PHYSICS

BOOKS - DHANPAT RAI & CO PHYSICS (HINGLISH)

PHYSICAL WORLD AND MEASUREMENTS

Example

1. Write the order of magnitude of the following measurements:

(i) 25,710,000 m

(ii) 0. 00000521 kg

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2. Express 1 light year in terms of metre. What is its order of magnitude?

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3. Express 1 parsec in terms of meters . What its order of magnitude .

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4. A student measures the thickness of a human hair by looking at it through a microscope of magnification 100. He makes 20 observations and findsd that the average width of the hair in the field of view of the microscope is 3.5mm. What is his estimate on the thickness of hair?

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5. If the size of a nucleus $\left(\approx 10^{-15} m \right)$ is scaled up to the tip of a sharp pin $\left(\approx 10^{-5} m \right)$, what roughly is the size of an atom?

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6. The photograph fo a house occupies an area of $1.7cm^2$ on a 35 slide. The slide is projected on to a screen, and the area of the house on the screen is $1.55m^2$ What is the liner magnification of the projector screen arrangement?

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7. What is the distance in km of a quaser from which ligth takes 3.0 billion years to reach us ?

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8. A SONAR (sound navigation and ranging) uses ultrasonic waves to detect and locate object under water. In a submarine equaipped with as SONAR, the time delay between genration of a probe wave and the recption of its echo after refection from an enemy submarine is found to be 77.0 s. What is the distance of the enemy submarine ? (speed of sound in water $= 1450ms^{-1}$

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9. A laser light beamed at the moon the takes $2.56s$ to return after reflection at the moon 's surface . How much is the radius of the lunar obit around the earth ?

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10. The shadow of a tower standing on a level plane is found to be 50m longer when sun's altitude is 30° then when it is 60°. Find the height of tower.

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11. The moon subtends an angle of 57 minutes at the base line equal to radius of earth. What is the distance of moon from earth. Given radius of earth is 6400 km.

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12. When planet Jupiter is at a distance of 824.7 million km from earth, its angular diameter is measured to be 35.72'' of arc. Calculate the diameter of Jupiter.

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13. It is a well known fact that during a total solar eclipes the disc of the moon almost completely covers the disc of the sun. From this fact and from the information you can gather from Solved Examples 3 and 4 on page 1//44, determine the approximate diameter of the moon.

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14. The nearest star to our solar system is 4.29 light years away. How mcuh is this distance in terms of par sec ? How mcuh parallax would this

star show when viewed from two locations of the earth six months apart in its orbit around the sun?

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15. The radius of a hydrogen atom is about 0.5Å . What is the total atomic volume in m^3 of a mole of hydrogen atoms ?

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16. One mole of an ideal gas at NTP occupies 22.4 liters (molar volume). What is the ratio of molar volume to atomic volume to atomic volume of a mole of hydrogen ? Take size of hydrogen molecule to be 1 Å. Why is this ratio so large?

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17. A drop of olive oil of radius 0.25 mm spreads into a circular film of diameter 20cm on the water surface. Estimate the size of the oil molecule.

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18. The sun is a hot plasma (ionised matter) with its linner core at a temperature excedding 10^7 K, and its outer surface at a temperature of about 6000K. At such high temps, no substance remains in a solid or liquid phase. In what range do you expect the mass density of the sun to be? In the range of densities of solids, liquieds or gases ? Check if your guess is correct from the following data : mass of sun $= 2.0 \times 10^{30} kg$, radius of the sun $= 7.0 \times 10^8 m$

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19. Estimate the averaage atomic mass density of a sodium atom, assuming its size ot be 2.5 Å. Compare it with density of sodium in its

crystalline phase $\left(970 kgm^{-3}\right)$. Are the two denities of the same order of magnitude ? If so, why ?

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20. The unit of length convenient on nuclear scale is a fermi, $1f = 10^{9} - 15)$m. Nuclear sizes obey rougholy the following empricial relation : $r = r_0 A^{1/3}$, where r is radius of the nucleus and r_0 is a constant equal to 1.2 f. show that the rule implies that nuclear mass density in nearly constant for different neclei. Estimate the mass density of sodium nucleus. Compare it with avarge mass density of sodium atom is Q. 27 $\left(4.67 \times 10^{3} kg/m^{3}\right)$.

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21. The avarage life of an Indian is 56 years .Find the number of times the human heart beats in the life of an Indian ,If the heat beats once in 0.8 s.

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22. It is claimed that two cesium clocks, if allowed to run for 100 years, free from any disturbance, may differ by only about 0.02s. What does this imply for the accuracy of the standard cesium clock in measuring a time interval of 1s ?

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23. The mean life of an elementary particle pion is 2×10^{-7} ns. The age of the univers is about 4×10^{9} years. Identify a physically meaning time that is approximately half way between these two on a logarithmic scale.

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24. Deduce the dimensinal formulae for the ollowing physical quantites: Graviatinal constant (ii) Powr (iii) Young's modulus (iv) Coeffcient of viscosity (v) Surface tension (vi) Planck,s constant .

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25. Deduce the dimensinal formulae for the ollowing physical quantites:

(i) Heat (ii) Specific heart (iii) Latent heat (iv) Gas constant (v) Boltzmann's constant (vi) Coffcient of thermal conductivity (vii) Meachanical equivalent of heart .

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26. Find the dimensionalformulae of (i) charge (ii) potential (iii) resistance (iv) capacitance.

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27. Name the physical quantites whose dimensional formulae are as follows:

(i) $ML^2T^{-2}(ii)ML^2T^{-3}(iii)MT^{-2}(iv)ML^{-1}T^{-1}(v)ML^{-1}T^{-2}$,

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28. Taking velocity , time and force as the fundamental quantities , find the dimension of mass .

