CBSE Test Paper 02

Chapter 2 Units and Measurements

1. The surface tension of a liquid is 70 dyne/cm. In MKS system its value is? **1**
   a. 7×10^{2} N/m
   b. 7×10^{3} N/m
   c. 70 N/m
   d. 7×10^{-2} N/m
2. When two quantities are added or subtracted, the absolute error in the final result is **1**
   a. absolute value of the difference of errors of individual quantities
   b. the sum of the absolute errors in the individual quantities
   c. absolute value of the sum of individual quantities
   d. absolute value of the sum of errors of individual quantities
3. 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 volume of the sheet to correct significant figures. **1**
   a. $0.1855\ m^3$
   b. $0.0755\ m^3$
   c. $0.08552\ m^3$
   d. $0.0855\ m^3$
4. Percentage error δa is given by **1**
   a. $\delta \mathrm{a} = (\Delta \mathrm{a}_{\mathrm{mean}}/\mathrm{a}_{\mathrm{mean}})$ 80%
   b. $\delta \mathrm{a} = (\Delta \mathrm{a}_{\mathrm{mean}}/\mathrm{a}_{\mathrm{mean}})$100%
   c. $\delta \mathrm{a} = (\Delta \mathrm{a}_{\mathrm{mean}}/\mathrm{a}_{\mathrm{mean}})$70%
   d. $\delta \mathrm{a} = (\Delta \mathrm{a}_{\mathrm{mean}}/\mathrm{a}_{\mathrm{mean}})$ 200%
5. The unit of length convenient on the atomic scale is known as an angstrom and is denoted by $\overset{0}{A} : 1\overset{0}{A} = 10^{-10}$ m. The size of a hydrogen atom is about $0.5\overset{0}{A}$. What is

the total atomic volume in m^3 of a mole of hydrogen atoms ? **1**

a. $\cong 3.3 \times 10^{-7} m^3$
b. $\cong 3 \times 10^{-7} m^3$
c. $\cong 2.9 \times 10^{-6} m^3$
d. $\cong 3.2 \times 10^{-6} m^3$

6. How many astronomical units make one metre? **1**

7. 5.74 g of a substance occupies 1.2 cm^3. Express its density keeping the significant figures in view. **1**

8. Two resistances $R_1 = 100 \pm 3\ \Omega$ and $R_2 = 200 \pm 4\ \Omega$ are connected in series. What is their equivalent resistance? **1**

9. What is the concept of length in physics? **2**

10. How many metric tons are there in teragram? **2**

11. The unit of length convenient on the atomic scale is known as an angstrom and is denoted by $\overset{\circ}{A}$: 1 $\overset{\circ}{A}$ = 10^{-10} m. The size of a hydrogen atom is about 0.5$\overset{\circ}{A}$ what is the total atomic volume in m^3 of a mole of hydrogen atoms? **2**

12. How can you estimate the distance of a near star by parallax method? **3**

13. The radius of the atom is of the order of 2$\overset{\circ}{A}$ and radius of a nucleus is of the order of a fermi. How many magnitudes higher is the volume of the atom as compared to the volume of the nucleus? **3**

14. Compute the following with regards to significant figures. **3**

i. 4.6×0.128
ii. $\frac{0.9995 \times 1.53}{1.592}$
iii. 876 + 0.4382

15. Briefly discuss different types of systematic errors. **5**

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Answer

1. d. 7×10^{-2} N/m

   Explanation: 7×10^{-2} N/m

2. b. the sum of the absolute errors in the individual quantities

   Explanation: When two quantities are added or subtracted, the absolute error in the final result is the sum of the absolute errors in the individual quantities.
   e.g: error Δx in the sum x=a+b is $\Delta x = \pm(\Delta a + \Delta b)$
   maximum value of error Δx = $(\Delta a + \Delta b)$

3. d. 0.0855 m^3

   Explanation: length, l = 4.234 m

   breadth,b = 1.005 m

   thickness, t = 2.01 cm = 2.01×10^{-2} m

   volume = l × b × t

   => V = 4.234 × 1.005 × 0.0201 = 0.0855289 = 0.0855 m^3 (Significant Figures = 3)

