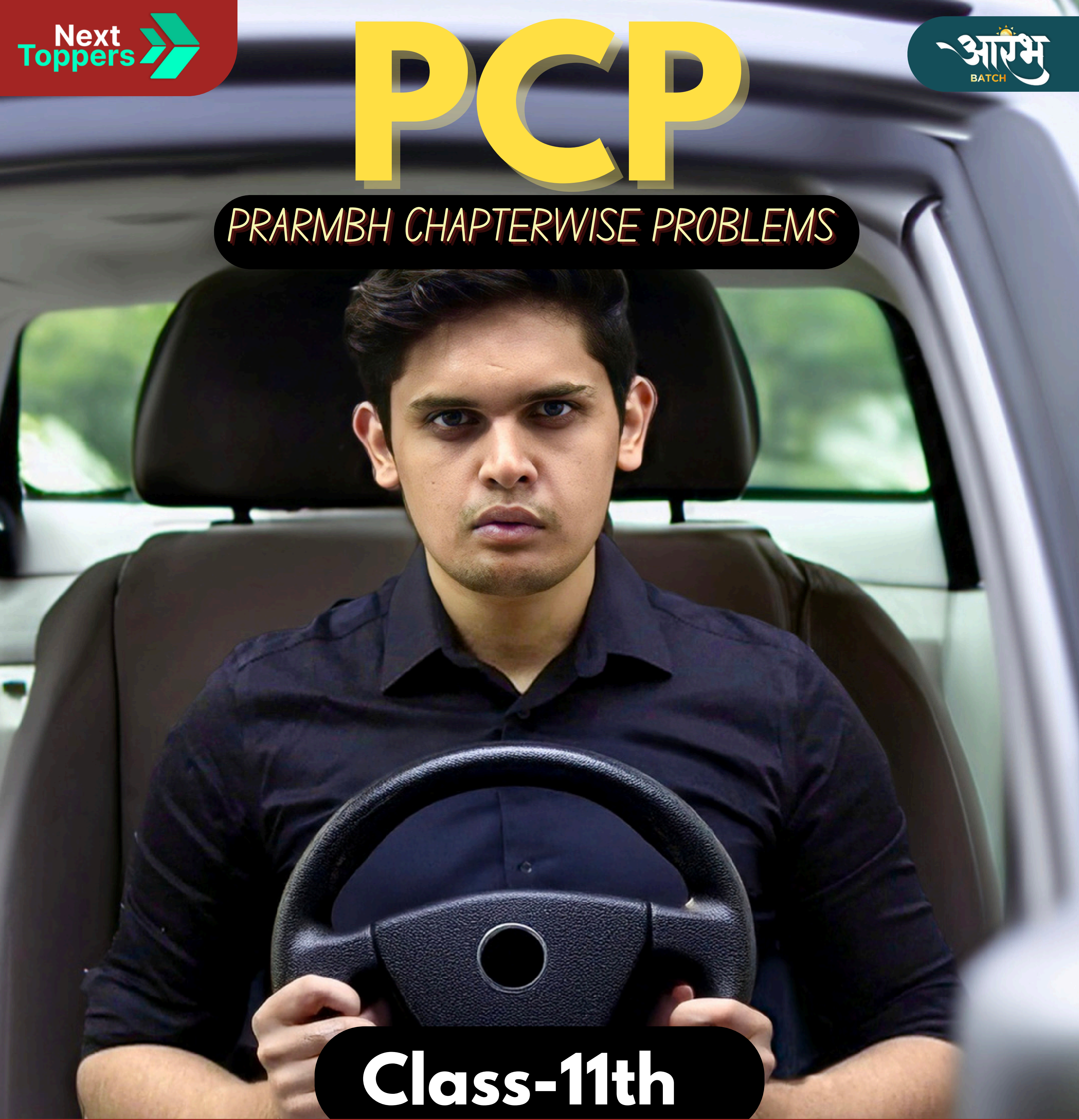

PCP

PRARMBH CHAPTERWISE PROBLEMS

Class-11th

Units And Measurement

PRASHANT KIRAD

Units And Measurements

(Options acche se padhna)

VERY SHORT QUESTIONS (1 Mark)

1) Which of the following is most accurate ?
A. 7000m
B. 7×10^2 m
C. 7×10^3

2) The dimensions of Kinetic energy is same as that of
a. Pressure
b. Work
c. Momentum
d. Force