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29. 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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30. If C (the velocity of light) g , (the acceleration due to gravity), P (the atmospheric pressure) are the fundamental quantities in MKS system , then the dimensions of length will be same as that of

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31. Number of particles is given by $n = -D\frac{n_2 - n_1}{x_2 - x_1}$ crossing a unit area perpendicular to X-axis in unit time, where n_1 and n_2 are number of particles per unit volume for the value of x meant to x_2 and x_1. Find dimensions of D called as diffusion constant

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32. Fill in the blanks by suitable conversion of units :

(a) $1kgm^2s^{-2} = gcm^2s^{-2}$ (b) 1m = ... Light year (c) $3ms^{-2} = ...Kmh^{-2}$

(d) $G = 6.67 \times 10^{-11}Nm^2kg^{-2} = ...cm^3s^{-2}g^{-1}$

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33. The value fo universal gravitationla constant G in CGS system is 6.67×10^{-8} dyne cm^2g^{-2}. Its value in SI system is

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34. Convert an energy of 1 joule into ergs.

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35. Find the value of 60 J per min on a system that has 100g, cm and 1 min. as the base units.

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36. A calorie is a unit of heat or energy and it equals about $4.2J, where 1J = 1kgm^2s^{-2}$. Suppose we employ a system of units in which the unit of mass equals αkg, the unit of length equals is βm , the unit of time is γs. Show tthat a calorie has a magnitude $4.2\alpha^{-1}\beta^{-1}\gamma^2$ in terms of the new units.

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37. Relative density of an oil is 0.8.Find the absolute density of oil in CGS and SI units.

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38. The Young's modulus of steel is $1.9 \times 10^{11} Nm^{-2}$. Calculate its value in dyne cm^{-2}.

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39. The value of Stefan's constant is $\sigma = 5.76 \times 10^{-8} Js^{-1} m^{-2} K^{-4}$. Find its value in cgs system.

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40. A new unit of length is chosen such that the speed of light in vecuum is unity. What is the distance between the sun and the earth in terms of

the new unit, if light takes 8 min and 20 sec. to cover the distance ?

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41. If the unit of force is 1 kN, unit of length 1 km and unit of time is 100s, what will be the unit of mass?

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42. If the fundamental units are the velocity of light in air $\left(3 \times 10^{10} cms^{-1}\right)$, the acceleration due to gravity $\left(981 cms^{-1}\right)$, the density of mercury $\left(13.6 gcm^{-3}\right)$, fing the units of mass , length and time.

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43. Check the correctness of following equation by the method of dimensions :

$S = ut + \frac{1}{2}at^2$.

where S is the distance covered bu a body in time t, having initial velocity u and acceleration a.

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44. Check the correctness of the equation,

$FS = \frac{1}{2}mv^2 - \frac{1}{2}\mu^2$

where F is the force acting on a body of mass m and S is the distacne moved by the body when its velocity changes from u to v.

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45. Check the correctness of the relation $\pi = I\alpha$ whare π is torque acting on the body, I is moment of inertia and α is angular acceleration.

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46. Check the dimensional consistency of the following equations :

(i) de-Broglie wavelength , $\lambda = \frac{h}{mv}$ (ii) Escape velocity ,$v = \sqrt{\frac{2GM}{R}}$.

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47. 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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48. By the method of dimensions, test the accuracy of the equation : $\delta = \frac{mgl^3}{4bd^3Y}$ where δ is depression in the middle of a bar of length l,

breadth b, depth d, when it is loaded in the middle with mass m. Y is Young's modulus of material of the bar.

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49. The distance covered by a particle in time t is given by $x = a + bt + ct^2 + dt^3$, find the dimensions of a,b,c and d.

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50. Write the dimensions of a/b in the relation $F = a\sqrt{x} + bt^2$ where F is force x is distance and t is time.

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51. Write the dimensions of a and b in the relation $P = \frac{(b-x)^2}{at}$ Where P is power, x is distance and t is time.

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52. In Vander Wall's equation $\left(P+\frac{a}{V^2}\right)(V-b)=RT$ What are the dimensions of a and b ? Here, P is pressure, V is volume, T is temperature and R is gas constant.

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53. When white light travels through glass, the refractive index of glass (μ =velocity of light in air/velocity of light in glass) is found to vary with wavelength as $\mu=A+\frac{B}{\lambda^2}$. Using the principle of homogeneity of dimensions, Find the SI units in which the constants A and B expressed.

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54. Find the dimensions of the quantity v in the equation,

$$v=\frac{\pi p\left(a^2-x^2\right)}{2\eta l}$$

where a is the radius and l is he length of the tube in which the fluid of

coefficient of viscosity η is flowing , x is the distacne from the axis of the tube and p is the pressure differnece.

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55. A particles of mass m moving in a circle of radius r with unform speed v. The force F acting on a particle is proportional to $m^a v^b r^c$. Find the values of a, b and c.

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56. In the equation $y = A\sin(\omega t - kx)$, obtain the dimensional formula of ω and k. Given x is distnace and t is time.

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57. A book with many printing errors contains four different forumlae for the displacement y of a particle undergoing a certain periodic motion : (i)

$y = a\frac{\sin(2\pi t)}{T}$ (ii) $y = a\sin vt$ (iii)$y = \frac{a}{T}\frac{\sin(t)}{a}$ (iv) $y = \frac{a}{\sqrt{2}}\left[\frac{\sin(2\pi t)}{T} + \frac{\cos(2\pi t)}{T}\right]$ Here, a is maximum displacement of particle, v is speed of particle, T is time period of motion. Rule out the wrong forumlae on dimensinal grounds.

