Date: 13/10/2021

Q1. Why do we have different units for the same physical quantity?

Q2. Express unified atomic mass unit in kg.

Q3. The radius of atom is of the order of 1 Å and radius of nucleus is of the order of fermi. How many magnitudes higher is the volume of atom as compared to the volume of nucleus?

Q4. Name the device used for measuring the mass of atoms and molecules.

Q5. Why length, mass and time are chosen as base quantities in mechanics?

Q6. A function $f(\theta)$ is defined as:

$$f(\theta) = 1 - \theta + \frac{\theta^2}{2!} - \frac{\theta^3}{3!} + \frac{\theta^4}{4!} \ldots$$

Why is it necessary for q to be a dimensionless quantity?

Q7. The distance of a galaxy is of the order of 10^{25} m. Calculate the order of magnitude of time taken by light to reach us from the galaxy.

Q8. Which of the following time measuring devices is most precise?

(a) A wall clock (b) A stop watch (c) A digital watch. (d) An atomic clock

Give reason for your answer.

Q9. Give an example of

(a) a physical quantity which has a unit but no dimensions.

(b) a physical quantity which has neither unit nor dimensions.

(c) a constant which has a unit. (d) a constant which has no unit.

Q10. If the unit of force is 100 N, unit of length is 10 m and unit of time is 100 s, what is the unit of mass in this system of units?

Q11. During a total solar eclipse the Moon almost entirely covers the sphere of the Sun. Write the relation between the distances and sizes of the Sun and moon.

Q12. The vernier scale of a travelling microscope has 50 divisions which coincide with 49 main scale divisions. If each main scale division is 0.5 mm, calculate the minimum inaccuracy in the measurement of distance.

Q13. Einstein's mass-energy relation emerging out of his famous theory of relativity relates mass (m) to energy (E) as $E = mc^2$, where c is speed of light in vacuum. At the nuclear level, the magnitudes of energy are very small. The energy at nuclear level is usually measured in MeV, where 1 MeV = 1.6×10^{-13} J; the masses are measured in unified atomic mass unit (u) where 1 u = 1.67×10^{-27} kg.

(a) Show that the energy equivalent of 1 u is 931.5 MeV.

(b) A student writes the relation as 1 u = 931.5 MeV. The teacher points out that the relation is dimensionally incorrect. Write the correct relation.

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Q14. A physical quantity X is related to four measurable quantities a, b, c and d as follows:

$$X = a^2 b^3 c^{5/2} d^{-2}.$$

The percentage error in the measurement of a, b, c and d are 1%, 2%, 3% and 4%, respectively. What is the percentage error in quantity X? If the value of X calculated on the basis of the above relation is 2.763, to what value should you round off the result.

Q15. Time for 20 oscillations of a pendulum is measured as t_1 = 39.6 s; t_2 = 39.9 s; t_3 = 39.5 s. What is the precision in the measurements? What is the accuracy of the measurement?

Q16. Calculate the solid angle subtended by the periphery of an area of 1 cm^2 at a point situated symmetrically at a distance of 5 cm from the area.

Q17. Calculate the length of the arc of a circle of radius 31.0 cm which subtends an angle of $\frac{\pi}{6}$ at the centre.

Q18. (a) The Earth-Moon distance is about 60 Earth radius. What will be the diameter of the Earth (approximately in degrees) as seen from the Moon?

(b) Moon is seen to be of (½)° diameter from the Earth. What must be the relative size compared to the Earth?

(c) From parallax measurement, the Sun is found to be at a distance of about 400 times the Earth-Moon distance. Estimate the ratio of Sun-Earth diameters.

Q19. If velocity of light c, Planck's constant h and gravitational constant G are taken as fundamental quantities then express the time in terms of dimensions of these quantities.

Q20. If velocity of light c, Planck's constant h and gravitational constant G are taken as fundamental quantities then express the length in terms of dimensions of these quantities.

Q21. If velocity of light c, Planck's constant h and gravitational constant G are taken as fundamental quantities then express the mass in terms of dimensions of these quantities.

Q22. An artificial satellite is revolving around a planet of mass M and radius R, in a circular orbit of radius r. From Kepler's Third law about the period of a satellite around a common central body, square of the period of revolution T is proportional to the cube of the radius of the orbit r. Show using dimensional analysis, that

$$T = \frac{k}{R}\sqrt{\frac{r^3}{g}},$$

where k is a dimensionless constant and g is acceleration due to gravity.