4. b. $\delta \mathrm{a} = (\Delta \mathrm{a}_{\mathrm{mean}} / \mathrm{a}_{\mathrm{mean}})100\%$

   Explanation: Percentage Error: It is the relative error measured in percentage.
   So Percentage Error $\delta a = \frac{mean\ absolute\ value}{mean\ value} \times 100\%$
   $\delta a = \frac{\Delta a_{mean}}{a_{mean}} \times 100\%$

5. b. $\cong 3 \times 10^{-7} m^3$

   Explanation: Radius of hydrogen atom, *r* = 0.5 Å = 0.5×10^{-10} m

   Volume of hydrogen atom = (4/3) π r^3

   = (4/3) × (22/7) × $(0.5 \times 10^{-10})^3$

   = 0.524×10^{-30} m^3

   1 mole of hydrogen contains 6.023×10^{23} hydrogen atoms.

   ∴ Volume of 1 mole of hydrogen atoms = $6.023 \times 10^{23} \times 0.524 \times 10^{-30}$

$= 3.16 \times 10^{-7}\ m^3$

$\approx 3 \times 10^{-7} m^3$

6. 1 Astronomical Unit (AU) is defined as the amount of distance travelled by light in one year.
   1 AU = 149,598,000 kilometers = 149,598,000,000 meters.
   and 1 m = 6.67×10^{-12} AU

7. Density = $\frac{\text{Mass}}{\text{Volume}} = \frac{5.74\text{g}}{1.2\text{cm}^3}$ = 4.783 g cm^{-3}
   = 4.8 g cm^{-3}
   [according to the significant figure rule, the final result is rounded off upto 2 significant figures(minimum number of significant figures]

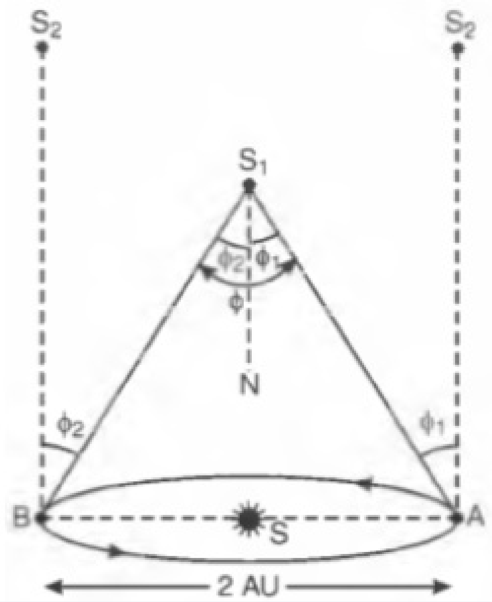
8. Equivalent resistance.
   $R = R_1 \pm R_2$
   Using the addition rule of errors
   R= (100 ± 3)± (200 ± 4)
   = (100 + 200) ± (3 + 4)
   = (300 ± 7) Ω

9. The concept of length involves the comparison of size of two objects. Length is the term used for representing the size of an object from one end to another end. Length of an object may be defined as the distance of separation between its two ends and the distance of separation is measured in comparison to some standard of length. A metre rod is commonly used as a standard measurement for measuring the lengths.

10. We know that 1 teragram = 10^{12} g
    1 metric ton = 10^3 kg
    = $10^3 \times 10^3$ g ($\because$ 1kg = 10^3 g)
    = 10^6 g
    Therefore, Number of metric tons are in a teragram = $\frac{10^{12}\text{g}}{10^6\text{g}}$ = 10^6

11. Radius of hydrogen atom, r = 0.5 $A = 0.5 \times 10^{-10} m$
    Volume of hydrogen atom $= \frac{4}{3}\pi r^3$

$= \frac{4}{3} \times \frac{22}{7} \times \left(0.5 \times 10^{-10}\right)^3$
$= 0.524 \times 10^{-30} \mathrm{m}^3$
1 mole of hydrogen contains 6.023×10^{23} hydrogen atoms.
$\therefore$ Volume of 1 mole of hydrogen atoms $= 6.023 \times 10^{23} \times 0.524 \times 10^{-30}$
$= 3.16 \times 10^{-7} m^3$

12. 

