CBSE Test Paper 03

Chapter 2 Units and Measurements

1. Population of a town is reported as 158000 . Which of the following statements correct? **1**

   a. the population is 158000±300
   b. the population is 158000±400
   c. the population is 158000±250
   d. the population is 158000±500

2. The number of significant digits in 0.2370 is **1**

   a. 4
   b. 3
   c. 5
   d. 6

3. The result of rounding off 34.216 to 3 digits is **1**

   a. 3.42
   b. 34.2
   c. 34.22
   d. 342

4. The dimensional formula for Planck's constant is **1**

   a. $[ML^2T^{-1}]$
   b. $[M^2L^2T^{-1}]$
   c. [MLT]
   d. $[ML^1T^{-1}]$

5. When two quantities are multiplied or divided, the relative error in the result is **1**

   a. the difference of the absolute errors in the multipliers
   b. the sum of the absolute errors in the multipliers

c. the difference of the relative errors in the multipliers
d. the sum of the relative errors in the multipliers

6. What are the dimensions of a and b in the relation: F = a + bx, where F is force and (x) is distance? **1**
7. Convet : **1**
   i. $3.0 m/s^2$ = ... km/hr^2
   ii. $6.67\ 10^{-11} Nm^2/kg^2$ = ... $g^{-1}cm^3s^{-2}$
8. Write S.I unit of luminous intensity and temperature. **1**
9. Does AU and $\mathring{A}$ represent the same unit of length? **2**
10. Time for 20 oscillations of a pendulum is measured as t_1=39.6 s; t_2=39.9 s; and t_3=39.5 s. What is the precision in the measurements? What is the accuracy of measurement? **2**
11. Find the dimensional formulae of **2**
    1. Kinetic energy
    2. Pressure.
12. Explain the 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 **3**
    i. Atoms are very small objects.
    ii. A jet plane moves with great speed.
    iii. The mass of Jupiter is very large.
    iv. The air inside this rooms contains a large number of molecules.
    v. A proton is much more massive than an electron.
    vi. The speed of the sound is much smaller than the speed of light.
13. Express the average distance of the earth from the sun in: **3**
    i. a light year
    ii. par sec.
14. Answer the following: **3**
    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?

15. Just as precise measurements are necessary in science, it is equally important to be able to make rough estimates of quantities using rudimentary ideas and common observations. Think of ways by which you can estimate the following (where an estimate is difficult to obtain, try to get an upper bound on the quantity): **5**
    a. the total mass of rain-bearing clouds over India during the Monsoon
    b. the mass of an elephant
    c. the wind speed during a storm
    d. the number of strands of hair on your head
    e. the number of air molecules in your classroom.

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Answer

1. d. the population is 158000$\pm$500

   Explanation: The value 158000 implies that the population is likely between about 157500 and 158500, or 158000±500.

   The absolute uncertainty of 1000 translates into a relative uncertainty of $\frac{1000}{158000}$ or 1 part in 158, or about 0.6 percent.

2. a. 4

   Explanation: There are three rules on determining how many significant figures are in a number:

   - Non-zero digits are always significant.
   - Any zeros between two significant digits are significant.
   - A final zero or trailing zeros in the decimal portion ONLY are significant.

   So keeping these rules in mind, there are 4 significant digit.

3. b. 34.2

   Explanation: The rules for rounding off are following.

   - If the first non-significant digit is less than 5, then the least significant digit remains unchanged.
   - If the first non-significant digit is greater than 5, the least significant digit is incremented by 1.
   - If the first non-significant digit is 5, the least significant digit can either be incremented or left unchanged.
   - All non-significant digits are removed.

   So rounding off 34.216 upto 4 digits is 34.22 and upto 3 digits is 34.2

4. a. $[ML^2T^{-1}]$

   Explanation: $[ML^2T^{-1}]$ (Hint use E = hν)

5. d. the sum of the relative errors in the multipliers

   Explanation: When two quantities are multiplied or divided, the relative error in the result is the sum of the relative errors in the multipliers.

e.g x = a x b

maximum possible error is: $\frac{\Delta x}{x} = \pm(\frac{\Delta a}{a} + \frac{\Delta b}{b})$

similarly, for error in quotient: x= $\frac{a}{b}$

maximum possible error is: $\frac{\Delta x}{x} = \pm(\frac{\Delta a}{a} + \frac{\Delta b}{b})$

6. [a] = [F] = [N] = [MLT^{-2}] and $[b] = \left[\frac{\mathrm{F}}{x}\right] = \left[\frac{\mathrm{N}}{m}\right] = \left[\frac{\mathrm{MLT}^{-2}}{L}\right] = \left[\mathrm{MT}^{-2}\right]$

