

Physics



Q.1:Define:

- | | |
|---------------------------------|-------------------------------------|
| 1- Measurement. | 2- Fundamental physical quantities. |
| 3- Derived physical quantities. | 4- Standard meter. |
| 5- Standard kilogram. | 6- Standard second. |
| 7- Dimensional formula. | 8- Absolute error. |
| 9- Relative error. | 10- Scalar quantities. |
| 11- Vector quantities. | 12- Distance. |
| 13- Displacement. | 14- Resultant force. |

Q.2:What is meant by?

- 1- The dot product of two vectors **A** and **B** = 75.2.
- 2- The vector product of two vectors **A** and **B** = $43.6 \vec{n}$.

Q.3:By using Dimensional formula prove that:

- | | |
|-------------------------------------|----------------------------------|
| 1- $F \times v = w/t$ | (where v is velocity, W is work) |
| 2- $F = m \cdot a$ | (a is acceleration) |
| 3- $F = \frac{M \times V^2}{r}$ | |
| 4 - $t = 2\pi \sqrt{\frac{L}{g}}$ | (g is acceleration of gravity) |
| 5 - $v^2 = 2 g \cdot x$ | |
| 6 - $x = v_0 t + \frac{1}{2} g t^2$ | (v_0 is initial velocity) |

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Q.4: compare between:

- 1 – Direct and indirect measurements.
- 2 – Dot and cross product of vectors.

Q.5: Give reasons:

1. Volume is a derivable quantity while length is a fundamental quantity.
2. The measuring process can't be 100% accurate.
3. We don't use glass in the standard meter instead of platinum & iridium.
4. The direct measurement is more accurate than the indirect one.
5. The relative error is a better indication for measurement accuracy than absolute error.
6. Speed is a scalar quantity while velocity is a vector one.

Q.6: Derive the Dimensional Formula of:

power = work / time

pressure = force / Area

Impulse = $f \times \Delta t$

Q.7: Complete :

1. Mass is measured inunit in British system, while it is measured inunit in S.I.
2. Length is measured inunit in Gaussian system, while it is measured inunit in British system.
3. Temperature is measured inunit in S.I, while the intensity of current is measured inunit in S.I.

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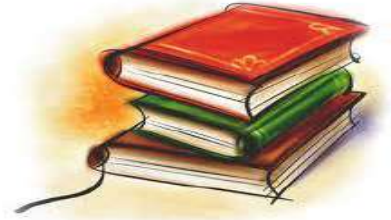


4. Solid angle is measured inunit ,While plane angle is measured inunit.
5. D.F of velocity is ,While its measuring unit is
6. D.F of force is and its measuring unit is
7. $\vec{A} \cdot \vec{B} = \dots\dots\dots$, while $\vec{A} \wedge \vec{B} = \dots\dots\dots$
8. If a force of 10 N makes an angle 60° with (x-axis) ,so
 $f_x = \dots\dots\dots$, While $f_y = \dots\dots\dots$
9. In a measuring process of length, if $L = (5 \pm 0.2)$,so the absolute error is and the relative error is

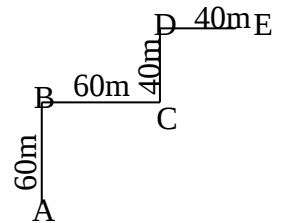
Q.8:Problems :

- (1) If $X = (5 \pm 0.1)$ cm and $y = (10 \pm 0.2)$ cm. calculate each of :
a. $X + Y$ b. $2X + Y$ c. XY d. XY^2
- (2) Find the relation error in estimating the volume of a cube of side length 5 cm if the relative error in measuring length is 0.01 . Also , find the absolute error in this case .
- (3) A ship sails north at velocity 12 km/h. due to tides, it is deviated to west at velocity 15 km/h. Find the magnitude and direction of the resultant velocity of the ship.

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(4) In the opposite diagram , a person has moved from point (A) to point (E) passing by the points (B) , (C) & (D) . find his displacement and the distance he moved .



(5) Two perpendicular forces F_x and F_y act on an object where

$$F_x = F_y = 80\text{N. Find :}$$

- The resultant of the two forces F_1 and F_2 .
- The angle between their resultant x-axis .
- Do object move or remain stationary?

(6) $\vec{A}$ and $\vec{B}$ are two vectors having an angle 120° between them where the magnitude of $(\vec{A}) = 3$ units and the magnitude of $(\vec{B}) = 4$ units. Find: their dot product and their cross product.

