

HC VERMA Solutions for Class 11 Physics Chapter 1 - Introduction to Physics

Question 1

Find the dimensions of

- a) linear momentum
- b) frequency
- c) pressure

Solution 1

a) Linear momentum = mv

Dimension = $[MLT^{-1}]$

b) Frequency = $1/T$

Dimension = $[T^{-1}]$

c) Pressure = Force/Area

Dimension = $[MLT^{-2}]/[L^2] = [ML^{-1}T^{-1}]$

Question 2

Find the dimensions of a) angular speed, b) angular acceleration, c) Torque T c) moment of Inertia I

Solution 2

a) Angular speed = radian/time = $[M^0L^0T^{-1}]$

b) Angular acceleration = Angular speed/time = $[M^0L^0T^{-2}]$

c) Torque = $\vec{r} \times \vec{F} = [ML^2T^{-2}]$

d) Moment of Inertia = $Mr^2 = [ML^2]$

Question 3

Find the dimensions of a) Electric field, b) Magnetic field, c) Magnetic permeability μ_0

Solution 3

a) Electric field = $F/q = [MLT^{-2}]/[IT] = [MLT^{-3}I^{-1}]$

b) Magnetic field = $F/qv = [MLT^{-2}]/[IL] = [MT^{-2}I^{-1}]$

c) Magnetic Permeability = $B \times 2\pi a/l = [MT^{-2}I^{-1}][L]/[I] = [MLT^{-2}I^{-2}]$

Question 4

Find the dimensions of a) Electric dipole moment p, b) magnetic dipole moment M

Solution 4

a) Electric dipole moment = $qL = [IT] \times [L] = [LIT]$

b) Magnetic dipole moment = $IA = [I] \times [L^2] = [IL^2]$

Question 5

Find the dimensions of Planck's constant h from the equation $E = hv$ where E is energy and v is frequency

Solution 5

$$h = \frac{E}{\nu}$$

So, $[h] = [ML^2T^{-2}]/[T^{-1}] = [ML^2T^{-1}]$

Question 6

Find the dimensions of a) the specific heat capacity c, b) the coefficient of linear expansion α , c) the gas constant R

Solution 6

- a) Specific heat constant $c = Q/m(T_2 - T_1) = [ML^2T^{-2}]/[M][\theta] = [L^2T^{-2}\theta^{-1}]$
 $= \frac{[L]}{[T][\theta]} = [\theta]$
b) Coefficient of linear expansion α
c) Gas constant $R = PV/nT = [ML^{-1}T^{-2}][L^3]/[mol][\theta] = [ML^2T^{-2}\theta^{-1}(mol)^{-1}]$

Question 7

Taking force, length and time to be fundamental quantities find the dimensions of a) Density, b) Pressure, c) momentum and d) energy

Solution 7

- a) Density = $\frac{\text{mass}}{\text{volume}} = \frac{\text{force}}{\text{acceleration} \times \text{volume}} = [F/LT^{-2}][L^3] = [FL^{-4}T^{-2}]$
b) Pressure = $\frac{\text{force}}{\text{area}} = [F][L^2] = [FL^{-2}]$
c) Momentum = $\frac{\text{force}}{\text{acceleration}} \times \text{velocity} = [F]/[LT^{-2}] \times [LT^{-1}] = [FT]$
d) Energy = $\frac{\text{force}}{\text{acceleration}} \times (\text{velocity})^2 = [F]/[LT^{-2}] \times [L^2T^{-2}] = [FL]$

Question 8

Suppose the acceleration due to gravity at a place is 10m/s^2 . Find its value in $\text{cm}/(\text{minute})^2$.

Solution 8

$$g = 10 \text{ metre/sec}^2 = 10 \times 100 \times 3600 \text{ cm/min}^2 = 36 \times 10^5 \text{ cm/min}^2.$$

Question 9

The average speed of a snail is 0.020 miles/hour and that of a leopard is 70 miles/hour. Convert these speeds in SI units.

Solution 9

1 mile = 1.6 km = 1600 m, and 1 hour = 3600 seconds.
Speed of snail = $0.02 \times 1600 / 3600$ metre per sec = 0.0089 m/sec.
Speed of leopard = $70 \times 1600 / 3600$ metre per sec = 31 m/sec.

Question 10

The height of a mercury column in a barometer in a Calcutta Laboratory was recorded to be 75 cm. Calculate this pressure in SI and CGS using the following data: Specific gravity of mercury = 13.6, Density of water = 1000kg/m^3 , $g = 9.8\text{m/s}^2$ at Calcutta. Pressure = hpg in usual symbols

Solution 10

H = 75 cm, density of mercury = 13600kg/m^3 , $g = 9.8\text{ms}^{-2}$
then, pressure = 10^5 N/m^2 .
In C.G.S. units, $P = 10 \times 10^5 = 10^6 \text{ dyne/cm}^2$

Question 11

Express the power of a 100 watt bulb in CGS unit

Solution 11

1 watt = 1 Joule/sec = 10^7 erg/sec
So, 100 watt = 10^9 erg/sec .

Question 12

The normal duration of I.Sc physics practical period in Indian colleges is 100 minutes. Express this period in microcenturies. 1 microcentury = $10^{-6} \times 100$ years.

