Units And Measurements

Chapter 1

NCERT Exercise Solutions

Q. Fill in the blanks: (Take care of significant figures)

(a) Side of cube = 1 cm

Volume of cube $= (\text{side})^3$

$= (1\ cm)^3$

$= (1 \times 10^{-2})^3$ [$\because 1\ cm = 10^{-2}\ m$]

$= 10^{-6}\ m^3$

(b) Radius $r = 2\ cm = 20\ mm$ [$1\ cm = 10\ mm$]

height $h = 10.0\ cm = 100\ mm$

Surface area of solid cylinder $= 2\pi r(r+h)$

$= 2 \times \frac{22}{7} \times 20(20+100)$

$= \frac{880 \times 120}{7}$

$= \frac{1056\,0}{7}$

$= 15085$

$\approx 1.5 \times 10^4\ mm^2$ [2 S.F]

(c) Speed $= 18\ km/h$

$= 18 \times \frac{5}{18} = 5\ m/s$

(d) Relative density of lead $= 11.3$

$$\text{Relative density} = \frac{\text{density of substance}}{\text{density of water}}$$

$$11.3 = \frac{\text{density of lead}}{1}$$ [density of water $= 1\ g\text{-}m^{-3}$]

So, density of lead $= 11.3\ g\text{-}cm^{-3}$ Ans

$= 11.3 \times 10^{-3} \times (10^{-2})^{-3}$ [$1\ g = 10^{-3}\ kg$, $1\ cm = 10^{-2}\ m$]

$= 11.3 \times 10^{-3+6}$

$= 11.3 \times 10^3\ kg\ m^{-3} = 1.13 \times 10^4\ kg\ m^{-3}$ Ans

Q.2. Fill in the blanks by suitable conversion of units

Ans. (a) $1\ kg\ m^2 s^{-2} = (1\times10^3)\ g\ (10^2)^2\ cm^2 s^{-2}$

$= 10^3 \times 10^4\ g\ cm^2 s^{-2}$ $\quad [1\ kg = 10^3 g,\ 1\ m = 10^2 cm]$

$= 10^7\ g\ cm^2 s^{-2}$ =

(b) 1 light year $= 9.46\times10^{15}\ m$

$1\ m = \dfrac{1}{9.46\times10^{15}}\ ly$

$= \dfrac{10^{-15}}{9.46}$

$= \dfrac{10\times10^{-16}}{9.46}$

or $1\ m = 1.057\times10^{-16}\ ly = 10^{-16}\ ly$

(c) $3.0\ m/s^2 = 3\times\dfrac{1}{1000}\ km\times(60\times60)^2\ h^2$

$= \dfrac{3\times3600\times3600}{1000}\ km/h^2$

$= 38880\ km\ h^{-2}$

$= 3.9\times10^4\ km\ h^{-2}$ Ans [2 S.F.]

(d) $G = 6.67\times10^{-11}\ N\ m^2\ kg^{-2}$

$1\ N = 10^5\ dyne,\ 1\ m = 10^2 cm,\ 1\ kg = 10^3 g$

so $G = 6.67\times10^{-11}\times10^5\times(10^2)^2\times(10^3)^{-2}\ dyne\ cm^2\ g^{-2}$

$= 6.67\times10^{-11+5+4-6}\ dyne\ cm^2\ g^{-2}$

$= 6.67\times10^{-8}\ dyne\ cm^2\ g^{-2}$ Ans

Q.3. A calorie is a - - - - - - - - - of the new unit.

Ans. $1\ cal = 4.2\ J$, $1\ J = 1\ kg\ m^2 s^{-2}$

New system of units →

Dimensions of energy $= [M L^2 T^{-2}]$

$\therefore a = 1,\ b = 2,\ c = -2$

$M_1 = 1\ kg,\ L_1 = 1\ m,\ T_1 = 1\ s$

$M_2 = \alpha\ kg,\ L_2 = \beta\ m,\ T_2 = \gamma\ s$

here $n_1 = 4.2$

By $n_2 = n_1\left(\frac{u_1}{u_2}\right) = n_1\left[\frac{M_1}{M_2}\right]^a\left[\frac{L_1}{L_2}\right]^b\left[\frac{T_1}{T_2}\right]^c$

$= 4.2\left[\frac{kg}{\alpha kg}\right]^1\left[\frac{m}{\beta m}\right]^2\left[\frac{s}{\gamma s}\right]^{-2}$

$n_2 = 4.2\,\alpha^{-1}\beta^{-2}\gamma^2$ new units Ans

Q.5. A new unit of length - - - - - - - - this distance.