Q23. In the expression $P = El^2 m^{-5} G^{-2}$, E, m, l and G denote energy, mass, angular momentum and gravitational constant, respectively. Show that P is a dimensionless quantity.

Q24. The volume of a liquid flowing out per second of a pipe of length l and radius r is written by a student as

$$v = \frac{\pi}{8}\frac{Pr^4}{\eta l},$$

where P is the pressure difference between the two ends of the pipe and η is coefficient of viscosity of the liquid having dimensional formula $ML^{-1}T^{-1}$.

Check whether the equation is dimensionally correct.

Q25. A new system of units is proposed in which unit of mass is α kg, unit of length β m and unit of time γ s. How much will 5 J measure in this new system?

Q26. The displacement of a progressive wave is represented by $y = A \sin(\omega t - kx)$, where x is distance and t is time. Write the dimensional formula of (a) ω and (b) k.

Q27. In an experiment to estimate the size of a molecule of oleic acid 1 mL of oleic acid is dissolved in 19 mL of alcohol. Then 1 mL of this solution is diluted to 20 mL by adding alcohol. Now 1 drop of this diluted solution is placed on water in a shallow trough. The solution spreads over the surface of water forming one molecule thick layer. Now, lycopodium powder is sprinkled evenly over the film and its diameter is measured. Knowing the volume of the drop and area of the film we can calculate the thickness of the film which will give us the size of oleic acid molecule.

Read the passage carefully and answer the following questions:

(a) Why do we dissolve oleic acid in alcohol?

(b) What is the role of lycopodium powder?

(c) What would be the volume of oleic acid in each mL of solution prepared?

(d) How will you calculate the volume of n drops of this solution of oleic acid?

(e) What will be the volume of oleic acid in one drop of this solution?

Q28. (a) How many astronomical units (A.U.) make 1 parsec?

(b) Consider a Sun like star at a distance of 2 parsecs. When it is seen through a telescope with 100 magnification, what should be the angular size of the star? Sun appears to be $(1/2)°$ from the Earth. Due to atmospheric fluctuations, eye can't resolve objects smaller than 1 arc minute.

(c) Mars has approximately half of the Earth's diameter. When it is closest to the Earth it is at about 1/2 A.U. from the Earth. Calculate what size it will appear when seen through the same telescope.

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S1. Because, bodies differ in order of magnitude significantly in respect to the same physical quantity. For example, interatomic distances are of the order of angstroms, inter-city distances are of the order of km, and interstellar distances are of the order of light year.

S2. One atomic mass unit is the $\frac{1}{12}$ of the mass of a ${}_6C^{12}$ atom.

Mass of one mole of ${}_6C^{12}$ atom = 12 g

Number of atoms in one mole = Avogadro's number

$$= 6.023 \times 10^{23}$$

$$\therefore \quad \text{Mass of one } {}_6C^{12} \text{ atom} = \frac{12}{6.023 \times 10^{23}} \text{ g}$$

$$1 \text{ amu} = \frac{1}{12} \times \text{mass of one } {}_6C^{12} \text{ atom}$$

$$\therefore \quad 1 \text{ amu} = \left(\frac{1}{12} \times \frac{12}{6.023 \times 10^{23}}\right) \text{g} = 1.67 \times 10^{-24} \text{ g}$$

$$= 1.67 \times 10^{-27} \text{ kg} \qquad [\because 1 \text{ g} = 10^{-3} \text{ kg}]$$

S3. Radius of atom = 1 Å = 10^{-10} m

Radius of nucleus = 1 fermi = 10^{-15} m

$$\text{Volume of atom} = V_A = \frac{4}{3}\pi R_A^3$$

$$\text{Volume of nucleus } V_N = \frac{4}{3}\pi R_N^3$$

$$\frac{V_A}{V_N} = \frac{\frac{4}{3}\pi R_A^3}{\frac{4}{3}\pi R_N^3} = \left(\frac{R_A}{R_N}\right)^3 = \left(\frac{10^{-10}}{10^{-15}}\right)^3 = 10^{15}$$

Note: In such type of questions, always change the value in same unit.

S4. Mass spectrograph.

S5. Length, mass and time are chosen as base quantities in mechanics because

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(a) Length, mass and time cannot be derived from one another, that is these quantities are independent.