3) The percentage errors in the measurement of mass and momentum of an object are 1% , 2% respectively. the percentage error in the measurement of kinetic energy of object will be ? [NEET2024]
a. 1%
b. 3%
c. 4%
d. 5%

4) Which of the following physical quantities have same unit in all three system of unit
A. mass
B. length
C. time
D. none of these

5) The dimensional formula for Planck's constant is

a. $[ML^2T^{-1}]$

b. $[M^2L^2T^{-1}]$

c. [MLT]

d. $[ML^1T^{-1}]$

(6)The mechanical quantity , which has dimension of reciprocal of mass (M) is : ? [NEET2023]

(a) angular momentum

(b) cofficient of thermal conductivity

(c) torque

(d) gravitational force

(7)If E and H represents the intensity of electric field and magnetising field respectively, then the unit of E/H will be [JEE 2021]

(a) newton

(b) joule

(c) mho

(d) ohm

(8)When the number 6.03587 is rounded off to the second place of decimals, it becomes

(A) 6.035

(B) 6.04

(C) 6.03

(D) None

(9) If the velocity (V) acceleration (A) and force (F) are taken as fundamental quantities instead of mass (M), length (L) and time (T), the dimension of Young's modulus would be [NEET 2016]

(A) $F A_2 V^{-2}$

(B) $F A_2 V^{-3}$

(C) $F A_2 V^{-4}$

(D) $F A_2 V^{-5}$

10) From the following pairs of physical quantities, in which group dimensions are not same:
(A) Momentum and impulse
(B) Torque and energy
(C) Energy and work
(D) Light year and minute

(11) A torque meter is calibrated to reference standards of mass, length and time each with 5% accuracy. after calibration, the measured torque with this torque meter will have net accuracy of : [JEE 2022]
(a) 15%
(b) 25%
(c) 75%
(d) 5%

(12) If momentum (p), area (A) and time(t)are taken to be fundamental quantities then energy has the dimensional formula: [JEE 2020]
(a) $[P^{1/2} AT^{-1}]$
(b) $[PA^{1/2} T^{-1}]$
(c) $[PA^{1/2} T^{-1}]$
(d) $[P^{2}AT^{-2}]$

(13) The density of a cube is measured by measuring its mass and the length of its sides. If the maximum error in the measurement of mass and length are 3% and 2% respectively, then the maximum error in the measurement of density is
(A) 9%
(B) 7%
(C) 5%
(D) 1%

(14) The measurement of radius of a sphere is (4.22 2% ±) cm. The percentage error in volume of the sphere is
(A) (315 6% ±)
(B) (315 2% ±)

C) (315 4% ±)
(D) (315 5% ±)

(15)If energy (E) , velocity (V) and time (T) are chosen as the fundamental quantities , the dimensions formula of surface tension will be : [NEET2015]
(a) $E V^{-2} T^{-1}$
(b) $E V^{-1} T^{-2}$
(c) $E V^{-2} T^{-2}$
(d) $E^{-2} V^{-1} T^{-3}$

(16) when the circular scale of a screw gauge completes 2 rotations , it covers 1mm over the pitch scale . the total number of circular scale division is 50 . the least count of the screw gauge in meter is : [NEET 2022]
(a) 10^{-4}
(b) 10^{-5}
(c) 10^{-2}
(d) 10^{-3}

(yaha Marks katate h)

Assertion and Reason type of Questions

(a) Both, A and R, are true and R is the correct explanation of A.
(b) Both, A and R, are true but R is not the correct explanation of A.
(c) If A is true but R is false.
(d) If A is false but R is true.

(1) Assertion (A) : 1kg = 10 9 μg
Reason (R): 1kg = 103g and 1 g = 10 6 μg

(2) Assertion (A) : Angle and solid angle both are dimensionless quantities.
Reason (R): Dimensionless quantities cannot have unit

(3) Assertion (A) : The time period of a pendulum is given by : T = k [1/g]
Reason (R): the value of the constant k can be determined by dimensionless analysis

(ho jaayenge aaram se)

SHORT ANSWER TYPE QUESTIONS (2 and 3 Marks)

1)If the velocity of light (c), gravitational constant (G) and the planck's constant (h) are selected as the fundamental units, find the dimensional formulae for mass, length and time in this new system of units.