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58. A famous relation in phyics relates the moving mass m to the rest mass m_0 of a particle in terms of its speed v and the speed of light c.(This relation first arose as a consequence of the special theory of relativity due to Albert Einstein). A body recalls the relation almost correctly but forgets where to put the constant c . He writes $m = \frac{m_0}{(1 - V^2)^{1/2}}$. Guess where to put the missing c.

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59. A man wlaking briskly in rain with speed v must slant his umbrella forward making an angle θ with the vertical . A student derives the

following relation between θ and v :

$\tan\theta = v$

and checks that the relations has a correct limit : as $v \to 0, \theta \to 0$, as expected . (We are assuming there is no string wing and that the rains falls vertically for a stationary man). Do you think this relation can be correct ? If not, guess at the correct relation .

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60. Derive an expression for time period (t) of a simple penduleum, which may depend upon : mass of bob (m), length of pendulum (I) and acceleration due to gravity(g).

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61. The velocity of water wave v may depend on their wavelength λ, the density of water ρ and the acceleration due to gravity g. The method of dimensions gives the relation between these quantities as

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62. The time period 'T' of a body executing SHM may be supposed to depend upon (i) the amplitude 'A' , (ii) the force constant 'k' and (iii) the mass 'm' . Deduce by the method of dimensions the formula for T.

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63. Assuming that the mass m of the largest stone that can be moved by a flowing river depends upon the velocity v, of water, its density ρ and acceleration due to gravity g, then m is directly proportional to

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64. The velocity of sound waves 'v' through a medium may be assumed to depend on :

(i) the density of the medium 'd' and (ii) the modulus of elasticity 'E' .

Deduce by the method of dimensions the formula for the velocity of sound . Take dimensional constant K=1.

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65. The frequency of vibration (v) of a string may depend upon length (I) of the string, tension (T) in the string and mass per unit length (m) of the string. Using the method of dimensions, derive the formula for v.

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66. A planet moves around the sun in nearly circular orbit. Its period of revolution 'T' depends upon :

(i) radius 'r' or orbit (ii) mass 'M' of the sum and

(iii) the gravitational constant G.

Show dimensionally that $T^2 \propto r^2$.

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67. Reynold number N_R a dimensionless quantity determines the condition of laminar flow of a viscous liquied through a pipe. N_R is a function of density ρ of liquid, average speed v and coeff. Of viscosity η. Given that $N_R \propto D$, diameter of pipe. Show by the method of dimensions that $N_R \propto \frac{\rho v D}{\eta}$

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68. Derive by the method of dimensions, an expression for the volume of a liquid flowing out per second through a narrow pipe. Asssume that the rate of flow of liwquid depends on

(i) the coeffeicient of viscosity η of the liquid

(ii) the radius 'r' of the pipe and

(iii) the pressure gradient $\frac{P}{l}$ along the pipte. Take $K = \frac{\pi}{8}$.

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69. The period of vibration of a tunign fork depends on the length I of its prong, density d and Young's modulus Y of the meterial. Deduce an expression for the period of vibration (T) using dimensional analysis.

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70. The frequency (V) of an oscillating drop may depends upon radius (r) of the drop density (ρ) of liquid and the surface tension (S) of the liquid. Deduce of formula dimensionally.

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71. The rate of volume of flow of water (V) through a canal is found to be a function of the area of cross section A of the canal and velocity of water v. Show that the rate of volume flow is proportional to the velocity of flow of water.

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72. The escape velocity v of a body depends upon the acceleration due to gravity of the planet and the radius of the planet R. Establish dimensionally the relationship between v, g and R.

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73. State the number of significant figures in the following:

(i) 453.5 (ii) 53,000,000 (iii) 400.08

(iv) 0.000243 (v) 0.0650 (vi) 2.43×10^5

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74. State the number of significant figures in the following:

(i) $0.007m^2$ (ii) $2.64 \times 10^{24}kg$ (iii) $0.2370cm^{-3}$

(iv) 6.320J (v)$6.032nM^{-2}$ (vi) 0.0006032

(vii) 2.000m (viii) 5100kg (ix) 0.050cm.

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75. Round off the following numbers as indicated:

(i) 18.35 upto 3 digits (ii) 143.45 upto 4 digits

(iii) 18967 upto 3 digits (iv) 12.653 upto3 digits

(v) 248337 upto 3 digits (vi) 321.135 upto 5 digits

(vii) 101.55×10^{6}upto 4 digits (viii) $31.325 \times x10^{-5}$upto 4 digits.

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76. Add 7.21, 12.41 and 0.0028, and express the result the rsult to an appropriate number of significant figures.

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77. Subtract 4.27153 from 6.807 and express the result to an appropriate number of significant figures.

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78. Subtract $2.5 \times 10^4 \text{from} 3.9 \times 10^5$ with due regard to significant figures.

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79. Subtract $2.5 \times 10^6 \text{from} 4.0 \times 10^4$ with due regard to significant figures.

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80. Express the result of the following calcultaeion to an appropriate number of significant figures:

(i) 943.0.00345 (ii) $\frac{3.24 \times 0.08666}{5.006}$.

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81. Solve the following and express the result to an appropriate number of significant figures:

(i) Add 6.2g, 4.33g, and 17.456g.

(ii) Subtract 63.54kg, from 187.2kg. (iii) 75.5 xx 125.2 xx 0.51.

(iv) $\frac{2.13 \times 24.78}{458.2}$ (v) $\frac{2.51 \times 10^{-4} \times 1.81 \times 10^{7}}{0.4463}$

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82. The mass of a box measured by a grocer's balance is 2.300kg. Two gold pieces of masses 20.15 g and 20.17 g are added to the box. What is (a) the total mass of the box, (b) the difference in the masses of the pieces to correct significant figures?

