Short Answer Type Question – II

Q.1. What is system of units? Mention some of them.

Ans. In general, a complete set of base units as well as derived units is called system of units. But, it was a practice to name the system of units after three fundamental units of length, mass and time only, e.g.,

(a) FPS system—In this system length is measured in foot (F), mass in pound § and time in second (S). So this system is called FPS system. This system is also known as British Engineering system of units of simply British system of units.

(b) C.G.S. system—In this system length is measured in cm, mass in kilogram and time in second, so this system is called C.G.S. system.

(c) M.K.S. system—In this system length is measured
in metre, mass in kilogram and time in second, so this system is called M.K.S. system or metric system.

Q.2. What is a prefix? Give some common prefixes for multiples and submultiples.

Ans. Prefix is used to increase or decrease the value of a fundamental or derived unit as per practical requirements

Multiples		**Submultiples**	
Exa(a)	= 10^{18}	atto(a)	= 10^{-18}
Peta(P)	= 10^{15}	femto(f)	= 10^{-15}
Tera(t)	= 10^{12}	pico(P)	= 10^{-12}
Giga(G)	= 10^{9}	nano(n)	= 10^{-9}
Mega(M)	= 10^{6}	micro(μ)	= 10^{-6}
Kilo(k)	= 10^{3}	milli(m)	= 10^{-3}
Hecto(h)	= 10^{2}	centi(c)	= 10^{-2}
Deca(da)	= 10^{1}	deci(d)	= 10^{-1}

Q.3. What are the advantages of S.I.?

Ans. The advantages of S.I. are as under:

(i) S.I. has broader base. It has seven base units and two supplementary units.

(ii) S.I. is rational, i.e., it gives one unit for one physical quantity, e.g., for energy of any type, i.e., mechanical or heat or electrical. There is only one unit, Joule (J) but in M.K.S. system unit for mechanical energy is Joule.

(iii) S.I. is coherent.

(iv) S.I. is metric.

(v) S.I. is the modernised and improved form of M.K.S. system so it is readily accepted in almost all the countries of the world.

(vi) The symbols fixed by S.I. are not subject to change whatever may be the language, e.g., unit of mass kilogram having symbol 'kg' has to be written like this only in French or German or Hindi or Punjabi etc.

Q.4. List the S.I. base quantities and find their units with symbols.

Ans.

S.No.	Base Quantity	S.I. unit	Symbol
(i)	Length	metre	m
(ii)	Mass	kilogram	kg
(iii)	Time	second	s
(iv)	Electric current	ampere	A
(v)	Temperature	kelvin	K
(vi)	Amount of substance	mole	mol
(vii)	Luminous intensity	candela	cd

Q.5. Give characteristics of a standard unit.

Ans. Following are the important characteristics of standard unit:

(i) It should be easily understandable.

(ii) It should be changed with change in physical factors.

(iii) It should not change with place or time.

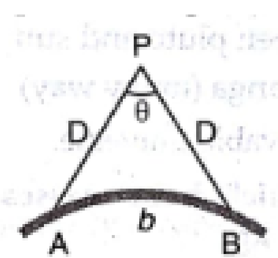
(iv) It should be easily duplicated.

(v) It should be in accordance with the size of the quality to be measured.

(vi) It should be properly defined

Q.6. Give a method for the measurement of large distance.

Ans. Let there be a planet P far away from earth. The planet is observed from two different observation points A and B on earth called observatories. If distance AB = b and angle APB = θ radian, then θ being very small $\frac{b}{D} << 1$. Angle θ is called parallax or parallactic angle.



Now radius: AP = BP = D = $\frac{b}{\theta}$

Or

b = Dθ

Q.7. Give a method to determine the angular size of a planet.

Ans. Try Yourself, similar to Q.6 Short Answer Type Questions-II

Q.8. How SONAR, RADAR and LASER can be used to measure distance?

Ans. These methods are basically based upon reflection (echo) method. In this method a beam is put on a target which reflects it.

