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UNITS, DIMENSIONS AND VECTOR

Physics: Scope and Excitement

- The scope of Physics is very wide and it covers a vast variety of natural phenomena.
- It includes the study of mechanics, heat and thermodynamics, optics, waves and oscillations, electricity and magnetism, atomic and nuclear physics, electronics and communication etc.

Unit of Measurement

- The laws of physics are expressed in terms of physical quantities such as distance, speed, time, force, volume, electric current, etc. For measurement, each physical quantity is assigned a unit.

The SI Units

- The name SI is abbreviation for Système International d'Unitésfor the International System of units

- Standards of Mass, Length and Time

Quantity	unit	Symbol
Length	Meter	m
Mass	Kilogram	Kg
Time	Second	s
Electric current	ampere	A
Temperature	Kelvin	K
Luminous intensity	Candela	Cd
Amount of substance	mole	Mol

Mass:

The SI unit of mass is kilogram. It is the mass of a particular cylinder made of platinum-iridium alloy.

Length:

The SI unit of length is metre. One metre is defined as the distance travelled by light in vacuum in a time interval of 1/299792458 second.

Time:

One second is defined as the time required for a Cesium - 133 (133Cs) atom to undergo 9192631770 vibrations between two hyperfine levels of its ground state.

Significant Figures

Digits in measurement that are known with certainly plus the first uncertain digit are called significant figures.

- All non-zero digits are significant. For example, 315.58 has five significant figures
- All zeros between two non-zero digits are significant. For example, 5300405.003 has ten significant figures.
- All zeros which are to the right of a decimal point and also to the right of a non-zero digit are significant. For example, 50.00 has four significant figures
- All zeros to the right of a decimal point and to the left of a non-zero digit in a decimal fraction are not significant. For example, .00043 has only two significant figures but 2.00023 has 6 significant figures
- All zero to the right of last of non-zero digit are significant, if they come from some measurement.
- The number of significant figures does not vary with the change in unit.
- In a whole number all zeros to the right of the last non zero number are not significant, for example 5000 has only one significant figure.

Derived Units

It is a unit that results from a mathematical combination of SI base unit.

Applications of Dimensions (or dimensional equations)

- Derivation of a relationship between different physical quantities (or formula).
- Checking up of accuracy of a formula (or relationship between different physical quantities).
- Conversion of one system of units into another.
- Derivation of units of a physical quantity

Vectors and Scalars

A scalar quantity has only magnitude; no direction.

A vector quantity has both magnitude and direction.

Representation of Vectors

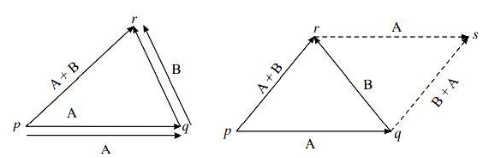
A vector is represented by a line with an arrow indicating its direction.

$$\vec{A}$$

Addition of Vector

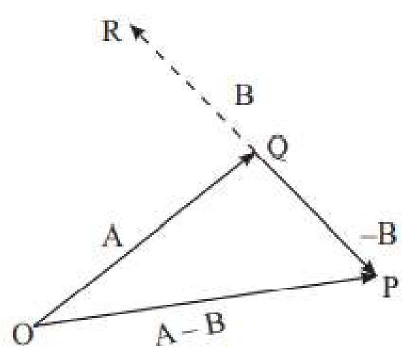
If two vectors are represented in magnitude and direction by the two sides of a triangle taken in order, the resultant is represented by the third side of the triangle taken in the opposite order. This is called triangle law of vectors.

$$\vec{R} = \vec{A} + \vec{B}$$



Subtraction of Vector

$$\vec{R} = \vec{A} + \overrightarrow{(-B)}$$



Multiplication of Vectors

Scalar Product of Vector

The scalar product of two vectors A and B is written as A.B and is equal to AB cosθ, where θ is the angle between the vectors.

The scalar product of two vectors is a scalar quantity

Vector Product of Vectors

The vector product of two vectors A and B is written as A×B and is equal to AB sinθ, where θ is the angle between the vectors.

The vector product of two vectors is a vector

Unit Vector

Unit vector has unitary magnitude and has a specified direction. It has no units and no dimensions.

$$\hat{A} = \frac{\vec{A}}{|A|}$$

CHECK YOURSELF

1. **Significant number in 42003042.02 is**
   A. 15
   B. 10
   C. 7
   D. 5
2. Dimension of Kinetic energy
   A. $ML^{-1}T^{-2}$
   B. $M^2L^2T^{-2}$
   C. MLT^{-2}
   D. ML^2T^{-2}
3. SI unit of strain is
   A. Nm^{-1}
   B. Nm^{-2}
   C. J
   D. No units
4. Two forces 20 N and 5 N are acting at an angle 20^0 below magnitude of resultant force.
   A. 18.03N
   B. 18.0 N
   C. 17.0 N
   D. 16.5N
5. Length of (A+B) if A $=3\hat{\imath} + 2\hat{\jmath}$ and B= $\hat{\imath} - 2\hat{\jmath} + 3\hat{k}$
   A. 4
   B. 3
   C. 5
   D. 7

STRETCH YOURSELF

- All constants are dimensionless? Explain, what types of quantity is Avogadro's number.
- Is the commutative and associative law applicable to vector subtraction? Explain
- The velocity of sound in air is 332m/s if the unit of length is km and unit of time is hour. What would be the value of velocity?

Answer to check Yourself

1B) 2D) 3D) 4A) 5C)