Consider the figure. Parallax method is used to estimate the distance of a near star S_1 from Earth. Firstly consider a very distant star S_2 whose position and direction considered to remain unchanged even after six months. The parallax angle ϕ_1 subtended by a near star in one position of Earth (say A) with respect to distant star S_2 is measured.

After six months, earth in its orbit around the Sun S will reach at the diametrically opposite position B. In this position again, measure the parallax angle ϕ_2 subtended by a near star S_1 on Earth with respect to distant star S_2.

$\therefore$Total parallax angle subtended by star S_1 on Earth's orbital diameter AB (where AB = 2 AU, = 2 $\times$ 1.496 $\times$ 10^{11} m = 3 $\times$ 10^{11} m) will be ϕ = ϕ_1 + ϕ_2

Let, S_1A = S_1B = d. As, d is very large, ϕ is very small. So, AB = BS_1 and

$\phi = \frac{AB}{d} = \frac{3\times10^{11}}{d}$ rad

$\Rightarrow$ The distance of star S_1 from Earth, d = $\frac{3\times10^{11}}{\phi}$ m.

13. Given that the Radius of an atom, (R_{Atom}) is $2\overset{o}{A}$ = 2 $\times$ 10^{-10} m and the radius of a

nucleus, ($R_{Nucleus}$) is 1 fermi = 10^{-15} m

Volume of an atom, $V_{Atom} = \frac{4}{3}\pi R^3_{Atom}$

Volume of a nucleus, $V_{Nucleus} = \frac{4}{3}\pi R^3_{Nucleus}$

$$\frac{V_{Atom}}{V_{Nuclues}} = \frac{\frac{4}{3}\pi R^3_{Atom}}{\frac{4}{3}\pi R^3_{Nucleus}} = \left[\frac{R_{Atom}}{R_{Nucleus}}\right]^3 = \left[\frac{2\times10^{-10}}{10^{-15}}\right]^3 = 8 \times 10^{15}.$$

Volume of an atom is roughly 10^{16} times more than that of nucleus, therefore most of the atom is free / empty space and nucleus is heavy and dense as per Rutherford's observation.

14. i. Here, We have

    $4.6 \times 0.128 = 0.5888 = 0.59$

    The obtained result has been rounded off to have two significant digits (as in 4.6)

    ii. Here, we have

    $\frac{0.9995\times1.53}{1.592} = 0.96057 = 0.961$

    The above result has been rounded off to three significant digits (as in 1.53).

    iii. Here, we have

    $876 + 0.4382 = 876.4382 = 876$

    Since there is no decimal point in 876, therefore, the above result of addition has been rounded off to no decimal point.

15. Systematic errors are those errors that tend to be in one direction, either positive or negative. It is a repeatable error. Different types of systematic errors are:

    i. **Instrumental errors** which arise from the errors due to imperfect design or calibration of the measuring instrument. Zero error present in vernier callipers, backlash error in screw gauge / spherometer, etc., are examples of instrumental errors. Appropriate corrections may be applied for these errors.

    ii. **Errors due to imperfection in experimental technique or procedure:** For example, a nurse tries to measure the body temperature of a young child by placing the thermometer under his armpit. Naturally, the temperature is less than the real body temperature and produces an error. Similarly, heat loss due to radiation in calorimetry experiments or effect of buoyancy of air while weighing a body are errors of this type.

    iii. **Errors due to external cause:** These errors are due to external conditions like change in temperature, atmospheric pressure, humidity, wind velocity etc., during the course of experiment. Effect of these errors may be eliminated by performing experiment under different external conditions spread over a long time and then taking the mean value.

iv. **Personal errors:** These errors arise due to an individual's bias, lack of proper setting of apparatus or carelessness of the observer while taking the observations. To minimise these errors the person performing an experiment should be extremely careful and should follow proper procedures.