SONAR—It is the short form of Sound Navigation and Ranging. This method generally employs ultrasonic waves. These waves are beamed to a target in water which reflects them back.

RADAR—It is the short form of Radio Detection and Ranging. Radiowaves are beamed in air with the help of the transmitter of the radar. In case an aeroplane comes in their way, they are reflected back. The receiver of radar detects them. Velocity of radiowaves is taken as 3×10^8 m/s and time is noted between sending and receiving the radiowaves, then

$$s = \frac{v \times t}{2} - \frac{c \times t}{2}$$

(c is velocity of light)

LASER—It is the short form for Light Amplification by Stimulated Emission of Radiations. Laser is a very strong beam of one colour and one direction. Large distances like moon from earth can be measured by echo-method using laser beam, i.e., laser is beamed on moon and the reflected beam is received back

By $s = \frac{v \times t}{2}$,where v is velocity of laser and t is the duration between sending and receiving of the beam. Generally v is taken as the velocity of light in vacuum.

Q.9. Give sizes of some objects as distances from 10^{-15} to 10^{26} m.

Ans. 10^{-15} → Size of proton
10^{-14} → Size of nucleus
10^{-10} → Size of atom
10^{-8} → Size of virus
10^{-7} → Wavelength of light
10^{-5} → Size of RBC (Red Blood Corpuscles)
10^{-4} → Paper thickness
10^{4} → Height of Mount Everest
10^{7} → Earth's radius
10^{8} → Distance between moon and earth
10^{11} → Distance between sun and earth
10^{13} → Distance between pluto and sun
10^{21} → Size of Akashganga (milky way)
10^{26} → Extinct of observable universe.

Q.10. Give some objects which have masses in the range of 10^{-30} kg to 10^{55} kg.

Ans. 10^{-30} kg → an electron
10^{-27} kg → a proton
10^{-25} kg → an atom

10^{-13} kg → an RBC
10^{-6} kg → a drop of rain
10^{-5} kg → a mosquito
10^{-3} kg → a grapes
10^{2} kg → a human being
10^{8} kg → a large aircraft
10^{23} kg → the moon
10^{25} kg → the earth
10^{30} kg → the sun
10^{41} kg → our galaxy
10^{55} kg → observable universe.

Q.11. Give Avogadro's method to measure distance of the order of 10^{-10} m.

Ans. It is the indirect method of measuring the distances of the order of 10^{-10} m, which is the size of an atom, i.e., small distances, an atom is a tiny sphere. When such atom lie packed in any substance, empty spaces are left in between. According to Avogadro's hypothesis volume of all atoms in one gram of substances 2/3 of the volume occupied by one gram of the substances.

$$V' = \frac{2}{3} V \qquad ..(i)$$

V = Actual volume of one gram mass.

V' = Volume occupied by atoms in 1 gram mass.

ρ = Density of the substance

$$V = \frac{1}{\rho} \qquad ..(ii)$$

Let M = atomic weight of the substances

N = Avogadro's no.

∴ No. of atoms in 1 gm of the substance

$$= \frac{N}{M}$$

If r b the radius of each atom; then

V' = no. of atom in 1 gm × volume of each atom

$$V' = \frac{N}{M} \times \frac{4}{3}\pi r^3 \qquad ..(iii)$$

∴ From eqns. (i), (ii) and (iii), we get

$$\frac{N}{M} \times \frac{4}{3}\pi r^3 = \frac{2}{3} \times \frac{1}{\rho}$$

$$r = \left(\frac{M}{2\pi N\rho}\right)^{\frac{1}{3}}$$

Q12. How is one system of units converted to another with the help of dimensions?

Ans. Let a physical quantity be given by

$$A = n_1 u_1 = n_2 u_2$$

where n_1 is numerical value with u_1 as unit in one system and similarly $n_2$is numerical value with u_2 as unit in another system.