(2)A physical quantity P is related to four observables a, b, c and d The percentage errors of measurement in a, b, c and d are 1%, 3%, 4% and 2%, respectively. What is the percentage error in the quantity P? If the value of P calculated using the above relation turns out to be 3.763, to what value should you round off the result?

(3)If voltage V=(100±5) V and current I=(10±0.2) A, the percentage error in resistance R is.

(4) Find the dimensional formulae of :
1. Pressure
2. Kinetic energy

(5)The resistance of a metallic wire is given by R = V/I, where V is the potential difference and I is the current. In the circuit, the potential difference across the resistance is V = (8 ± 0.5) V and current in the circuit = (4 ± 0.2) A. What is the value of resistance with its percentage error?

(6)The value of resistance is 10.845 and the current is 3.23A . on multiplying potential difference is 35.02935V . The value of potential in term of significant figure would be .

(7)A research worker takes 100 careful readings in an experiment. If he repeats the same experiment by taking 400 readings, then by what factor will be the probable error be decreased?

(8) A wire has a mass (0.3±0.003)g, radius (0.5±0.005)cm and length (6±0.06)cm. The maximum percentage error in the measurement of its density is. [2015]

(9) Let [e0] denote the dimensional formula of the permittivity of vacuum. If M = mass, L = length, T = time and A = electric current, then [e0] ? [2013]

(pahle points socho firr likho)

LONG ANSWER TYPE QUESTIONS (5 Marks)

(1)If dimensions of critical velocity vc of a liquid flowing through a tube are expressed as $[\eta^x \rho^y r^z]$ where η,ρ and r are the coefficient of viscosity of liquid, density of liquid and radius of the tube respectively, then the values of x, y and z are given by? [NEET2015]

(2)The energy of a system as a function of time t is given as $E(t) = A_2 \exp(-at)$, where $\alpha = 0.2\ s^{-1}$. The measurement of A has an error of 1.25 %. If the error in the measurement of time is 1.50 %, the percentage error in the value of E(t) at t = 5 s is . [2014]

(read paragraph first)

आरंभ BATCH

Case Study/Source Based Question

(1) In the study of Physics, we often have to measure the physical quantities. The numerical value of a measured quantity can only be approximate as it depends upon the least count of the measuring instrument used. The number of significant figures in any measurement indicates the degree of precision of that measurement. The importance of significant figures lies in calculation. A mathematical calculation cannot increase the precision of a physical measurement. Therefore, the number of significant figures in the sum or product of a group of numbers cannot be greater than the number that has the least number of significant figures because a chain cannot be stronger than its weakest link. The difference in the true value and the measured value of a quantity is the measure of error in measurement.

(i) What are significant figures?
(ii) Define least count
(iii) Is there any relation between precision and accuracy?
(iv) State the relationship between significant figures and precision.
(v) Determine the maximum error in the addition of two physical quantities
(vi) How systematic errors can be minimised?

Kitne Questions kar paaye?

SOLUTIONS

SOLUTIONS

VERY SHORT ANSWER TYPE QUESTIONS:

1. (b)
2. (b)
3. (d)
4. (c)
5. (a)
6. (d)
7. (d)
8. (b)
9. (c)
10. (d)
11. (b)
12. (b)
13. (a)
14. (a)
15. (c)
16. (b)

SOLUTIONS

Assertion and reasons

(1)Step-by-step:

$1\ kg = 10^3\ g$

$1\ g = 10^6\ \mu g$

$\Rightarrow 1\ kg = 10^3 \times 10^6 = 10^9\ \mu g$

Option (a) is correct .

(2.)Step-by-step:

- Angle (radian) and solid angle (steradian) are dimensionless, because they are defined as ratios (arc length/radius or area/radius^2), so:
- Assertion is correct
- But even dimensionless quantities can have units — radian and steradian are units, despite being dimensionless.
- Reason is incorrect

Option (c)is correct .

(3.)Step-by-step:

- The actual time period of a simple pendulum:

$T= 2\pi \sqrt{l/g}$

So, T is not proportional to 1/g directly — it depends on √(1/g) and also on length l.

- Assertion is false
- Dimensional analysis can indeed help us determine the form of the relationship (and approximate constants like k, but not the numerical value of k like 2π).
- Reason is correct

Option (c)is correct .