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83. Each side of a cube is measured to be 6.203m. What is the total surface area and volume of the cube to appropriate significant figures?

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84. The length , breath and thickness of a metal sheet are $4.234m$, $1.005m$, and $2.01cm$ respectively then the volume of the sheet is

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85. The diameter of circle is 1.06m. Calculate the area enclosed by the circle in correct number of significant figures.

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86. The radius of a sphere is 1.41. its volume to an appropring number of significant figure is

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87. The length and the radius of a cylinder measured with a slide cllipers re found to be 4.54 cm and 1.75 cm respectively. Calculate the volume of

the cylinder.

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88. The mass of a body is 275.32g and its volume $is 36.41 cm^3$. Express its density upto appropriate significant figures.

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89. The radius of the earth is $6.37 \times 10^6 m$ and its mass is $5.975 \times 10^{24} kg$. Find the earth's average density to approopriate significant figures.

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90. The length of a rod as measured in an experiment was found to be 2.48m, 2.46 m, 2.49 m, 2.50 m and 2.48m. Find the average length, absolute arror in each observation and the percentage error.

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91. In successive measurement, the reading of the period of oscillation of a simple pendulum were found to be 2.63s, 2.56s, 2.71s and 2.80s in an experiment. Calculate (i) mean value of the period oscillation (ii) absolute errer in each measurement (iii) mean absolute error (iv) releative error (v) percentage error and (vi) express the result in proper form.

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92. In an experiment the refractive index of glass was observed to be $1.45, 1.56, 1.54, 1.44, 1.54, \text{ and } 1.53$. Calculate

(a). Mean value of refractive index

(b). Mean absolute error

(c) Fractional error

(d) Percentage error

(e) Express the result in terms of absolute error and percentage error

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93. Two resistance $R_1 = 100 \pm 3\Omega$ and $R_2 = 200 \pm 4\Omega$ are connected in seriesg. What is their equivalent resistance?

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94. Two differences masses are determined as (23.7 ± 0.5) g and $(17.6 \pm 0.3)g$. What is the sum of their masses?

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95. The initial and final temperatures of a water bath are $(18 \pm 0.5).^\circ C$ and $(40 \pm 0.3).^\circ C$. What is the rise in temperature of the path

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96. A capacitor of capacitance $(2.0 \pm 0.1)\mu F$ is charged to a voltage V= $(2.0 \pm 0.2)\text{volt}$. What will be the charge on the capcitor?

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97. The length and breadth of a rectangular block are 25.2 cm and 16.8 cm, which have both been measurd to an accurancy of 0.1 cm find the area of the rectangular block.

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98. A force of (2500 ± 5)N is applied over an area of $(0.32 \pm 0.02)m^2$ Calculate the pressure exerted over the area.

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99. The resistance $R = \frac{V}{I}$, whereV=$100 \pm 5V$ and $I = 10 \pm 0.2A$. The pressure error in V is 5% and in I is 2%. What is the total percentage error in R?

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100. If the error involved in the measurement of mass and length of one side of a cube are 4% and 3% respectively. What is the maximum permissible relative error in calculation of density of meterail of the cube?

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101. The error in the measurement of radius of a sphere of radius of a sphere is 2%. What would bet the volume of sphere?

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102. The percentage errors in the measurement of mass and speed are 2% and 3%, respectively. How much will be the maximum error in the estimation of KE obtained by measuring mass and speed?

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103. the length, breadth and heigth of a rectangular block of wood wre measured to be :

$l = 12.13 \pm 0.02cm, b = 8.16 \pm .01cm, h = 3.46 \pm 0.01cm$

Determine the percentage error in the volume of the block.

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104. To find the value of 'g' by using a simple pendulum, the following observations were made: Length of the thread, $I = (100 \pm 0.1)cm$ Time period of oscillation, $T = (2 \pm 0.1)s$ Calculate the maximum permissible in measurement of 'g' which quanitiy should be measured more accurately and why ?

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105. A physcial quantity P is realted to four observables a, b, c and d as follows : $P = a^3b^2 / \left(\sqrt{c}d\right)$ 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 calculate using the above relation turns out to be 3.763, to what value should you round off the result ?

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106. In an experiment , the following observations were recorded:

$L = 2.820m, M = 3.00kg, l = 0.087cm, diameter, D = 0.041cm.$

Taking $g = 9.81ms^{-2}$ and using the formula , $Y = \frac{4MgL}{\pi D^2 l}$, find the maximum permissible error in Y.

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107. The specific resistance ρ of a thin wire of radius r cm, resistance R ohm and length L is given by $\rho = \frac{\pi r^2 R}{L}$. $IfL = 78 \pm 0.01cm$ $r = 0.26 \pm 0.02$ and $R = 32 \pm 1\Omega$, What is the percentage error in ρ?

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108. 108 . If two resistors of resistances $R_1 = (4 \pm 0.5)\Omega$ and $R_2 = (16 \pm 0.5)\Omega$ are connected (i) in series and (ii) in parallel, find the equivalent resistance in each case with limits of percentage error.

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Problem

1. if the velocity of light c, the constant of gravitation G and plank,s constant h be chosen os fundamentad units , find the dimensions of mass

, length and time in terms of c , G and h.

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2. The velocity of a freely falling body changes as $g^p h^q$where g is acceleration due to gravity and h is the height. The values of p and q are

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3. A gas bubble , from an explosion under water , oscillates with a period T proportional in $P^a D^b E^c$, where p is the static pressure , d is the density of water and E is the total energy of the explosion . Find the value of$a$, b and$c$.

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4. A small steel ball of radius r is allowed to fall under gravity through a column of a viscous liquid of coefficient of viscosity η. After some time the

velocity of the ball attains a constant value known as terminal velocity v_T. The terminal velocity depends on (i) the mass of the ball m (ii) η, (iii) r and (iv) acceleration due to gravity g . Which of the following relations is dimensionally correct?