7. i. 3.0m/s^2 = $\frac{3\times10^{-3}}{\left(\frac{1}{3600}h\right)^2}$ km/hr^2

   = 3.9 $\times 10^4$ km/hr^2

   ii. 6.67 10^{-11}Nm^2/kg^2 = g^{-1}cm^{3}s^{-2}

   $= 6.67 \times 10^{-11} kg^{-1} m^3 s^{-2}$

   $= 6.67 \times 10^{-11} \times 10^3 \times \left(10^2\right)^3$

   $= 6.67 \times 10^{-8} g^{-1} cm^3 s^{-2}$

8. S.I unit of luminous intensity is candela (cd) and of temperature is Kelvin(K).

9. No, $\mathring{\mathrm{A}}$ and AU are the two different units of length.

   AU = 1 astronomical unit = mean distance between the earth and the sun = 1.496 $\times$ 10^{11} m

   and 1 $\mathring{\mathrm{A}}$ = 1 angstrom = 10^{-10} m

10. t_1=39.6 s, t_2=39.9 s, and t_3=39.5 s

    the least count of instrument is 0.1 s

    Hence precision (LC)=0.1 s

    Mean value of time for 20 oscillations

    $= \frac{39.6+39.9+39.5}{3} = \frac{119.0}{3} = 39.7$ s

    Absolute errors in measurement

    $|\Delta t_1| = \left|\bar{t} - t_1\right| = |39.7 - 39.6| = |0.1| = 0.1s$

    $|\Delta t_2| = \left|\bar{t} - t_2\right| = |39.7 - 39.9| = |0.2| = 0.2s$

    $|\Delta t_3| = \left|\bar{t} - t_3\right| = |39.7 - 39.5| = |0.2| = 0.2s$

    $\therefore$ Mean absolute error = $\frac{0.1+0.2+0.2}{3} = \frac{0.5}{3} \cong 0.2s$

    $\therefore$ Accuracy of measurement =$\pm$0.2 s.

11. i. KE = $\frac{1}{2}mv^2$; using the dimensions of mass and velocity, the dimensional formula of KE is $[ML^2T^{-2}]$

    ii. Pressure = $\frac{\text{Force}}{\text{Area}} = \frac{[MLT^{-2}]}{[L^2]}$ = $[ML^{-1}T^{-2}]$.

12. Any dimensional physical quantity can be called large or small by specifying a standard for comparison. For example, the mass of a human being is 40 kg, which is very small in comparison to the mass of the earth (6×10^{24} kg) but very large in comparison to the mass of an electron (9.1×10^{-31} kg).

    i. An atom is a very small object when we compare it with a cricket ball.

    ii. A jet plane moves with a speed greater when we compare it with a motor bike.

    iii. The mass of Jupiter is very large as compared to the mass of Venus.

    iv. The air inside this room contains a large number of molecules than in one mole of air.

    v. The given statement is already correct.

    vi. Speed of sound is less than the speed of light. Speed of sound 346 m/ sec while speed of light is 3 x 10^8 m / sec in air at 25 ^{0}C, hence statement is true.

13. i. Let the average distance of earth from the sun is (r), then we have

    r = 1 AU = 1.496×10^{11} m

    $= \frac{1.496 \times 10^{11}}{9.46 \times 10^{15}}$ = 1.58×10^{-5} light years

    ii. In terms of par sec we have, r = $\frac{1.496 \times 10^{11}}{3.08 \times 10^{16}}$ par sec

    = 4.86×10^{-6} par sec.

14. a. Wrap the thread on a uniform smooth rod in such a way that the coils thus formed are very close to each other. Measure the length of the thread winding using a metre scale. The diameter of the thread is given by the relation, Diameter=length of thread winding/no. of turns

    b. It is not possible to increase the accuracy of a screw gauge by increasing the number of divisions of the circular scale. Increasing the number divisions of the circular scale will increase its accuracy to a certain extent only. Due to low resolution of human eye, it may not be possible to read very closed divisions pricely.

    c. A set of 100 measurements is more reliable than a set of 5 measurements because random errors involved in the former are very less as compared to the latter.

15. India receives about 215 cm of rains during monsoons i.e., the height of water column, h = 215 cm = 2.15 m

Area of India , A = $3.3 \times 10^{12} \mathrm{m}^2$

Hence, volume of rain water, $V = Area \times height$

$V = 3.3 \times 10^{12} \times 2.15 = 7.09 \times 10^{12} \mathrm{m}^3$

Density of water, $density, \rho = 1 \times 10^3 kgm^{-5}$

Hence, mass of rain water $M = \rho \times V = 7.09 \times 10^{15}$

Hence, total mass if clouds over India $M = 7.09 \times 10^{15}$ kg.

Let us consider a ship of base area = A.

Let us consider its depth in sea = d_1.

Volume of water displaced by the ship, V1 = Ad_1

Now, let us assume an elephant on the ship .

Now , let us consider the depth of the ship in this case be = d_2

Volume of water displaced by the ship with the elephant , V_{be} = Ad_2

Now Volume of water displaced by the elephant

$V = Ad_2 - Ad_1$

Let us assume the density of water = ρ

Mass of elephant , $M = A\rho(d_2 - d_1)$

Wind speed during a storm can be measured by an anemometer. As wind blows, it rotates. The rotation made by the anemometer in one second gives the value of wind speed.

Area of the head surface carrying hair = A

With the help of a screw gauge, the diameter and hence, the radius of a hair can be determined. Let it be r.

$\therefore$ Area of one hair $= \pi r^2$

Number of strands of hair $\approx \frac{\text{Total surface area}}{\text{Area of one hair } \pi} = \frac{A}{r^2}$

Let the volume of the room be V.

One mole of air at NTP occupies 22.4 l i.e., $22.4 \times 10^{-3} \mathrm{m}^3$ volume.

Number of molecules in one mole $= 6.023 \times 10^{23}$

$\therefore$ Number of molecules in room of volume V

$= \frac{6.023 \times 10^{23}}{22.4 \times 10^{-3}} \times \mathrm{V} = 134.915 \times 10^{26} \mathrm{V}$

$= 1.35 \times 10^{28} \mathrm{V}$