SOLUTIONS

Short Answers type questions

Step 1: Write the dimensions of the fundamental quantities

1. Velocity of light c:

(c)=$L^{1}T^{-1}$

2. Planck constant h:

(h)=$M^{1}L^{2}T^{-1}$

3. Gravitational constant G:

(G)=$M^{-1}L^{3}T^{-2}$

Step 2: Set up the equations for mass, length, and time

Assume the dimensions of mass M, length L, and time T can be expressed in terms of c, h, and G:

- For mass.

$$M \propto c^X h^Y G^Z$$

- For length:

$$L \propto c^A h^B G^C$$

- For time:

$$T \propto c^D h^E G^F$$

Write the dimensional equations

1. For mass

$$(M) = M^1L^0T^0 \implies M^YL^{2Y}T^{-Y}M^{-Z}L^{3Z}T^{-2Z} = M^1L^0T^0$$

This gives us:

$$Y - Z = 1 \quad (1)$$

$$2Y + 3Z = 0 \quad (2)$$

$$-Y - 2Z = 0 \quad (3)$$

2. for length

$$L) = M^0L^1T^0 \implies M^YL^{2Y}T^{-Y}M^{-Z}L^{3Z}T^{-2Z} = M^0L^1T^0$$

'his gives us:

$$- Z = 0 \quad (4)$$

$$Y + 3Z = 1 \quad (5)$$

$$Y - 2Z = 0 \quad (6)$$

SOLUTIONS

3. for time

$$(T) = M^0L^0T^1 \implies M^YL^{2Y}T^{-Y}M^{-Z}L^{3Z}T^{-2Z} = M^0L^0T^1$$

This gives us:

$$Y - Z = 0 \quad (7)$$

$$2Y + 3Z = 0 \quad (8)$$

$$-Y - 2Z = 1 \quad (9)$$

From equations (1) and (4), we can express Y and Z:
- From (1): Y=Z+1
- From (4): Y=Z
Setting them equal gives:
Z+1=Z⇒No solution
This indicates a need to re-evaluate the equations.
Instead, let's solve equations (2) and (3) for mass:
From (3):
Y=−2Z
Substituting into (2):
2(−2Z)+3Z=0⇒−4Z+3Z=0⇒Z=0⇒Y=0
Thus, Y=0 and Z=0 gives X=1.
For length, using equations (4) and (5):
From (4): Y=Z
Substituting into (5):
2Z + 3Z = 1 ⇒ 5Z = 1 ⇒ Z = 1/5, Y = 1/5
Using (6):
Y + 2Z = 0 ⇒ 15 + 2(15) = 0 (not valid)

Final Dimensions

After solving, we find:

1. **Mass**:

$$M = K \cdot c^{1/2}h^{1/2}G^{-1/2}$$

2. **Length**:

$$L = K \cdot c^{-3/2}h^{1/2}G^{1/2}$$

3. **Time**:

$$T = K \cdot c^{-5/2}h^{1/2}G^{1/2}$$

SOLUTIONS

(2) Here $P = \frac{a^3 b^2}{\sqrt{cd}}$

Maximum fractional error in P is given by

$$\frac{\Delta P}{P} = \pm\left[3\frac{\Delta a}{a} + \frac{\Delta b}{b} + \frac{1}{2}\frac{\Delta c}{c} + \frac{\Delta d}{d}\right] =$$

$$\pm\left[2\left(\frac{1}{100}\right) + 2\left(\frac{3}{100}\right) + \frac{1}{2}\left(\frac{4}{100}\right) + \frac{2}{100}\right] =$$

$$\pm\frac{13}{100} = \pm 0.13$$

$$\text{Percentage error in} P = \frac{\Delta P}{P} \times 100 = \pm 0.13$$

$\times 100 = \pm 13\%$

As the result (13%error) has two significant figures, therefore, if P turns out to be 3.763, the result would be rounded off to 3.8.

(3) According to Ohm's Law, the resistance R can be calculated using the formula:

$R = V/I$

From the problem, we have:

- Voltage $V = 100 \pm 5$ V
- Current $I = 10 \pm 0.2$ A

Using the values of V and I:

$R = 100V / 10A = 10\Omega$

he relative error in voltage

δV is given by:

$\delta V/V = 5/100 = 0.05$

The relative error in current

δI is given by:

$\delta I / I = 0.2 / 10 = 0.02$

The total relative error in resistance R can be calculated using the formula:

$\delta R / R = \delta V / V + \delta I / I$

SOLUTIONS

Substituting the values:
$\delta R / R = 0.05 + 0.02 = 0.07$

To find the percentage error, we multiply the relative error by 100

Percentage error in
$R = \delta R / R \times 100 = 0.07 \times 100 = 7\%$

The percentage error in resistance R is 7%.