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5. Derive dimensionally the relation :$S = ut + \frac{1}{2}at^2$.

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6. Assuming that the vibration frequency v of atoms in a crystal depends on the atomic mass m , the atomic spacing α and compressibilty β, find an expression for frequency.

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7. The pressure on a square plate is measured by measuring the force on the plate and the length of the sides of the plate . If the maximum error in the measurement of force and length are , respectively , 4% and 2%. Find the maximum error in the measurement of pressure.

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8. An experiment measures quantites a, b, c and X is calculated from the formula

$$X = \frac{ab^2}{c^3}$$

If the percentage errors in a, b, c are $\pm 1\%$, $\pm 3\%$, $\pm 2\%$ respectively, the perentage error in X can be

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9. The specific heats of a gas are measured as $C_p = (12.28 \pm 0.2)$ units and C_(upsilon =(3.97 +- 03)` units. Find the value of gas constant R and percentage error in R.

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10. The heat generated in a circuit is given by $Q = I^2Rt$, where I is current , R is resistance , and t is time . If the percentage errors in measuring $I, R,$ and $tare 2\%, 1\%,$ and 1% , respectively , then the maximum error in measuring heat will be

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Problem For Self Practice

1. Write the order of magnitude of the following :

(i) 8 (ii) 49 (iii)52 (iv) 999 (v) 1001 (vi) 753000 (vii) 0.05 (viii) 0.99

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2. What is one astronomical unit ? Express it in metres . Write its order og magnitude .

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3. What is the order of magnitude of second in a day ?

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4. IF the size of an atom (= 1Å) were enlarged to the tip of a sharp pin $\left(\cong 10^{-5} m \right)$, how large would the height of mout everest $\left(\cong 10^{4} m \right)$ be?

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5. If an atom of size 10^{-10}m were enlarged to the size of the earth $\left(\cong 10^{7} m \right)$, how large would its nucleus be ? Take size of nucleus

$= 10^{-14}$m.

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6. if the universe were shrunk to the size, of earth, how large would the earth be on this scale?

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7. A 35 mm wide slide with 24 mm $\times$ 36 mm picture is projected ona screen placed 12 cm from the slide. The image of the slide picture on the screen measures $1.0m \times 1.5m$. What is the linear magnification of the arrangement ?

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8. In a submarine fitted with a SONAR, the time between the genretaion of an ultrasonicwave and the reciept of its echo is 200 s. What is the

dsistance of the enemy sun=bmrine ? The speed of the sound in water is $1.450 kms^{-1}$

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9. A radar signal is beamed towards a planet and its echo is recived 7 minutes later. If the distance between the planet and earth is $6.3 \times 10^{10} m,$ calculate the speed of the signal.

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10. A rock under water is 1595 m deep. Find the time in which an ultrasonic signal returns after reflection from the rock. Speed of ultrasonic waves in water = $1450 m / s.$

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11. The angle of elevation of the top of a hill is 30° from a point on the ground. On walking 1 km towards the hill, angle is found to be 45°. Calculate the height of the hill.

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12. Find the distance of the moon from the earth if the parralrtic angle as measured from two places locaterd 6.4×10^6m apart is 1°.

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13. The parallex of a heavenly body measured ffrom two points diametrically opposite on equater of earth is 1.0 minutes. If the radius of the earth is 6400 m, find the distance of the heavenly body from the centre of the earth in AU. Given $1AU = 1.5 \times 10^{11}$m.

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14. The angular diameter of the sun is 1920". If the distance of the sun from the earth is 1.5×10^{11}m, what is the linear diameter of the sun ?

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15. The moon is observed from two diametrically opposite points A and B on earth. The angle θ substended at the moon by the two directions of observation is $1^{\circ}54'$. Given the diameter of earth to be about $1.276 \times 10^{7}m$, calculate the distance of moon from earth.

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16. The radius of a muonic hydrogen atom is $2.5 \times 10^{-13}m$. What is the total atomic volume in m^3 of a mole of such hydrogen atom.

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17. A drop of olive oil of radius 0.3 mm spreads into a rectangular film of $30cm \times 15cm$ on the water surface. Calculate the size of the oil molecule.

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18. Consider a white dwarf and a nutron star beach of one solar mass. The radius of the white dwarf is same as that of the eartyh (=6400km) and the radius of the neutron star is 10 km. Determine the densities of the two types of the stars. Take mass of the sun $= 2.0 \times 10^{30}$kg.

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19. A neutron star has a density equal to that of nuclear matter $\left(\cong 2.8X0^{17} kgm^{-3} \right)$. Assuming the star to be spherical, find the radius of the neutron star whose mass is $4.0X10^{30} kg$.

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20. Assume that trhe mass of the nucleus is given by M=Am_p, where A in the mass number and radius of a nuclear r=$r_0A^{1/3}$, where r_0=1.2 f. Estimate the density of the nuclear matter in kg m^{-3}. Given $m_p = 1.67 \times 10^{-27}$kg.

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21. Find the number of seconds in 1 year. Express them in order magnitude.

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22. Human heart beats one in 0.8s. Calculate how many times the human heart beats in the life of a person of 60 years.

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23. Two atomic clocks allowend to run for a average life of an indian (say 70 years) differ by 0.2 s only. Calculate the accuracy of standard atomic clock in measuring a time interval of 1 sec.

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24. If two celsium clocks differ only by 0.02 s in 200 yaers, what is the accuracy of cesium clock in measuring time intervals ?

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25. Age of the universe is about 10^{10} years whereas the mankind has existed for 10^{6} years. How many seconds would the man have existed if age of universe were one day.