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Answers

Q.1:Define :

- 1 – Measurement:** The process of comparing an unknown quantity with another one of its kind (called the unit of measurement) to find out how many times the first includes the second .
- 2 – Fundamental physical Quantities:** physical quantities that cannot be defined in terms of other physical quantities .
- 3 – Derived physical Quantities :** physical quantities that can be defined in terms of the fundamental physical quantities .
- 4 – Standard Meter :**The distance between two engraved marks at the ends of a rod made of platinum and iridium alloy kept at $0^{\circ}C$.
- 5 – Standard kilogram :** The mass of a cylinder made of platinum and iridium alloy of specific dimensions kept at $0^{\circ}C$.
- 6 – Standard second :**
The second = $\frac{1}{86400}$ of the average solar day.
- 7 – Dimensional formula :** The formula that expresses the derived physical quantities in terms of the fundamental physical quantities (mass ,length & time) each has a certain exponent .
- 8 – Absolute error :** The difference between the actual value (x_0) and the measured value (x) $\Delta x = |x_0 - x|$.

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9 – Relative error: The ratio between the absolute error (Δx) to the real value (x_0) $\rightarrow r = \frac{\Delta x}{x_0}$.

10 – Scalar quantity: the physical quantity that can be fully defined by its magnitude only.

11 – Vector quantity : The physical quantity that can be fully defined by both magnitude and direction.

12 – Distance : The length of the path moved by an object from a position to another. (Scalar quantity)

13 – Displacement : The change in the position of object, or the length of the straight line segment in a given direction between the starting point and the end point. (vector quantity)

14 – Resultant force : A single force that results in the same effect on the object as that produced by the original acting forces. or, the net force that affects an object as a result of the action of a number of forces.

Q.2 : what's meant by ?

1 – The dot product of two vectors A and B =75.2.

It's mean that the product of the magnitudes of (A) and (B) and the cosine of the angle between them ($\cos \theta$) = 75.2 or $AB \cos \theta = 75.2$

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2 – The cross product of two vectors $\vec{A}$ and $\vec{B} = 43.6 \text{ n}$.

It's mean that the product of the magnitudes of ($\vec{A}$) and ($\vec{B}$) and the sine of the angle between them and the unit vector directed in a direction perpendicular to the plane of both vectors = 43.6 n ,or

$$A B \sin \theta = 43.6 \text{ n}$$

Q.3 : By using dimensional formula prove that :

1 - $f \times v = w/t$ ($w = f.d$)

$$\begin{aligned} \text{Dimensions of L. H. S.} &= \text{MLT}^{-2} \times \text{LT}^{-1} \\ &= \text{ML}^2\text{T}^{-3} \quad (1) \end{aligned}$$

$$\begin{aligned} \text{Dimension of R. H. S.} &= \text{MLT}^{-2} \cdot \text{L/T} \\ &= \text{ML}^2\text{T}^{-2}/\text{T} \\ &= \text{ML}^2\text{T}^{-3} \quad (2) \end{aligned}$$

So $F \times V = w/T$ is dimensionally correct .

2- $F = M \times a$

$$\text{Dimensions of L. H. S.} = \text{MLT}^{-2}$$

$$\text{Dimension of R. H. S.} = M \times \text{LT}^{-2} = \text{MLT}^{-2}$$

So $F = M \times a$ is dimensionally correct.

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3- $F = \frac{m \times v^2}{r}$

L. H. S. = MLT^{-2} (1)

$$\begin{aligned} \text{R. H. S.} &= \frac{M \times (LT^{-1})^2}{L} \\ &= \frac{ML^2T^{-2}}{L} = MLT^{-2} \quad (2) \end{aligned}$$

So the relation is dimensionally correct.

4 - $T = 2\pi \sqrt{\frac{L}{g}}$

(numbers & constants having no dimensions)

L. H. s. = T (1)

$$\begin{aligned} \text{R. H. S.} &= \sqrt{\frac{L}{LT^{-2}}} \\ &= \sqrt{\frac{1}{T^{-2}}} = \sqrt{T^2} = T \quad (2) \end{aligned}$$

So the relation is dimensionally correct .

5- $V^2 = 2gx$

$$\begin{aligned} \text{L. H. S.} &= (LT^{-1})^2 \\ &= L^2T^{-2} \quad (1) \end{aligned}$$

$$\begin{aligned} \text{R. H. S.} &= LT^{-2} \times L \\ &= L^2T^{-2} \quad (2) \end{aligned}$$

So the relation is dimensionally correct .

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6- $X = v_0T + \frac{1}{2}gt^2$

$$L.H.S. = L \quad (1)$$

$$R.H.S. = LT^{-1} \times T + LT^{-2} \times T^2$$

$$= 2L = L \quad (2)$$

So the relation is dimensionally correct .

Q.4 : Compare between :

1 – Direct & indirect measurements.

Points of comparison

Direct measurement

Indirect measurement

No. of processes

One measurement process.

More than one measurement process.

calculations

No mathematical relation is applied.

A mathematical relation is applied to find the quantity.