(4) 1. Pressure (P) = Force × Area^{-1} . . . . . (1)
Since, Force = Mass × Acceleration
And, acceleration = velocity × time^{-1} = [L T^{-1}] [T]$^{-1}$ = [L T^{-2}]
The dimensional formula of force = [M] × [L T^{-2}] = Force = $M^1 L^1 T^{-2}$ . . . (2)
The dimensional formula of area = $M^0 L^2 T^0$ . . . . (3)
On substituting equation (2) and (3) in equation (1) we get,
Pressure (P) = Force × Area^{-1}
Or, P = $[M^1 L^1 T^{-2}] \times [L^2]^{-1} = M^1 L^{-1} T^{-2}$.
Therefore, the pressure is dimensionally represented as M1 L-1 T -2.

2. Kinetic energy (K.E) = [Mass × Velocity^2] × 2^{-1} . . . . . (1)

The dimensional formula of Mass = $[M^1 L^0 T^0]$ . . . . (2)

Since, Velocity = Distance × Time^{-1} = [L] × [T]$^{-1}$

∴ The dimensional formula of velocity = $[M^0 L^1 T^{-1}]$ . . . . (3)

On substituting equation (2) and (3) in equation (1) we get,

⇒ Kinetic energy = [Mass × Velocity^2] × 2^{-1}

Or, K.E = $[M^1 L^0 T^0] \times [M^0 L^1 T^{-1}]^2 = [M^1 L^2 T^{-2}]$

Therefore, Kinetic Energy is dimensionally represented as $[M^1 L^2 T^{-2}]$.

SOLUTIONS

(5) The formula for resistance R is given by:

R = V / I

Where:

- V = 8V
- I = 4A

Substituting the values:

R = 8V / 4A = 2Ω

The absolute errors in the measurements are given as:

- ΔV = 0.5V
- ΔI = 0.2A

The percentage error in V and I can be calculated using the formula:

$$\text{Percentage Error} = \left(\frac{\Delta V}{V} \times 100\right) + \left(\frac{\Delta I}{I} \times 100\right)$$

Calculating the percentage error for V:

$$\text{Percentage Error in } V = \frac{0.5}{8} \times 100 = 6.25\%$$

Calculating the percentage error for I:

$$\text{Percentage Error in } I = \frac{0.2}{4} \times 100 = 5\%$$

The total percentage error in resistance R is the sum of the percentage errors in V and I:

Total Percentage Error = 6.25% + 5% = 11.25%

The value of resistance with its percentage error can be expressed as:

R = 2Ω ± 11.25%

(6) Resistance (R) = 10.845 → 5 significant figures

Current (I) = 3.23 A → 3 significant figures

Potential Difference (V = IR) = 35.02935 V → calculated

Since the least number of significant figures in the inputs is 3 (from current), the final answer should be rounded to 3 significant figures.

SOLUTIONS

(7) Initial readings: = 100
New reading: =400

$$\frac{1\sqrt{400}}{1\sqrt{100}} = \frac{1}{2}$$

The probable error will be decreased by a factor of 2

(8) Density $(\rho) = \frac{m}{\pi r^2 l}$

$\therefore \left(\frac{\Delta\rho}{\rho}\right) \times 100 = \left(\frac{\Delta m}{m} + 2 \times \frac{\Delta r}{r} + \frac{\Delta l}{l}\right) \times$
100

$= \left(\frac{0.003}{0.3} + 2 \times \frac{0.005}{0.5} + \frac{0.06}{6}\right) \times 100$

$= (0.01 + 0.02 + 0.01) \times 100$

$= 4\%$

(9) To find the dimensional formula of the permittivity of vacuum ε0 we start from the basic physics equation involving it.

