Physics

Academic

Units and Measurements

Q1. How many par sec are there in one light year?

Q2. The mass of a proton is 1.67×10^{-27} kg. How many protons would make 1 gram?

Q3. Calculate the angle of (a) 1^o (degree) (b) 1' (minute of arc or arc min) and (c) 1" (second of arc or arc sec) in radian. Use $360^o = 2\ \pi$ rad., 1o = 60' and 1' = 60".

Q4. The mass of an electron is 9.11×10^{-31} kg. How many electrons would make 1 kg?

Q5. Express the average distance of earth from the sun in (i) light year (ii) par sec.

Q6. Fill in the blanks :

i) The density of a material is 0.8 g cm^{-3}. Its value in SI unit is _____.

ii) The Young's modulus of steel is 1.9×10^{11} N/m^2. Its value in CGS unit is _____.

Q7. Fill in the blanks :

i) The volume of a cube of side 10 cm is m^3.

ii) A vehicle moving with a speed of 36 km h^{-1} covers ____ m in 1 sec.

iii) The density of water of 4^oC is _____ g/cc or ____ kg/m^-.

Q8. It is estimated that per minute, each cm^2 of earth receives about 2 calories of heat energy from the sun. This constant is called solar constant S. Express solar constant in SI units.

Q9. The average distance from the earth to the sun is 1.49×10^{11} m. Find out the value of 1 par second in metre.

Q10. Express 1 light year in terms of metre. What is its order of magnitude?

Q11. The moon is observed from two diametrically opposite points A and B on earth. The angle θ subtended at the moon by the two directions of observation is 1^o 54'. Given the diameter of earth to be about 1.276×10^7 m, calculate the distance of moon from earth.

Q12. The sun's angular diameter is measured to be 1920". The distance of the sun from the earth is 1.496×10^{11} m. What is the diameter of the sun?

Q13. The distance of the sun from earth is 1.296×10^{11} m. If the angular diameter of the sun is 2000", find the diameter of the sun.

Q14. A man wishes to estimate the distance of a nearby tower from him. He stands at a point A in front of the C and spots a very distant object O in the line with AC. He then walks perpendicular to AC upto B, a distance of 100 m and looks at O and C again. Since O is very distant, the direction of BO is practically the same as AO, but he finds the line of sight of C shifted from the original line of sight by an angle $\theta = 40^o$ (θ is known as parallax). Estimate the distance of the tower C from his original position A.

Q15. The shadow of a tower standing on a level plane is found to be 50 m longer when sun's altitude is 30^o than when it is 60^o. Find the height of the tower.

Q16. 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.

Q17. Suppose there existed a planet that went around the sun twice as fast as the earth. What would be its orbital size?

Q18. A drop of olive oil of radius 0.25 mm spreads into a circular film of radius 10 cm on the waer surface. Estimate the size of molecule of oleic acid.

Q19. The radius of a muonic hydrogen atom is 2.5×10^{-13} m. What is the total atomic volume in m^3 of a mole of such hydrogen atom.

Q20. Age of the universe is about 10^{10} years whereas the man kind has existed for 10^6 years. How many seconds would the man have existed if age of universe were one day.

Q21. The atomic clocks allowed to run for 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.

Q22. The mean life of an elementary particle pion is 2 x 10^{-7} ns. The age of the universe is about 4 x 10^{9} years. Identify a physically meaning time what is approximately half way between these two on a logarithmic scale.

Q23. A 35 mm wide slide with 24 mm x 36 mm picture is projected on a screen placed 12 cm from the slide. The image of the slide picture on the screen measures 1.0 m x 1.5 m. What is the linear magnification of the arrangement?

Q24. If the size of a nucleus (=10^{-15} m) is scaled upto the tip of a sharp pin (=10^{-5} m), what roughly is the size of an atom?

Q25. If the universe were shrunk to the size of earth, how large would the earth be on this scale?

Q26. Ten drops of olive oil of radius 0.20 mm spread into a circular film of radius 14.6 cm, on the surface of water. Estimate the size of an oil molecule.

Q27. Convert an energy of one joule into ergs.

Q28. Find the value of 60 J per min on a system that has 100 g, 100 cm and 1 min, as the base units.

Q29. If the unit of force, energy and velocity are 20 N, 200 J and 5 m/s, find the units of mass, length and time.

Q30. In a new system of units called star units, 1 kg* = 10 kg ; 1 m* = 1 km and 1 s* = 1 minute, what will be the value of 1 J of energy in the new system?

Q31. Out of the formulae y = a sin $2\pi t/T$ and y = a sin νt for the displacement y of particle undergoing a periodic motion, rule out the wrong formula on the basis of dimensions symbols have standard meaning.

Q32. Time period of oscillating drop of radius r, density p and surface tension is $t = K\sqrt{\frac{\rho r^3}{S}}$. Check the correctness of the relation.

