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Questions:

5 Marks

1. One mole of an ideal gas at standard temperature and pressure occupies 22.4 L (molar volume). What is the ratio of molar volume to the atomic volume of a mole of hydrogen ? (Take the size of hydrogen molecule to be about 1 Å). Why is this ratio so large ?
2. The Sun is a hot plasma (ionized matter) with its inner core at a temperature exceeding 107 K, and its outer surface at a temperature of about 6000 K. At these high temperatures, 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 and liquids or gases ? Check if your guess is correct from the following data : mass of the Sun = 2.0 $\times 10^{30}$ kg, radius of the Sun = 7.0 $\times 10^{8}$ m
3. Explain this statement clearly :
"To call a dimensional quantity 'large' or 'small' is meaningless without specifying a standard for comparison". In view of this, reframe 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.
4. Consider a simple pendulum, having a bob attached to a string, that oscillates under the action of the force of gravity. Suppose that the period of oscillation of the simple pendulum depends on its length (l), mass of the bob (m) and acceleration due to gravity (g). Derive the expression for its time period using method of dimensions.
5. 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 ?
6. A calorie is a unit of heat (energy in transit) and it equals about 4.2 J where 1J = 1 kg-m^2/s^2 .Suppose we employ a system of units in which the unit of mass equals α kg, the unit of length equals β m, the unit of time is γ s. Show that a calorie has a magnitude 4.2 $\alpha^{-1} \beta^{-2} \gamma^{2}$ in terms of the new units.

3 Marks

7. The sun's angular diameter is measured to be 1920. The distance r of the sun from the earth is 1.496×10^{11} m. What is the diameter of the sun?
8. State the number of significant figures in the following :
(a) 0.007 m^2.
(b) 2.64×10^{24} kg
(c) 0.2370 g/cm^3
(d) 6.320 J
(e) 6.032 N/m^2.
(f) 0.0006032 m^2.
9. Write down the number of significant figures in the following
(a) 5238 N
(b) 4200 kg
(c) 34.000 m.
(d) 0.02340 N/m.
10. When the planet Jupiter is at a distance of 824.7 million kilometers from the earth, its angular diameter is measured to be 35.72 of arc. Calculate the diameter of Jupiter.
11. The length, breadth and thickness of a rectangular sheet of metal are 4.234 m, 1.005 m, and 2.01 cm respectively. Give the area and volume of the sheet to correct significant figures.
12. The mass of a box measured by a grocer's balance is 2.30 kg. 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 ?
13. Round off the following number as indicated
101.55×10^{6} upto 4 digits
14. Each side of a cube is measured to be 7.203 m. What are the total surface area and the volume of the cube to appropriate significant figures?
15. 5.74 g of a substance occupies 1.2 cm^3 . Express its density by keeping the significant figures in view.
16. Why length, mass and time are chosen as base quantities in mechanics?
17. Express the average distance of earthfrom the sun in
(i) light year
(ii) par sec.
18. The SI unit of energy is J = Kgm^2s^{-2} that of speed v is m s^{-1} and of acceleration a is m s^{-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) $K = (1/2)mv^2$
(c) K = ma
(d) $K = (3/16)mv^2$
(e) $K = (1/2)mv^2 + ma$
19. The unit of length convenient on the atomic scale is known as an angstrom and is denoted by Å: 1 Å = 10^{-10} m. The size of a hydrogen atom is about 0.5 Å. What is the total atomic volume in m^3 of a mole of hydrogen atoms ?
20. Why has second been defined in terms of p[eriods of radiations from Cesium -133
21. Answer the following :
(a) You are given a thread and a metre scale. How will you estimate the diameter of the thread ?
(b) 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 ?

(c) 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 ?

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