Measurement error

One measurement error.

More one measurement error.

Examples

Measuring volume using the graduated cylinder.

Measuring volume by length , width and height.

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2 – Dot and cross product of vectors.

Point of comparison

Dot product

Cross product

1. Result quantity.

Scalar quantity.

Vector quantity.

2. Mathematical relation.

$$\vec{A} \cdot \vec{B} = A B \cos \theta$$

$$\vec{A} \times \vec{B} = AB \sin \theta \vec{n}$$

Q. 5 : Give reason :

1. Volume is a derivable quantity , while length is a fundamental quantity.
 - Because volume can be defined in terms of length ($V = L \times w \times h$) ,while the length can't be defined in terms of any other physical quantity.
2. The measuring process can't be 100% accurate .
 - Because there are several reasons for measurement error

As: - choosing improper tools. – A defect in the measuring tool.

 – wrong procedure. - Environmental conditions.
3. We don't use glass in the standard meter instead of platinum and iridium alloy .
 - Because platinum & iridium alloy is rigid , chemically inactive and not affected by the surrounding temperature contrary to other materials like glass.
4. The direct measurement is more accurate than the indirect one.
 - Because in direct measurement there is only one measurement error, while in indirect one there are more than one error “Cumulative error”.

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5. The relative error is better indication for measurement accuracy than absolute error.

- Because it is found by the ratio between the absolute error (Δx) to the real value (X_0).

6. Speed is a scalar quantity ,while velocity is a vector one.

- Because speed can fully defined by its magnitude only, while velocity must be defined by both magnitude and direction.

Q. 6: Derive the dimensional formula of :

1- power =work/time (**work = F . d**)

$$\text{Work} = \text{MLT}^{-2} \cdot \text{L}$$

$$= \text{ML}^2\text{T}^{-2}$$

$$\text{Time} = \text{T}$$

$$\text{Power} = \frac{\text{ML}^2\text{T}^{-2}}{\text{T}} = \text{ML}^2\text{T}^{-3}$$

2- pressure= Force / Area

$$\text{Force} = \text{M L T}^{-2}$$

$$\text{Area} = \text{L}^2$$

$$\text{Pressure} = \frac{\text{MLT}^{-2}}{\text{L}^2} = \text{M L}^{-1}\text{T}^{-2}$$

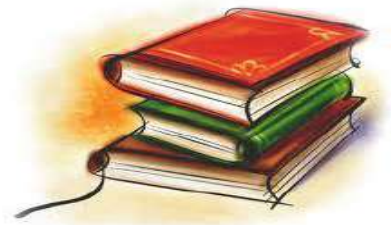
3- Impulse = F $\times$ Δt

$$\text{F} = \text{M L T}^{-2}$$

$$\Delta t = \text{T}$$

$$\begin{aligned}\text{Impulse} &= \text{M L T}^{-2} \times \text{T} \\ &= \text{M L T}^{-1}\end{aligned}$$

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Q .7: complete

1. pound - kilogram.
2. cm – foot.
3. Kelvin – Ampere.
4. Steradian - Radian.
5. $L T^{-1} - m/s$
6. $M L T^{-2} - Newton$
7. $AB \cos\theta - AB \sin\theta \vec{n}$

$$\begin{aligned} 8. F_x &= F \cos\theta \\ &= 10 \cos 60 \\ &= 5 N \end{aligned}$$

$$\begin{aligned} F_y &= F \sin\theta \\ &= 10 \sin 60 \\ &= 5\sqrt{3} \end{aligned}$$

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Q.8: Problems :

(1) If $X = (5 \pm 0.1)$ cm and $y = (10 \pm 0.2)$ cm. calculate

Each of :

a. $X + Y$

b. $2X + Y$

c. XY

d. XY^2

a. $X_0 + Y_0 = 5 + 10 = 15$ cm

$$\Delta x + \Delta y = 0.1 + 0.2 = 0.3 \text{ cm}$$

$$X + Y = (15 \pm 0.3) \text{ cm}$$

b. $2X_0 + Y_0 = 10 + 10 = 20$ cm

$$2\Delta X + \Delta Y = 0.2 + 0.2 = 0.4 \text{ cm}$$

$$2X + Y = (20 \pm 0.4) \text{ cm}$$

c. $r_1 = \frac{\Delta X}{X_0} = \frac{0.1}{5} = 0.02$

$$r_2 = \frac{\Delta y}{y_0} = \frac{0.2}{10} = 0.02$$

$$r = r_1 + r_2 = 0.02 + 0.02 = 0.04$$

$$r = \frac{\Delta(xy)}{x_0 y_0} \rightarrow \Delta(xy) = r x_0 y_0 = 0.04 \times 5 \times 10 = 2$$

