(B) CONCEPTUAL QUESTIONS

C1. What is a physical quantity? Give example.

C2. What is a unit? Give example.

C3. What are fundamental or base quantities? How many of these are known? Write their names?

C4.What are fundamental or base units? How many fundamental units are known? Write the names of these base units.

C5. What is the necessity of selecting some base quantities and units?

C6. What are derived quantities? Give example.

C7. What are derived units? Give example.

C8. What is a system of units? Give example.

C9. What are SI units? Write names of all the base units, and five derived units along with the names of the physical quantities to which they are associated. What are the advantages of adopting this system?

C10. Define (a) plane angle and (b) solid angle. What are their units?

C11. Write a relationship between numerical measure (n) of a physical quantity and the size of the unit (u).

C12. Does the (i) numerical measure change , (ii) magnitude of physical quantity change, when unit is changed?

C13. Define the unit metre in SI system.

C14. Define the unit kilogram in SI system.

C15. Define the unit second in SI system.

C16. Define the unit kelvin in SI system.

C17. Define the unit mol in SI system.

C18. Why do we have different units for the same physical quantity but lying in a wide range? Illustrate your answer by example.

C19. Why length, mass and time are chosen as base quantities in mechanics?

C20. Give an example of (a) a constant which has a unit, (b) a constant which has no unit.

C21. Is there any natural law which dictates that the fundamental physical quantities in mechanics must be length, mass and time? If yes, state that law, if no, write alternative possible set of fundamental quantities.

C22. Write SI units of the physical quantities (i) speed, (ii) angular acceleration, (iii) torque, (iv) momentum.

C23. Write the special name (and symbol) assigned to the derived units of the following physical quantities: (i) force, (ii) energy, (iii) electric potential difference, (iv) pressure, (v) resistance, (vi) solid angle, (vii)

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charge, (viii) frequency, (ix) power.

C24. Explain this statement clearly : "To call a dimensional quantity 'large' or 'small' is meaningless without specifying a standard for comparison". In view of this, re-frame the following statements wherever necessary :
(a) atoms are very small objects
(b) a jet plane moves with great speed
(c) the mass of Jupiter is very large
(d) the air inside this room contains a large number of molecules
(e) a proton is much more massive than an electron
(f) the speed of sound is much smaller than the speed of light.

C25. Explain this common observation clearly : If you look out of the window of a fast moving train, the nearby trees, houses etc. seem to move rapidly in a direction opposite to the train's motion, but the distant objects (hill tops, the Moon, the stars etc.) seem to be stationary. (In fact, since you are aware that you are moving, these distant objects seem to move with you).

C26. Which of the following are not a unit of time?
(a) Second
(b) Parsec
(c) Year
(d) Light year

C27. Why do we have different units for the same physical quantity?

C28. The radius of atom is of the order of 1 Å and radius of nucleus is of the order of fermi. How many magnitudes higher is the volume of atom as compared to the volume of nucleus?

C29. Calculate the length of the arc of a circle of radius 31.0 cm which subtends an angle of $\pi/6$ at the centre.

C30. Calculate the solid angle subtended by the periphery of an area of $1cm^2$ at a point situated symmetrically at a distance of 5 cm from the area.

C31. Express unified atomic mass unit in kg.

C32. Why length, mass and time are chosen as base quantities in mechanics?

C33. A new system of units is proposed in which unit of mass is α kg, unit of length β m and unit of time γ s. How much will 5 J measure in this new system?

C34. Name the device used for measuring the mass of atoms and molecules.

C35. What is parallax?

C36. Describe the method of parallax for measuring distance of a far away planet.

C37. How will you estimate diameter of a far away planet?

C38. Describe a procedure that you will adopt to estimate the molecular size of oleic acid

C39. The distance of a galaxy is of the order of 10^{25} m. Calculate the order of magnitude of time taken by

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light to reach us from the galaxy.

C40. Which of the following time measuring devices is most precise?

(a) A wall clock.

(b) A stop watch.

(c) A digital watch.

(d) An atomic clock.

Give reason for your answer.

C41. Define (i) error, (ii) mean absolute error, (iii) relative error and (iv) percentage error.

C42. What are systematic errors? What are the sources of systematic error?

C43. What are (i) random errors, and (ii) least count errors?

C44. How can systematic errors be eliminated?

C45. How can random errors be reduced?

C46. Write the rules for combination of error for (I) sum or difference, and (II) product or division of measured quantities

C47. Let the measured values (with absolute errors) of physical quantities A, B and C are $A \pm \Delta A$, $B \pm \Delta B$ and $C \pm \Delta C$. Suppose

$$Z = \frac{A^p B^q}{C^r} .$$

What is the relative error in Z?