Solution 12

1 microcentury = 10^{-4} years. = $10^{-4} \times 365 \times 24 \times 60$ min = 52.56 min.

So, 100 min = $100/52.26$ microcentury = 1.9 microcentury

Question 13

The surface tension of water is 72 dyne/cm. Convert it to SI unit.

Solution 13

Surface tension of water is 72 dyne/cm

In S.I. unit, it is = 0.072 N/m

Question 14

The kinetic energy K of a rotating body depends on its moment of Inertia I and its angular speed ω . Assuming the relation to be $K = kI^a\omega^b$, where k is a dimensionless constant, find a and b . Moment of

inertia of a sphere about its diameter is $\frac{2}{5}Mr^2$

Solution 14

$K = kI^a\omega^b$, where k = constant and K = Kinetic energy

So, $K = [ML^2T^{-2}]$

$I^a = [ML^2]^a$ and $\omega^b = [T^{-1}]^b$

So, $[ML^2T^{-2}] = [M^aL^{2a}T^{-b}]$

So, $a = 1$ and $b = 2$

Question 15

Theory of relativity reveals that mass can be converted into energy. The energy E so obtained is proportional to certain powers of mass m and the speed of light c . Guess a relation among the quantities using the method of dimensions.

Solution 15

Let us assume energy $E \propto m^a c^b$, or $E = k m^a c^b$, where k is a constant

Equating their dimensions ,

$[ML^2T^{-2}] = [M^a][L^bT^{-b}]$

From here, we see that $a = 1$ and $b = 2$

Question 16

Let I = current through a conductor, R = its resistance and V = potential difference across its ends.

According to Ohm's law, product of two of these quantities equals the third. Obtain Ohm's law from dimensional analysis. Dimensional formulae for R and V are $[ML^2I^{-2}T^{-3}]$ and $[ML^2T^{-3}I^{-1}]$ respectively

Solution 16

Dimension of $R = [ML^2I^{-2}T^{-3}]$

Dimension of $V = [ML^2T^{-3}I^{-1}]$

Now, $R = [ML^2I^{-2}T^{-3}] = [ML^2I^{-1}T^{-3}]/[I] = V/[I] = V/I$

or, $V = IR$.

Question 17

The frequency of vibration of a string depends on the length L between the nodes, the tension F in the string and its mass per unit length m . Guess the expression for its frequency from dimensional analysis.

Solution 17

Let, frequency $\nu = F^a L^b m^c$

or $[T^{-1}] = [MLT^{-2}]^a [L^b] [M^c]$

Equating the terms, we get $-2a = -1$, or $a = \frac{1}{2}$, and $c+a = 0$, so $c = -\frac{1}{2}$

and $a + b = 0$, so $b = -\frac{1}{2}$.

So, $v = F^{\frac{1}{2}} L^{-\frac{1}{2}} m^{-\frac{1}{2}}$

Question 18

Test if the following are dimensionally correct:

a) $h = \frac{2S \cos \theta}{\rho r g}$, b) $v = \sqrt{\frac{P}{\rho}}$, c) $\frac{\pi P t r^4}{8 \eta l}$, d) $\frac{1}{2\pi} \sqrt{\frac{mgl}{I}}$

Solution 18

a) $h = \frac{2S \cos \theta}{\rho r g}$

Here, $h = [L]$, $S = F/L = [MT^{-2}]$, $\rho = [ML^{-3}]$, $r = [L]$, $g = [LT^{-2}]$

$\frac{2S \cos \theta}{\rho r g}$

So, $\frac{2S \cos \theta}{\rho r g} = [MT^{-2}]/[ML^{-3}L^2T^{-2}] = [L]$

This relation is correct

b) Here, $[v] = [LT^{-1}]$, $P = [ML^{-1}T^{-2}]$ and $\rho = [ML^{-3}]$

Now, $P/\rho = [L^2T^{-2}]$, so, $\sqrt{\frac{P}{\rho}} = [LT^{-1}] = v$.

This relation is correct

c) $V = \frac{\pi P t r^4}{8 \eta l}$

$V = [L^3]$, $P = [ML^{-1}T^{-2}]$, $t = [T]$, $r = [L]$, $\eta = [ML^{-1}T^{-1}]$,

$\frac{\pi P t r^4}{8 \eta l}$

Now, $\frac{\pi P t r^4}{8 \eta l} = [ML^{-1}T^{-2}][L^4][T]/[MT^{-1}] = [L^3]$

This relation is correct

d) $v = [T^{-1}]$, $m = [M]$, $g = [LT^{-2}]$, $I = [ML^2]$

Now, $\frac{1}{2\pi} \sqrt{\frac{mgl}{I}} = [T^{-1}]$

Thus, this relation is also correct.

Question Q19

Let x and a stand for distance. Is $\int \frac{dx}{\sqrt{a^2 - x^2}} = \frac{1}{a} \sin^{-1} \frac{x}{a}$ dimensionally correct?

Solution Q19

Dimension of the Integral = $\int \frac{dx}{\sqrt{a^2 - x^2}} = \int \frac{L}{\sqrt{L^2 - L^2}} = L^0$. But for $\frac{1}{a} \sin^{-1} \frac{x}{a}$, the dimension is $[L^{-1}]$. So this expression is dimensionally incorrect.