$$x_0 y_0 = 5 \times 10 = 50$$

$$xy = (50 \pm 2) \text{ cm}^2$$

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$$\text{d. } r_1 = \frac{\Delta x}{x_0} = \frac{0.1}{5} = 0.02$$

$$r_2 = \frac{\Delta y^2}{y_0^2} = \frac{(0.2)^2}{10^2} = \frac{0.4}{100} = 4 \times 10^{-4}$$

$$r = r_1 + r_2 = 0.02 + 4 \times 10^{-4} = 0.0204$$

$$r = \frac{\Delta(xy^2)}{x_0 y_0^2}$$

$$\Delta(xy^2) = r X_0 y_0^2 = 0.0204 \times 5 \times 10^2 = 10.2$$

$$x_0 y_0^2 = 5 \times 10^2 = 500$$

$$xY^2 = (500 \pm 10.2) \text{ cm}^3$$

(2) Find the relative error in estimating the volume of a cube of side length 5 cm if the relative error in measuring length is 0.01 . Also , find the absolute error in this case .

$$r_1 = r_2 = r_3 = 0.01$$

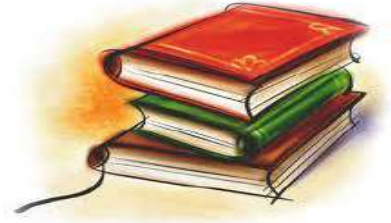
$$r = r_1 + r_2 + r_3 = 0.01 + 0.01 + 0.01 = 0.03$$

$$V_0 = X_0 Y_0 Z_0 = 5 \times 5 \times 5 = 125 \text{ cm}^3$$

$$r = \frac{\Delta V}{V_0}, \quad \Delta V = r V_0$$

$$\Delta V = 0.03 \times 125 = 3.75 \text{ cm}^3$$

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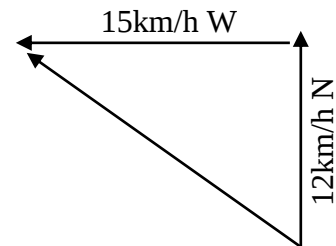
(3) A ship sails north at velocity 12 km/h. due to tides, it is deviated to west at velocity 15 km/h. Find the magnitude and direction of the resultant velocity of the ship.

$$v^2 = v_1^2 + v_2^2$$

$$V^2 = 12^2 + 15^2$$

$$V^2 = 144 + 225 = 369$$

$$V = 19.2 \text{ km/h (north-west direction)}$$



(4) In the opposite diagram, a person has moved from point (A) to point (E) passing by the points (B) , (C) & (n). find his displacement and the distance he moved.

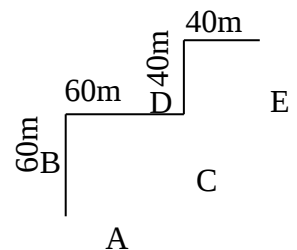
$$d = \overrightarrow{AE} = \overrightarrow{AC} + \overrightarrow{CE}$$

$$\overrightarrow{AC} = \sqrt{(60)^2 + (60)^2} = 84.9 \text{ m}$$

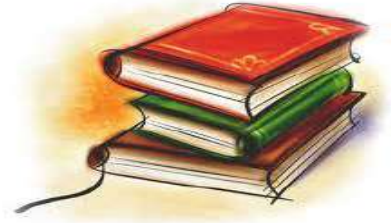
$$\overrightarrow{CE} = \sqrt{(40)^2 + (40)^2} = 56.6 \text{ m}$$

$$d = 84.9 + 56.6 = 141.5 \text{ m}$$

$$s = 60 + 60 + 40 + 40 = 200 \text{ m}$$



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(5) Two perpendicular forces F_x and F_y act on an object where

$F_x = F_y = 80N$. Find :

- a. the resultant of the two forces F_1 and F_2 .
- b. the angle between their resultant x-axis .
- c. Do object move or remain stationary ?

a . $F = F_x^2 + F_y^2 = \sqrt{80^2 + 80^2} = 113.13N$

b . $Tan\theta = \frac{F_Y}{F_X} = \frac{80}{80} = 1 = 45^\circ$

- c . the object moves .

(6) $\vec{A}$ and $\vec{B}$ are two vectors having an angle 120° between them where the magnitude of ($\vec{A}$) = 3 units and the magnitude of ($\vec{B}$) = 4 units. Find: their dot product and their cross product.

$$\begin{aligned}\vec{A} \cdot \vec{B} &= AB \cos \theta \\ &= 3 \times 4 \times \cos 120 \\ &= -6\end{aligned}$$

$$\begin{aligned}\vec{A} \wedge \vec{B} &= AB \sin \theta \vec{n} \\ &= 3 \times 4 \times \sin 120 \\ &= 6\sqrt{3}\end{aligned}$$