Soln. Given that speed of light in vacuum is unity in new system of units

$$c = \frac{1 \text{ new unit of length}}{\text{sec}}$$

Time taken by light to reach earth = 8 min 20s
= (8×60+20) s
= 500 s

Now distance = speed × time
= 1 × 500 s
= 500 units (new units) Ans

Q.6. Which of the - - - - - - - - - - wavelength.

Ans. (C) Because the least count of an optical instrument is very less in comparision to Vernier callipers and screw gauge. Therefore optical instrument is most precise.

Q.7. A student measures —— - - - - - - - thickness of hair

Linear magnification = $\frac{\text{Observed width}}{\text{Real width}}$

$1\omega = \frac{3.5}{\text{Real width}}$ [∵ Av. width = 3.5 mm]

or Real width = $\frac{3.5}{1\omega}$

= 0.035 mm

Ans

Q. 8. Answer the following — — — — —

Ans. (a) Wrap the thread on the meter scale with no gap between the threads. Measure the length l which contains n turns.

Diameter of thread $d = \frac{l}{n}$

(b) We know,

$$\text{least count} = \frac{\text{Pitch}}{\text{no. of div. on the circular scale}}$$

If we increase no. of divisions, least count will increase accuracy also increases but only to a certain limit as the resolution becomes less.

(c) To reduce random error, large number of observations are taken. Therefore the set of 100 measurement is more reliable than set of 5 measurments.

Q. 9. The photograph of a — — — — -arrangement.

Ans. If A = area and L = length, then

$$\frac{A_1}{A_2} = \frac{L_2^2}{L_1^2}$$

$$\Rightarrow \text{Linear magnification } \frac{L_2}{L_1} = \sqrt{\frac{A_1}{A_2}}$$

here $A_1 = 1.75\ cm^2 = 1.75 \times 10^{-4}\ m^2$

$A_2 = 1.55\ m^2$

then $\frac{L_2}{L_1} = \sqrt{\frac{1.55}{1.75 \times 10^{-4}}} = \sqrt{\frac{155 \times 10^4}{175}}$

$= 10^2 \sqrt{\frac{31}{35}} = 10^2 \sqrt{0.8857}$

$\Rightarrow \frac{L_2}{L_1} = 10^2 \times 0.9411 = 94.11 \simeq 94.1$ Ans

Q.10. State the number of significant figures -

Ans.

	value	no. of S.F
(a)	$0.007\ m^2$	1
(b)	$2.64 \times 10^{24}\ kg$	3
(c)	$0.2370\ g\ cm^{-3}$	4
(d)	$6.320\ J$	4
(e)	$6.032\ N m^{-2}$	4
(f)	$0.0006032\ m^2$	4

Q.11 The length, breath - — — — — - significant figures.

Ans. Given,

$l = 4.234\ m$, $b = 1.005\ m$

$h = 2.01\ cm = 0.0201\ m$

Area of the metal sheet

$A = 2(lb + bh + hl)$

$= 2[4.234 \times 1.005 + 1.005 \times 0.0201 + 0.0201 \times 4.234]$

$= 2[4.25517 + 0.0202005 + 0.0851034]$

$= 2 \times 4.3604739$

$= 8.720947\ m^2$

Or $A \simeq 8.72\ m^2$ Ans

Now Volume $= lbh$

$= 4.234 \times 1.005 \times 0.0201$

$= 0.0855289$

$= 0.0855\ m^3$ Ans

Q.12. The mass of a box — — — ——-- figures?

Ans. Given,

Mass of box = 2.30 kg

Mass of two gold pieces = 20.15 g and 20.17 g

= 0.02015 kg and 0.02017 kg

Now total mass of box and gold pieces

$= 2.30 + 0.02015 + 0.02017$

$= 2.34032$

In S.F, $= 2.3$ kg Ans

(b) Difference between masses of gold pieces

$= 20.17 - 20.15$

$= 0.02$ g Ans

Q.13. A famous relation — — — — — the missing c.