If dimensional formula of A is $[M^a L^b T^c]$

then, n_1 $[M_1{}^a L_1{}^b T_1{}^c] = n_2 [M_2{}^a L_2{}^b T_2{}^c]$

$$i.e., \qquad n_2 = n_1 \frac{[M_1^a L_1^b T_1^C]}{[M_1^a L_1^b T_1^C]}$$

$$= n_1 \left[\frac{M_1}{M_2}\right]^a \left[\frac{L_1}{L_2}\right]^b \left[\frac{T_1}{T_2}\right]^c$$

Q.13. What are the limitations of dimensional analysis?

Ans. (i) If a physical quantity depends upon more than three different base quantities, the formula cannot be derived with the help of dimensional analysis.

(ii) Dimensional analysis may not give the formula with true physical relationship, e.g., according to dimensional analysis. $s = ut + \frac{1}{2}at^2$ is the correct relationship. But, we know, the correct formula is $s = ut + \frac{1}{2}at^2$

(iii) Dimensionless constants like 1,2,3,…, e, π are not available in the formula derived with the help of dimensional analysis.

(iv) Formula containing trigonometric, exponential functions cannot be derived with the help of dimensional analysis.

(v) This method does not inform about the nature of the derived physical quantity, i.e., whether it is scalar or vector.

Q.14. Point out the measurable quantity likely to create the maximum error in the following experimental measurement: Young's Modulus 'Y' of the material of the beam is calculated using the relation Y = $\boldsymbol{\frac{Wgl^3}{4bd^3\delta}}$, where, $\boldsymbol{w}$ = mg, δ = depression, $\boldsymbol{l, b, d}$ = length, breadth, thickness.

Ans. Here, Y = $\frac{mgl^3}{4bd^3\delta}$, g is constant

∴ Maximum relative errors in Y is given by

$$\frac{\Delta Y}{Y} = \frac{\Delta m}{m} + \frac{3\Delta l}{l} + \frac{\Delta b}{b} + 3\frac{\Delta d}{d} + \frac{\Delta \delta}{\delta}$$

Thus, clearly $m, l, b, d,$ and δ introduce the maximum error in the measurement of Y.

Q.15. A screw gauge has a pitch of 1 mm and 200 divisions on the circular scale. Is it possible to increase the accuracy by increasing the number of divisions on the circular scale?

Ans. Yes because the least accurate measurement, i.e., least count of a screw gauge.

$$= \frac{\text{Pitch}}{\text{number of division on circular scale}}$$

∴ Least count is inversely proportional to number of division on the circular scale.

So, with the increase in number of division on the circular scale, the least count will improve. In simple words, accuracy of screw gauge will increase.

Q.16. A satellite is observed from two points A and B at a distance 1.3×10^7 m apart on earth. If angle subtended at the satellite is $1^o30'$, find distance of the satellite from earth.

Ans. We have, $\theta = 1^o30' = (60' + 30') = 90'$

$= (90 \times 60)''$

$= 5400''$

$= (5400)(4.85 \times 10^{-6})$ rad [∵ $1'' = 4.85 \times 10^{-6}$ rad]

and $b = 1.3 \times 10^7$ m.

using, $D = \frac{b}{\theta}$, we get

$$D = \frac{1.3 \times 10^7}{(5400(4.85 \times 10^{-6}))}$$

$$= \frac{1.3 \times 10^{11}}{54 \times 4.85}$$

$= 4.96 \times 10^8$ m.

Q.17. Convert 4.29 light years into parsecs. Calculate the parallax of a star at the distance when viewed from two locations of earth six months apart in its orbit around sun.

Ans. (a) Conversion : We know that

1 light year $= 9.46 \times 10^{15}$ m

∴ 4.29 light years $= 4.29 \times 9.46 \times 10^{15}$

$= 4.058 \times 10^{16}$ m

Also, 1 parsec $= 3.08 \times 10^{16}$ m

∴ 4.29 light year $= \frac{4.058 \times 10^{16}}{3.08 \times 10^{16}}$

$= 1.318$ parsec

= 1.32 parsec.

(b) Parallax− In six months, the distance between two observations will be equal to the diameter of the orbit, i.e.

