acceleration and force are vector quantities because they involve both magnitude and direction. Displacement tells the shortest distance in a specific direction, velocity describes speed in a given direction, acceleration tells the rate of change of velocity in a direction, and force acts in a particular direction. Hence, these quantities are vectors.

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**Q11. Justify and illustrate the use of a measuring cylinder to measure the volume of a liquid.**

**(6–8 Marks)**

A measuring cylinder is used to measure the volume of a liquid accurately. It is a transparent cylindrical container marked with volume graduations.

To measure the volume of a liquid, the measuring cylinder is placed on a horizontal surface and the liquid is poured into it. The level of the liquid is observed carefully. The correct reading is taken at the lower level of the meniscus by keeping the eye at the same level as the meniscus. This method helps in avoiding parallax error.

The measuring cylinder is suitable for measuring the volume of liquids because it provides direct reading and is easy to use in laboratories.

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**Q12. Differentiate between precision and accuracy.**

**(6–8 Marks)**

**Precision** refers to the degree of agreement among repeated measurements of the same physical quantity. It indicates how close the measured values are to each other. Precision depends on the sensitivity of the measuring instrument.

**Accuracy** refers to how close a measured value is to the true or accepted value of a physical quantity. It indicates the correctness of a measurement.

A measurement can be precise but not accurate if it is consistently far from the true value. On the other hand, a measurement is accurate only when it is close to the true value. Therefore, precision shows consistency, while accuracy shows correctness.

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