Ans. The boy writes the relation as

$$m = \frac{m_0}{(1 - v^2)^{1/2}}$$

Check the correctness of formula by dimensional method.

$$[M] = \frac{[M]}{[LT^{-1}]}$$

L.H.S $\neq$ R.H.S

hence formula is not correct.

For correction we need to put c^2 in division of v^2, then the denominator will become dimension-less and both sides will be of same dimensions.

i.e $m = \frac{m_0}{\left(1 - \frac{v^2}{c^2}\right)^{1/2}}$

This is the correct relation. Ans

Q.14. The unit of length — — — — hydrogen atom?

Ans The size of hydrogen atom $= 0.5\ A^\circ$

$= 5 \times 10^{-10}$ m

Volume of hydrogen atom $= \frac{4}{3}\pi r^3$

$= \frac{4}{3} \times 3.14 \times (0.5 \times 10^{-10})^3$

$= \frac{4}{3} \times 3.14 \times 0.125 \times 10^{-30}$

$= \frac{3.14 \times 0.5}{3} \times 10^{-30}$

$= 0.523 \times 10^{-30} m^2$

Now volume of one mole of hydrogen atom

1 mole = 6.023×10^{23} atoms

$= 6.023 \times 10^{23} \times 0.523 \times 10^{-30}$

$= 3.15 \times 10^{-7} m^3$

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

Q.15. One mole of - - — — — — — so large?

Ans. Radius of hydrogen molecules, $r = 1 Å = 1 \times 10^{-10} m$

Volume $= \frac{4}{3}\pi r^3$

$= \frac{4}{3} \times 3.14 \times (10^{-10})^3$

$= \frac{12.56}{3} \times 10^{-30}$

$= 4.189 \times 10^{-30} m^3$

Now Atomic volume $= 4.189 \times 10^{-30} \times 6.023 \times 10^{23}$

$= 25.23 \times 10^{-7} m^3$ $[N_A = 6.023 \times 10^{23}]$

Molar volume $= 22.4 l$

$= 22.4 \times 10^{-3} m^3$ $[1 l = 10^{-3} m^3]$

Ratio,

$\frac{\text{Molar volume}}{\text{Atomic volume}} = \frac{22.4 \times 10^{-3}}{25.23 \times 10^{-7}} = 0.89 \times 10^4$

$\cong 10^4$ Ans

The ratio is very large because the size of a gas

molecule is very small in comparision with the volume of the gas.

Q.16. Explain the common - — - - - - more with you.

Ans. The direction of line of sight changes very rapidly for nearby objects like trees, house etc. However, line of sight does not change much for distant object like hills, stars, moon etc. Therefore they appear stationary.

Q.17. The sun is a — — — — — — sun = 7.0×10^8 m

Ans. Given,

mass of sun = 2×10^{30} kg

Radius of sun = 7×10^8 m

density = $\frac{\text{mass}}{\text{volume}}$

$= \frac{2 \times 10^{30}}{\frac{4}{3} \times \pi (7 \times 10^8)^3}$

$= \frac{3 \times 10^{30} \times 10^{-24}}{2 \times \frac{22}{7} \times 7 \times 7 \times 7}$

$= \frac{3 \times 10^6}{44 \times 49}$

$= \frac{3000}{2156} \times 10^3 = 1.38 \times 10^3$

or density = 1.38×10^3 kg m^{-3}

$= 1.4 \times 10^3$ kg m^{-3}

The mass density of sun is in the range of densities liquids/solids not gases. This high density arises

due to inward gravitational attraction on outer layers due to inner layers of the sun.

Q.4. Explain the statement clearly:-

(a) atoms are very small objects in comparision to the objects we see in daily life.

(b) A jet plane moves at a much higher speed compared to the speed of a car or a bus.

(c) The mass of Jupiter is very large compared to the mass of moon.

(d) The air inside this room contains a very large number of air molecules even in just one cubic centimeter (cm^3)

(e) A proton is much more massive than an electron. Its mass is approx. 1836 times that of an electron.

(f) The speed of sound is much less than the speed of light. Speed of light $c = 3 \times 10^8$ m/s and speed of sound is 343 m/s in air.