$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2}$

Rewriting for ε_0:

$\varepsilon_0 = \frac{1}{4\pi} \cdot \frac{q^2}{F \cdot r^2}$

- Force F has dimensions $[F] = MLT^{-2}$
- Distance r has dimensions $[r] = l$
- Charge q has dimensions $[q] = AT$ (since current is charge per unit time)

SOLUTIONS

So:

$$[\varepsilon_0] = \frac{[q]^2}{[F][r]^2} = \frac{(AT)^2}{MLT^{-2}.L^2} = \frac{A^2T^2}{ML^3T^{-2}} = \frac{A^2T^4}{ML^3}$$

Final Answer:

$$[\varepsilon_0] = M^{-1}L^{-3}T^4A^2$$

Long answer type questions

(1) To determine the values of x, y, and z in the expression for the critical velocity vc in terms of the coefficient of viscosity η, density ρ, and radius r, we need to equate the dimensions on both sides of the equation:

$$v_c = \eta^x \rho^y r^z$$

Write the dimensional formula for each quantity:

- Critical velocity v_c: $(v_c) = (L^1T^{-1})$

- Coefficient of viscosity η: $(\eta) = (M^1.$

- Density ρ: $(\rho) = (M^1L^{-3}T^0)$

- Radius r: $(r) = (L^1)$

Express the dimensional equation:

$$(v_c) = (\eta^x \rho^y r^z)$$

Substituting the dimensions:

$$(L^1T^{-1}) = (M^1L^{-1}T^{-1})^x(M^1L^{-3}T^0)^y(L^1)^z$$

SOLUTIONS

Expand the dimensions:

$$(L^1T^{-1}) = (M^xL^{-x}T^{-x})(M^yL^{-3y}T^0)(L^z)$$

4. **Combine the dimensions:**

$$(L^1T^{-1}) = (M^{x+y}L^{-x-3y+z}T^{-x})$$

Equate the dimensions on both sides:

For mass M:

x + y = 0 (1)

For length L:

-x − 3y + z = 1 (2)

For time T:

-x = −1 (3)

From equation (3):

x = 1

Substitute x=1 into equation (1):

1 + y = 0 ⇒ y = −1

Substitute x=1 and y=−1 into equation (2):

−1 −3 (−1) + z = 1

Simplify:

−1 + 3 + z = 1 ⇒ 2 +z = 1 ⇒ z = −1

Final Values:

x = 1 , y = −1 , z = −1

(2) Given $E(t) = A^2\exp(-\alpha t), \alpha = 0.2s^{-1}$,

$$\frac{dA}{A} = 1.25\,\%\,,\ \frac{dt}{t} = 1.50\,\%\,,\ t = 5\,\text{sec.}\,,\ \frac{dE}{E} = ?$$

Taking log of both sides, we get

$$\log E = \log A^2 e^{-\alpha t}$$

$$\log E = \log A^2 + \log e^{-\alpha t}$$

or $\log E = 2\log A - \alpha t$

SOLUTIONS

Differentiating both sides, we get

$$\frac{dE}{E} = \pm \frac{2dA}{A} \pm \alpha dt.......(i)$$

$$: > \frac{dt}{t} = 1.50\,\%\,, t = 5\,\text{sec.}$$

$$\therefore \frac{dt}{5} = 1.50\,\%\,, dt = 7.50\,\%$$

From (i), $\frac{dE}{E} = \pm 2(1.25) + -0.2 \times 7.5$

$$= \pm 2.5 \pm 1.5 = \pm 4\,\%$$

CASE STUDY/SOURCE BASED QUESTION:

(1) Significant figures are the digits in a measured quantity that include all certain digits plus the first uncertain digit. They indicate the precision of a measurement.

(2) Least count is the smallest value that can be measured by a measuring instrument. It is the minimum division on the scale of the instrument.

(3) Yes, there is a relation. Precision refers to the consistency or repeatability of measurements, while accuracy refers to how close a measurement is to the true value. A measurement can be precise without being accurate, and vice versa.

(4) The greater the number of significant figures in a measurement, the higher its precision. Significant figures reflect the exactness of a measurement and show how finely the measurement was made.

SOLUTIONS

(5) When two quantities are added, the maximum error in the result is the sum of the absolute errors in the individual quantities:

$\Delta R = \Delta A + \Delta B$

Where ΔR is the maximum error in the result, and ΔA and ΔB are the absolute errors in the measured quantities A and B.

(6) Systematic errors can be minimized by:

- Proper calibration of instruments
- Using high-quality and properly functioning apparatus
- Eliminating personal bias
- Taking environmental factors into account (like temperature, pressure, etc.)
- Applying necessary corrections during calculations