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26. Deduce dimensional formulae for (i) angle (ii) angular velocity (iii) angular acceleration (iv) torque (v) angukar momentum and (vi) moment of inertia.

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27. Obtain dimensions of (i) impulse (ii) power (iii) surface energy (iv) cofficent of viscecity (v) bulk modules (vi) force constant.

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28. By the use of dimensions, show that energy per unit volume is equal to pressure.

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29. Show that angular momentum has the same dimensions as the Planck's constant.

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30. If force (F), length(L) and time (T) as chosen as the fundamental quantities, then what would be the dimensional formula for the density?

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31. Calculate the dimensions of ther force and impulse taking velocity, density and frequency as basic quantities.

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32. Calculate the dimensions of linear momentum and surface tension in terms of velocity (v), density (ρ) and frequency (V) as fundamental

units.

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33. If $E, M, J,$ and G , respectively , denote energy , mass , angular momentum , and gravitational constant , then EJ^2/M^5G^2 has the dimensions of

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34. If 'slap' times speed equals power, what is the dimensional formula for 'slap' ?

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35. By the method of dimensions, show that $1N = 10^5$ dynes .

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36. The value of acceleration due to gravity at a place is $9.8ms^{-2}$. Find its value in kmh^{-2}

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

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38. A body has a uniform acceleration of 5 kmh^{-2}. Express it in CGS units.

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39. The density of mercury is 13.6 g cm^{-3} in CGS system. Find its value in SI units.

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40. The surface tension of water is 72 dyne/cm. Express is in SI units.

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41. An electriv bulb has a power of 500 W. Express it in CGS units.

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42. If the value of atmospheric pressure is 10^6 dyne cm^{-2}, find its value in SI units.

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43. The value of Stefan's constant is $\sigma = 5.76 \times 10^{-8} Js^{-1} m^{-2} K^{-4}$. Find its value in cgs system.

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44. Find the value of 100 J on a system which has 20 cm, 250g and half minute as fundamental units of length, mass and time.

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45. If the unit of force energy and velocity are 20 N, 200J and 5m//s, find the units of mass, length and time.

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46. When 1m, 1kg and 1min. Are taken as the fundamental units, the magnitude of force is 36 units. What will be the value of this force is CGS system?

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47. If the units of length and force be increased three times, show that the unit pof energy is increased by 9 times.

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48. If velocity of light is taken as the unit of velocity and an year is taken as the unit of time, what is the unit of length? What is it called?

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49. Test the dimensional consistency of the following equations :

$(i) v = u + at \qquad (ii) v^2 = u^2 + 2as \qquad (iii) E = mc^2 \qquad (iv) \frac{1}{2}mv^2 =$

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50. Use principle of homogenity of dimensions to find which one of the following relations is correct : (i) $T^2 = 4\pi^2 r^2$

(ii) $T^2 = \frac{4\pi^2 r^3}{G}$

(iii) $T^2 = \frac{4\pi^2 r^3}{GM}$

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51. A student conclude that the velocity v of a body falling freely under gravity from a height is equal to $\sqrt{gh}$. Using the method of dimensions, verify whether his coclusion is correct.

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52. The viscous force 'F' acting on a small sphere of rtadius 'r' moving with velocity v through the liquid is gib=ven by F= $6\pi nrv$. Calculate the dimensions of n , the cofficent of viscosity.

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53. The dimensions of $'k'$ in the relation $V = k$ avt (where V is the volume of a liquid passing through any point in time t, $'a'$ is area of cross section, v is the velocity of the liquid) is

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54. The cirtical velocity (v) of flow of a liquied through a pipe of radius (r) is given by $v = \frac{\eta}{\rho r}$ where ρ is density of liquid and η is coefficient of visocity of the liquied. Check if the relaiton is correct dimensinally.

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55. The rate of flow (V) of a liquid flowing through a pipe of radius r and pressure gradient (P/l) is given by Poiseuille's equation$V = \frac{\pi}{8}\frac{Pr^4}{\eta I}$ Chack the dimensional correctness of this relation.

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56. Test if the following equations are dimensionally correct: (a) $h = \frac{2S\cos\theta}{\rho r g}$ (b) $\nu = \sqrt{\frac{P}{\rho}}$, (c) $V = \frac{\pi P r^4 t}{8\eta l}$, (d) $v = \frac{1}{2\pi}\frac{\sqrt{mgl}}{I}$ where h = height, S= surface tension, ρ= density, P= pressure, V=volume, η = coefficient of viscosity, v= frequency and I = moment of inertia.

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57. The time period of a compound pendulum is given by

$$T = 2\pi\sqrt{\frac{I}{mgl}}$$

where I=moment of inertia about the centre of the suspension, g=acceleration due to gravity , m=mass of the pendulam l=distance of the centre of the gravity from the centre of the susp

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58. Find the dimensions of the quantity q from the expression $T = 2\pi\sqrt{\frac{ml^3}{3Yq}}$, where T is time period of a bar of length l, mass m and Young's modulus Y.

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59. An artificial satellite of mass m is revolving in a circualr orbit around a planet of mass M and radius R. If the radius of the orbit of satellite be r, then period of satellite is

$$T = \frac{2\pi}{R}\sqrt{\frac{r^3}{g}}$$

Justify the relation using the method of dimensions.

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60. Check by the method of dimensions, the formula $v = \frac{1}{\lambda}\sqrt{\frac{K}{d}}$, where v is velocity of longitudinal waves, λ is wavelength of wave, K is coefficient of volume elasticity and d is density of the medium.

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61. Check the correctness of the equation : $y = a\sin(\omega t + \phi)$, where y = displacement , a = amplitude , ω = angular frequency and ϕ is an angle .

