PHYSICS

BOOKS - BHARATI BHAWAN PHYSICS (HINGLISH)

UNITS AND DIMENSION

Example

1. Find the dimensions of the following quantities :

(i)velocity, (ii)acceleration, (iii)force, (iv)angle, (v)angular velocity, (vi)density , (vii)pressure, (viii)kinetic energy, (ix)couple, (x)constant of gravitation, (xi)coefficient of viscosity, and (xii)permeability of a medium.

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2. The value of a force acting on a body is 20 N in SI units. What is the value of this force in cgs, units that is , dynes ?

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3. Check by the method of dimensions whether the following relations are true.

(i)$t = 2\pi\sqrt{\frac{l}{g}}$, (ii)$v = \sqrt{\frac{P}{D}}$ where v= velocity of sound P=pressure D=density of medium .

(iii)$n = \frac{1}{2l} = \sqrt{\frac{F}{m}}$ where n= frequency of vibration l=length of the string, F=stretching force m=mass per unit length of the string .

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4. Assuming that the critical velocity of flow of a liquid through a narrow tube depends on the radius of the tube, density of the liquid and viscosity of the liquid, find an expression for critical velocity.

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5. Show that $\frac{h}{m_0 c}$ is of the dimensions of length where h is Planck constant , m_0, rest mass and c, velocity of light.

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6. If density (D), acceleration due to gravity (g) and frequency (v) are taken as base quantities , find the dimensions of force.

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7. Find the dimensions of a in the formula $\left(p+\frac{a}{V^2}\right)(V-b)=RT$

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Exercise

1. Obtain the dimensions of the following physical quantities :

(i)momentum, (ii)moment, (iii)impulse, (iv)power, (v)power, (vi)frequency, (vi)angular acceleration, (vii)velocity gradient, (viii)surface tension, (ix)moment of inertia, (x)ε , permittivity of a medium , (xi)thermal conductivity, (xii)stress , (xiii)strain, (xiv)Young's modulus.

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2. Acceleration due to gravity in the fps system is 32.2. What is its value in SI units ?

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3. The value of coefficient of viscosity in the cgs system is 12. What is its value of the same in SI units ?

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4. Surface tension of water in the CGS units is 72 dyne/cm . What is its value in SI units ?

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5. The value of acceleration due to gravity is 980 $cm/\sec^2$.What will be its value if the unit of length is kilometer and that of time is hour ?

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6. Obtain the formula $t = k\sqrt{\frac{l}{g}}$ by the method of dimensions.

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7. Assuming that the largest mass that can be moved by a flowing river depends on the velocity of flow, density of river water and acceleration due to gravity , show that the mass varies as the sixth power of velocity of flow.

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8. The velocity of sound in a gas depends on its pressure and density . Obtain the relation between velocity , pressure and density.

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9. The viscous force on a spherical body, when it moves through a viscous liquid, depends on the radius of the body, the coefficient of

viscosity of the liquid and the velocity of the body.Find an expression for the viscous force.

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10. The rate of volume flow of water through a canal is found to be a function of the area of cross-section of the canal and velocity of water. Show that the rate of volume flow is proportional to the velocity of flow of water.

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11. Show that the following are the dimensions of energy.

(i)mc^2 where m=mass and c=velocity of light

(ii)$\frac{mP}{\rho}$ where P=pressure , ρ =density of liquid and m=mass

(iii)mB where m=magnetic moment and B =magnetic induction field.

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12. Show that RC, where R is the resistance and C is the capacitance, is of the dimension of

time.

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13. Using force (F), length (L) and time (T) as base quantities , find the dimensions of (i)mass, (ii)surface tension and (iii)Young's modulus.

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14. If the units of length and force be increased three times, show that the unit of energy is increased nine times.

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15. A gas bubble, from an explosion under water, oscillates with a period proportional to $P^a d^b E^c$, where P is the static pressure , d is the density and E is the total energy of the explosion. Find the values of a,b and c.

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16. If the time period $(T)$of vibration of a liquid drop depends on surface tension (S) , radius(r) of the drop , and density (ρ) of the liquid , then find the expression of T.

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17. In the formula $X = 3YZ^2$, X and Z have dimensions of capacitance and magnetic

induction respectively. The dimensions of Y in MKSQ system are ....., ...

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18. If the velocity of light c, the gravitational constant G and Planck constant h are chosen as the fundamental units, find the dimensions of length , mass, and time in the new system.

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19. The viscosity η of a gas is determined by its density ρ, molecular velocity c and its mean free path λ.Show that $\eta = k\rho c\lambda$ where k is a dimensionless constant.

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20. Assuming that the vibration frequency of atoms in a crystal depends on the atomic mass m, the atomic spacing a and

compressibility β, find an expression for frequency.

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21. If the resistance experienced by a spherical body moving through a liquid is proportional to the square of the velocity.show that it is independent of viscosity.

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22. The critical angular velocity ω_c of a cylinder inside another cylinder containing a liquid at which its turbulence occurs depends on viscosity η, density ρ and the distance d between the walls of the cylinders . Find an expression for ω_c.

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23. Find the physical quantity whose value depends on the velocity of light c, mass of

electron m and Planck constant h and which has the dimension of distance.

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24. The force of attraction between two points 1 kg masses I_m apart proposed as the unit of force and call it neodyne, the first Bohr orbit $\left(0.5 \times 10^{-10} m\right)$ as the unit of length and call it neometre and the mass of electron $\left(9 \times 10^{-31} kg\right)$ as unit of mass and call it

neogram.Find the value of 'neosecond' in this system.

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25. Find dimensionally the relation between reverberation period t of a room, its volume V , its surface area A and the velocity of sound C.Assume that period is proportional to the volume and inversely proportional to area.

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26. The resistance R to the motion of a ship depends on the velocity v of the ship, l the length of ship, ρ the density of sea water and g the acceleration due to the gravity.Show that R is proportional to l^3.

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