C48. The number of significant figures in 0.03900 is

(a) 2

(b) 3

(c) 4

(d) 5

C49. State the number of significant figures in the following :

(a) 0.005 m^2

(b) 3.34×10^{24} kg

(c) 0.1170 g cm^{-3}

(d) 3.620 J

(e) 6.002 N m^{-2}

(f) 0.00050032 km^2

C50. The sum of the numbers 421.22, 217.2 and 0.302 in appropriate significant figures is

(a) 638.722

(b) 638.72

(c) 638.7

(d) 669

C51. The numbers 1.645 and 6.735 on rounding off to 3 significant figures will give

(a) 1.65 and 6.74

(b) 1.64 and 6.73

(c) 1.65 and 6.73

(d) 1.64 and 6.74

C52. Which of the following is the most precise device for measuring length : (a) a vernier callipers with 20 divisions on the sliding scale; (b) a screw gauge of pitch 1 mm and 100 divisions on the circular scale; (c) an optical instrument that can measure length to within a wavelength of light ? Justify your answer.

C53. You are given a thread and a metre scale. How will you estimate the diameter of the thread ?

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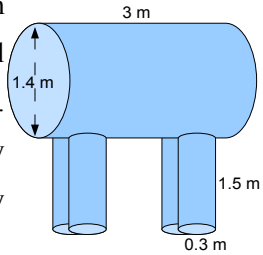
C54. A screw gauge has a pitch of 1.0 mm and 200 divisions on the circular scale. Do you think it is possible to increase the accuracy of the screw gauge arbitrarily by increasing the number of divisions on the circular scale ?

C55. The mean diameter of a thin brass rod is to be measured by vernier callipers. Why is a set of 100 measurements of the diameter expected to yield a more reliable estimate than a set of 5 measurements only ?

C56. Estimate the number (N) of air molecules in a room of length 4.0 m, width 3.5 m, and height 1.5 m. Assume the temperature (T) is 300 K, and pressure (p) is 10^5 Pa . Use the ideal gas law $p\ V=N\ k\ T$, where k is Boltzmann constant = $1.38\times10^{-23}\ \text{J K}^{-1}$ and V is the volume.

C57. Estimate the number of strands of hair on your head. (Assume head as a hemispherical surface of radius 10 cm, and density of hair strands as 2 hairs per mm^2 of area.)

C58. Estimate the mass of an elephant. Assume the model shown here for the elephant. The density of body mass may be taken as equal to the density of water.



C59. What is the meaning of dimensions of a physical quantity?

C60. (a) What is a dimensional formula? (b) What is a dimensional equation?

C61. Mention the applications of dimensional analysis.

C62. State the principle of homogeneity of dimensions.

C63. Mention limitations of dimensional analysis.

C64. Which of the following pairs of physical quantities does not have same dimensional formula?
(a) Work and torque.
(b) Angular momentum and Planck's constant.
(c) Tension and surface tension.
(d) Impulse and linear momentum.

C65. Which of the following ratios express pressure?
(a) Force/ Area
(b) Energy/ Volume
(c) Energy/ Area
(d) Force/ Volume

C66. A function $f(\theta)$ is defined as:

$$f(\theta)=1-\frac{\theta}{1!}+\frac{\theta^2}{2!}-\frac{\theta^3}{3!}+\frac{\theta^4}{4!}-.....$$

Why is it necessary for θ to be a dimensionless quantity?

C67. During a total solar eclipse the moon almost entirely covers the sphere of the sun. Write the relation between the distances and sizes of the sun and moon.

C68. Give an example of (a) physical quantities which have a unit but no dimensions. (b) physical quantities which have neither unit nor dimensions. (c) constants which have a unit. (d) constants which have

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no unit.

C69. If momentum (P), area (A) and time (T) are taken to be fundamental quantities, then energy has the dimensional formula

(a) $[P^1 A^{-1} T^1]$

(b) $[P^2 A^1 T^1]$

(c) $[P^1 A^{-1/2} T^1]$

(d) $[P^1 A^{1/2} T^{-1}]$

C70. If P, Q, R are physical quantities, having different dimensions, which of the following combinations can never be a meaningful quantity?

(a) (P – Q)/R

(b) PQ – R

(c) PQ/R

(d) $(PR - Q^2)/R$

(e) (R + Q)/P

C71. Photon is quantum of radiation with energy $E = h\nu$ where ν is frequency and h is Planck's constant. The dimensions of h are the same as that of

(a) Linear impulse

(b) Angular impulse

(c) Linear momentum

(d) Angular momentum

C72. If Planck's constant (h) and speed of light in vacuum (c) are taken as two fundamental quantities, which one of the following can, in addition, be taken to express length, mass and time in terms of the three chosen fundamental quantities?

(a) Mass of electron (m_e)

(b) Universal gravitational constant (G)

(c) Charge of electron (e)

(d) Mass of proton (m_p)

C73. The displacement of a progressive wave is represented by $y = A \sin(\omega t - k x)$, where x is distance and t is time. Write the dimensional formula of (i)ω and (ii) k.

C74. Young's modulus of steel is 1.9×10^{11} N/m^2. When expressed in CGS units of dynes/cm^2, it will be equal to ($1N = 10^5$ dyne, $1m^2 = 10^4$ cm^2)

(a) 1.9×10^{10}

(b) 1.9×10^{11}

(c) 1.9×10^{12}

(d) 1.9×10^{13}

C75. If the unit of force is 100 N, unit of length is 10 m and unit of time is 100 s, what is the unit of mass in this system of units?

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