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62. Find the dimension of (a/b) in the equation : v = a + bt , where v is velocity and t is time

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63. Write the dimensions of $a \times b$in the relation $E = \frac{b - x^2}{at}$, where E is the energy , x is the displacement , and t is the time.

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64. The dimension of $\frac{a}{b}$ in the equation $p = \frac{a - t^{-2}}{bx}$ where P is pressure, x is distance and t is time are ----------?

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Based On Deriving Relationship

1. The wavelength λ associated with a moving electron depends on its mass m , its velocity v and Planck's constant h . Prove dimensionally that $\lambda \propto \frac{h}{mv}$.

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2. Obtain an expression for the centripetal force F acting on a particle of mass m moving with velocity v in a circle of radius r . Take dimensionless constant K = 1 .

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3. The orbital velocity v of a satellite may depend on its mass m , the distane r from the centre of the earth and acceleration due to gravity g .

Obtain an expression for its orbital velocity .

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4. A small spherical ball of radius r falls with velocity v through a liquid having coeffiecinet of viscosity η. find viscous darg F on the wall if it depends or r, v, η. $TakeK = 6\pi$

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5. The velocity of a freely falling body is a function of the distance fallen through (h) and acceleration due to gravity g . Show by the method of dimensions that $v = K\sqrt{gh}$.

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6. Using the method of dimensions , derive an expressions for the energy of a body executing SHM , assuming this energy depends upon its mass m

, frequency v and amplitude of vibration r .

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7. A body of mass m hung at one end of the spring executes simple harmonic motion . The force constant of a spring is k while its period of vibration is T. Prove by dimensional method that the equation $T = 2\pi m / k$ is correct. Dervive the correct equation , assuming that they are related by a power law.

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8. 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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9. By the method of dimensions, obtain an expression for the surface tension S of a liquid rising in a capillary tube. Assume that S depends on mass m of liquied, Pressure p of liquid and radius r of the capillary tube. Take $K = 1/2$.

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10. The depth x to which a bullet penetrates a human body depends on (i) coeffeicint of elasticity, η and (ii) KE (E_k) of the bullet, By the method of dimensions, show that

$$x \propto \left(\frac{E_k}{\eta}\right)^{1/3}$$

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11. A U - tube of uniform cross section contains mercury upto a height h in either limb. The mercury in one limbe is depressed a little and then

relased. Obtain an expression for time period (T) of oscillation, assuming that T depends on h,ρ and g, where ρ is density of mercury.

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12. The cirtical angular velocity ω_c of a cylinder inside another cylinder containing a liquied at which its turbulance occurs depends on visocisity η density ρ and disntac d between wall of the cylinder. Obtain an expression for ω_c using method of dimensios.

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Based On Significant

1. Statement the number of significant figures in the following

(i)

$2.653 \times 10^4 \quad (ii) 0.00368 \quad (iii) 653 \quad (iv) 0.368 \quad (v) 0.0300 \quad (vi) 876.00$

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2. State the number of significant figures in the following measurements :

(i)

$0.009m^2 \quad (ii)5.049Nm^{-2} \quad (iii)0.1890gcm^{-3} \quad (iv)1.90 \times 10^{11}kg \quad (v)$

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3. Round off the following numbers as indicated :

(i) 15.654 upto 3 digits $\quad (ii)15.\ 75$ upto 3 digits $\quad (iii)15.654$ upto 4 digits $\quad (iv)15.65$ upto 3 digits (v) 142667 upto 5 digits (vi) 5.996×10^5 upto 3 digits . (vii) 0.7995 upto 1 digit (viii) 2.5946×10^{-4} upto 2 digits .

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4. Solve the following to the appropriate number of significant figures :

(i) $0.58 + 324.65$

(ii) 3.124×4.576

(iii) $\dfrac{324 \times 0.08666}{5.006}$

$$\frac{1.35 \times 10^{-6} \times 0.4}{5.6}$$

(v) $\frac{2.03 \times 10^{-5} \times 3.5 \times 10^{-7}}{0.6423}$

(vi) $\sqrt{3.5 - 3.31}$

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5. (a).Add $3.8 \times 10^{-6} \rightarrow 4.2 \times 10^{-5}$ with due regard to significant figures.

(b). Subtract $3.2 \times 10^{-6} om 4.7 \times 10^{-4}$ with regard to significant figures.

(c). Subtract $1.5 \times 10^{3} om 4.8 \times 10^{4}$ with due regard to significant figures.

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6. (a).Add $3.8 \times 10^{-6} \rightarrow 4.2 \times 10^{-5}$ with due regard to significant figures.

(b). Subtract $3.2 \times 10^{-6} om 4.7 \times 10^{-4}$ with regard to significant figures.

(c). Subtract $1.5 \times 10^3 om 4.8 \times 10^4$ with due regard to significant figures.

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7. A jewaller puts a diamond weighing 5.42g in a box weighing 1.2kg. Find the total weight of the box and the diamond to correct number of significant figures.

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8. The mass of a box measured by a grocer's balance is 4.2 kg . Two additional masses 10.20 g and 15.25 g are added to the box . What is the total mass of the box ?

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9. The length , breadth and thickness of a metal block are $4.327m, 2.825m$ and 4.32 cm respectively . Calculate its (i) surface area and (ii) volume and express the results to an appropriate number of significant figures .

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10. The diameter of a circle is 2.486 m. Calculate the area with due regard to significant figures.

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11. The diameter of a sphere is 4.24 m . Calculate its surface area with due regard to significant figures .

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12. The diameter of a sphere is 2.78 m . Calculate its volume with due regard to significant figures .

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13. Each side of a cube is measured to be 7.203 m . What is (i) the total surface area and (ii) the volume of the cube to appropriate significant figures ?