2 × radius of orbit

2 AU = $2 \times 1.496 \times 10^{11}$ m

Using, $\theta = \frac{b}{D}$

where $b = 2 \times 1.496 \times 10^{11}$ m

and $D = 4.058 \times 10^{16}$

we get, $\theta = \frac{2 \times 1.496 \times 10^{11}}{4.058 \times 10^{16}}$

$= 7.37 \times 10^{-6}$ rad

$= 7.37 \times 10^{-6} \times \frac{180 \times 60 \times 60}{\pi}$

= 1.52 second of arc.

Q.18. Distance of a star from earth is 1.5 $\times$ 10^{11} m. If the angular size of the star is 2000''. Find the diameter of the star.

Ans. We have, α = 200''

$= 2000 \times 4.85 \times 10^{-6}$ rad. [∵ 1'' = 4.85×10^{-6} rad]

And $D = 1.5 \times 10^{11}$

Using $d = \alpha D$, we get

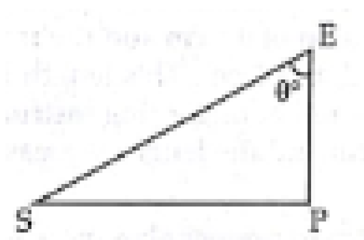
$d = 2000 \times 4.85 \times 10^{-6} \times 1.5 \times 10^{11}$

$= 2 \times 4.85 \times 1.5 \times 10^{8}$

$= 1.455 \times 10^{9}$ m.

Q.19. Maximum elongation in the case of a planet is 50°. Find the distance between the planet and sun and the distance between the planet and earth. Also find the orbital time period of the planet in years.

Ans. We know, the distance between earth and sun is 1 AV.



We have, $\theta = 50^o$

Let r_{PS} be the distance between plane and sun

$\therefore r_{PS} = \sin\theta$ (AU)

$= \sin 50^0$ AU

= 0.766 AU

Let r_{PE} be the distance between planet and earth.

$\therefore r_{PE} = \cos\theta$ (AU)

$= \cos 50^0$ AU

= 0.642 AU

Now, Applying Kepler's 3rd law

$$\frac{r_{PS}^3}{T_{ES}^3} = \frac{r_{PS}^2}{T_{ES}^2}$$

Or $T_{PS}^2 = \left[\frac{r_{PS}}{r_{ES}}\right]^3 \times T_{ES}^2$

Or $T_{PS} = \left[\frac{r_{PS}}{r_{ES}}\right]^{\frac{3}{2}} \times T_{ES}$

$T_{PS} = \left[\frac{0.766\ \text{AU}}{1\ \text{AU}}\right]^{3/2} \times 365$ days

= 244.7 days

= 0.67 years

Q.20. Orbital radius of mercury around the sun is 0.38 A.U. Find maximum elongation for mercury and its distance from earth at this elongation.

Ans. We have

$r_{PS} = 0.38$ AU

Using $r_{PS} = \text{AU} \sin\theta$,

or $\sin\theta = \frac{r_{PS}}{\text{AU}}$

$= \sin^{-1} 0.38 = 22^o3'$

Now $r_{PE} = \text{AU} \cos\theta$

$\therefore$ $r_{PE} = (1.496 \times 10^{11}\ \text{m}) \times \cos 22^o3'$

$= 1.384 \times 10^{11}$ m

$= 1.384 \times 10^8$ km.

Q.21. Mankind has existed for about 10^6 years whereas the universe is about 10^{10} year old. If the age of universe is taken to be one day, how many seconds has the mankind existed?

Ans. Since, 10^{10} years = 1 day

$$10^6 \text{ years} = \frac{1}{10^{10}} \times 10^6 \text{ days}$$

$$= 10^{-4} \text{ days}$$

$$= 10^{-4} \times 24 \times 60 \times 60 \text{ s}$$

$$= 86400 \times 10^{-4} \text{ s}$$

$$= 8.64 \text{ sec.}$$