Q33. Check the correctness of the relation $v = \frac{\pi p(a^2 - x^2)}{2\eta l}$.

Where v is velocity, p is pressure difference, a is radius of tube, x is distance from the axis of tube, n is coeff, of viscosity and l is length of the tube.

Q34. By the method of dimension, 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.

Q35. Check the correctness of the relation, $S_{nth} = u + \frac{a}{2}(2n-1)$ where u is initial velocity, a is acceleration and S_{nth} is the distance travelled by the body in nth second.

Q36. Let us consider an equation $\frac{1}{2}mv^2 = mgh$, where m is the mass of the body, v its velocity, g is acceleration due to gravity and h is the height. Check whether this equation is dimensionally correct.

Q37. The SI unit of energy us J = kg m^2 s^{-2}, that of speed v is ms-1 and of acceleration a is ms^{-2}. Which of the formulae for kinetic energy (K) given below can you rule out on the basis of dimensional arguments (m stands for the mass of the body).

a) $K = m^2 v^3$ b) $K = \frac{1}{2}mv^2$ c) K = ma d) $K = \frac{3}{16}mv^2$ d) $K = \frac{1}{2}mv^2 + ma$

Q38. Find the dimensions of the quantity q from the expression: $T = 2\pi\sqrt{\frac{ml^3q}{5Y}}$ where T is time period of bar of length l, mass m and Young's modulus Y.

Q39. The refractive index μ of a medium is found to vary with wavelength λ as $\mu = A + \frac{B}{\gamma^2}$. What are the dimensions of A and B?

Q40. Check the dimensional consistency of the following equations :

a) v = u + at b) $s = ut + \frac{1}{2}at^2$ iii) v2 – u2 = 2as

Q41. Find the dimensions of a/b in the relation. $P = ax + bt^2$, where P is pressure, x is distance and t is time.

Q42. 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.

Q43. 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.

Q44. Find the dimensions of a/b in the relation $P = \frac{a - x^2}{bt}$, where x is distance, t is time and P is pressure.

Q45. Find the dimensions of $\frac{a\,x\,b}{c}$ in the relation y = 4 at + 3 cos bt – ct where t is time and y is distance.

Q46. The velocity v of water waves depends on the wavelength λ, density of water p and acceleration due to gravity g. Establish dimensionally the relation between these quantities.

Q47. The period of revolution (T) of a planet around the sun depends upon (i) radius ® of obit (ii) mass M of the sun and (iii) gravitational constant G. Prove that $T2 \propto r^3$.

Q48. By the method of dimension, obtain an expression for the surface tension S of a liquid rising in a capillary tubne. Assume that S depends on mass m of liquid, pressure p of liquid and radius r of the capillary tube. Take K = ½.

Q49. The frequency of vibration (v) of a string may depend upon length (l) 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.

Q50. The velocity of sound (v) in a gas depends upon coefficient of volume elasticity E of the gas and density d of the gas. Use method of dimensions to derive the formula for v.

Q51. The period of the vibration of a tuning fork depends on length (l) of its prongs, density d and Young's modulus (Y) of its material. Determine an expression for period of vibrating using the method of dimensions.

Q52. Consider a simple pendulum having a bob attached to a string that oscillates under the action of a force of gravity. Suppose that the period of oscillation of the simple pendulum depends on its length (l), mass of the bob (m) and acc, due to gravity (g), Derive the expression for its time period using method of dimensions.

Q53. Show dimensionally that the relation $t = 2\pi\left(\frac{1}{g}\right)$ is incorrect, where l is length and t is time period of a simple pendulum; g is acc, due to gravity. Find correct form of the relation, dimensionally.

Q54. The heat produced in a wire carrying an electric current depends on the current the resistance and the time. Assuming that the dependence is of the product of powers type, guess an eqn. betweens these quantities using dimensional analysis. The dimensional formula of resistance is $ML^2 A^{-2} T^{-3}$ and heat is a form of energy.

Q55. 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.

Q56. An artificial satellite of mass m is revolving in a circular 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.

Q57. The diameter of a wire as measured by a screw gauge was found to be 1.328, 1.330, 1.325, 1.334 and 1.336 cm. Calculate i) mean value of diameter ii) absolute error in each measurement iii) mean absolute error iv) fractional error, v) percentage error. Also, express the result in term sof absolute error and percentage error.

Q58. The sides of a rectangle are (10.5 ± 0.2) cm and (5.2 ± 0.1) cm. Calculate its perimeter with error limits.

Q59. We measure the period of oscillation of a simple pendulum. In successive measurements, the readings turn out to be 2.63 s, 2.56 s, 2.42 s, 2.71 s and 2.80 s. Calculate the absolute errors, relative error and percentage error.

Q60. The temperature of two bodies measured by a thermometer are : $t_1 = 20^oC \pm 0.5^o$ C and $t_2 = 50^oC \pm 0.5^oC$. Calculate the temperature difference and the error there in.