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14. A thin wire has a length of 21.7 cm and radius 0.46 mm. Calculate the volume of the wire to correct significant figures.

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15. A substance weight 5.74 g occupies a volume of $1.2cm^3$. Caluclate its density with due regard to significant digits.

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Based On Errors In Measurements

1. The diameter of a wire as measured by a screw gauge was found to be 0.026 cm, 0.028 cm, 0.029 cm, 0.027cm, 0.024cm and 0.027 cm. Calculate

(i) mean value of diameter

(ii) mean absoulte error

(iii) relative error (iv) percentage error. Also express the result in terms of absolute error and percentage error.

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2. The refractive index of water as measured by the relation $\mu = \frac{\text{Real depth}}{\text{Apparent depth}}$ was found to have the values $1.29, 1.33, 1.34, 1.35, 1.32, 1.36, 1.30, 1.33.$

Calculate (i) mean value of μ (ii) mean value of absolute error (iii) relative error (iv) percentage error .

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3. In an experiment to measure focal length of a concave mirror , the value of focal length in successive observations turns out to be 17.3 cm , 17.8 cm , 18.3 cm , 18.2 cm , 17.9 cm and 18.0 cm . Calculate the mean absolute error and percentage error . Express the result in a proper way .

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Based On Combination

1. The length of two rods are recorded as $l_1 = (25.2 \pm 0.1)$ cm and $l_2 = (16.8 \pm 0.1)$ cm . Find their combined length .

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2. Two resistance $(200 \pm 4)\Omega$ and $(150 \pm 3)\Omega$ are connected in series . What is their equivalent resistance ?

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3. The initial and final temperature of water were recorded as $(56.3 \pm 0.4)^\circ C$ and $(27.5 + 0.3)^\circ C$. Determine the fall in the temperature of water .

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4. If $l_1 = (10.0 \pm 0.1)$ cm and $l_2 = (9.0 \pm 0.1)$ cm , find the their sum , difference and error in each .

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5. A capacitor $C = (2.0 \pm 0.1)\mu F$ is charged to a voltage $V = (20 \pm 0.5)$ volt. Calculate the charge Q with error limits.

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6. The resistance R of a conductor is defind as the ratio of the potential difference applied across it to the current flowing through ti . If V = $(100 \pm 5)V$ and I = $(5 + 0.1)$ A , what is the percentage error in R ?

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7. The relative density of a material is found by weighing the body first in air and then in water . If the weight in air is $(10.0 \pm 0.1)gf$ and the weight in water is $(5.0 \pm 0.1)gf$, then the maximum permissible percentage error in relative density is

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8. The length and breadth of a rectangular block are 25.2 cm and 16.8 cm, which have both been measurd to an accurancy of 0.1 cm find the area of the rectangular block.

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9. While measuring the volume of a sphere , an error of 1.2% is commited in the measurement of radius . What percent error is introduced in the measurement of its volume ?

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10. The voltage across a lamp is $(6.0 \pm 0.1)V$ and the current passing through it is (4.0 ± 0.2) ampare. Find the power consumed by the lamp.

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11. The radius of a sphere is measured to be (2.1 ± 0.5) cm. Calculate its surface area with error limits .

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12. The radius of a sphere is (5.3 ± 0.1)cm` The perecentage error in its volume is

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13. The measure of the diameter of a cylinder is (1.60 ± 0.01) cm and its length is (5.0 ± 0.1) cm . Calculate the percentage error in its volume .

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14. The measured mass and volume of a body are 2.00 g and $5.0cm^3$ respectively . With possible errors of 0.01 g and $0.1cm^3$, what would be the percent error in density ?

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15. Two resistance R_1 and R_2 are connected in (i) series and (ii) parallel. What is the equivalent resistance with limit of possible percentage error in each case of $R_1 = 5.0 \pm 0.2\Omega$ and $R_2 = 10.0 \pm 0.1\Omega$

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16. A body travels uniformly a distance of $(13.8 \pm 0.2)m$ in a time $(4.0 \pm 0.3)s$. Find the velocity of the body within error limits and the percentage error.

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17. The centripetal force acting on a body of mass m moving with speed v along a circular path of radius r is given by

$$F = \frac{mv^2}{r}$$

If the values of m , v and r are measured as 0.5 kg , $10ms^{-1}$ and 0.4 m respectively to the accuracies of 0.005 kg , $0.01ms^{-1}$ and 0.01 m respectively , calculate the percentage error in the force acting on the body.

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18. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. L is about $10cm$ and is known to $1mm$ accuracy . The period of oscillation is about $0.5s$. The time of 100 oscillation is measured with a wrist watch of $1s$ resolution . What is the accuracy in the determination of g ?

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19. Calculate the percentage error in specific resistance , $\rho = \pi r^2 R/l$, where r = radius of wire $= 0.26 \pm 0.02cm$, l = length of wire $= 156.0 \pm 0.1cm$, and R = resistance of wire $= 64 \pm 2\Omega$.

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20. The Young's modulus Y is determined by stretching a wire by using the formula ,

$$Y = \frac{4FL}{\pi d^2 l}$$

where F is the streching force , L is length of wire , l is extension in length and d is its diameter . If F is of the order of 500 N and known to 1 part in 1000 L , is of the order of 3 m and measured with an accuracy of 1 mm , l is of the order of 5 mm measured to 0.1 mm and d is of the order of 1 mm measured correct upto 0.01 mm , estimate the percentage error in the measurement of Y .

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21. A physical quantify X is related to three observations a , b, c as $X = \sqrt{a}b^2 / c^2$. The errors of measurement in a ,b and c are 2% , 1% and 3% respectively . What is the percentage error in the quantity X ?

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