(b) All other quantities of mechanics can be expressed in terms of length, mass and time through simple relations.

S6. Since $f(\theta)$ is a sum of different powers of θ, it has to be dimensionless

S7. Given, Distance of the galaxy = 10^{25} m

Speed of light = 3×10^8 m/s

Hence, time taken by light to reach us from galaxy is,

$$t = \frac{\text{Distance}}{\text{Speed}} = \frac{10^{25}}{3 \times 10^8} = \frac{1}{3} \times 10^{17}$$

$$= \frac{10}{3} \times 10^{16} = 3.33 \times 10^{16}\text{ s.}$$

S8. An atomic clock is the most precise time measuring device because atomic oscillations are repeated with a precision of 1*s* in 10^{13} s.

S9. (a) Angle or solid angle.

(b) Relative density, etc.

(c) Planck's constant, universal gravitational constant, etc.

(d) Raynold number.

S10. Dimension of force $F = [MLT^{-2}] = 100$ N ... (i)

Length $(L) = [L] = 10$ m ... (ii)

Time $(t) = [T] = 100$ s ... (iii)

Substituting values of L and T from Eqs. (ii) and (iii) in Eq. (i), we get

$$M \times 10 \times (100)^{-2} = 100$$

$$\Rightarrow \quad \frac{M \times 10}{100 \times 100} = 100$$

$$\Rightarrow \quad M = 100 \times 1000\text{ kg}$$

$$M = 10^5\text{ kg.}$$

S11. Consider the diagram given below

R_{me} = Distance of Moon from Earth

R_{se} = Distance of Sun from Earth

Let angle made by Sun and Moon is θ, we can write

$$\theta = \frac{A_{\text{Sun}}}{R_{se}^2} = \frac{A_{\text{Moon}}}{R_{me}^2}$$

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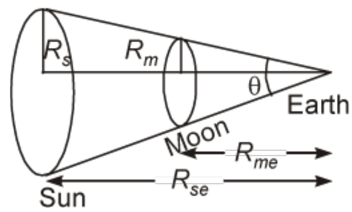
Here, A_{Sun} = Area of the Sun

A_{Moon} = Area of the Moon



$\Rightarrow$ $$\theta = \frac{\pi R_s^2}{R_{se}^2} = \frac{\pi R_m^2}{R_{me}^2}$$

$\Rightarrow$ $$\left(\frac{R_s}{R_{se}}\right)^2 = \left(\frac{R_m}{R_{me}}\right)^2$$

$\Rightarrow$ $$\frac{R_s}{R_{se}} = \frac{R_m}{R_{me}}$$

$\Rightarrow$ $$\frac{R_s}{R_m} = \frac{R_{se}}{R_{me}}.$$

S12. By question, it is given that 50 VSD = 49 MSD

$$1 \text{ MSD} = \frac{50}{49} \text{ VSD}$$

$$1 \text{ VSD} = \frac{49}{50} \text{ MSD}$$

$$\text{Minimum inaccuracy} = 1 \text{ MSD} - 1 \text{ VSD}$$

$$= 1 \text{ MSD} - \frac{49}{50} \text{ MSD} = \frac{1}{50} \text{ MSD}$$

Given, 1 MSD = 0.5 mm

Hence, $$\text{Minimum inaccuracy} = \frac{1}{50} \times 0.5 \text{ mm} = \frac{1}{100} = 0.01 \text{ mm}.$$

Minimum accuracy can also be called the least count of the instrument.

S13. (a) Since $1 \text{ u} = 1.67 \times 10^{-27}$ kg,

Applying, $$E = \Delta mc^2$$

$$= (1.67 \times 10^{-27})(3 \times 10^8)^2 \text{ J}$$

$$= 1.67 \times 9 \times 10^{-11} \text{ J}$$

$$E = \frac{1.67 \times 9 \times 11^{-11}}{1.6 \times 10^{-13}} \text{ MeV} = 939.4 \text{ MeV}$$

[1 ev = 1.6×10^{-19} J and 1 mev = 10^6 ev]

(b) The dimensionally correct relation is

$$1 \text{ u} \times c^2 = 931.5 \text{ MeV}.$$

S14. Given, physical quantity is $X = a^2 b^3 c^{5/2} d^{-2}$

Maximum percentage error in X is

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$$\frac{\Delta X}{X} \times 100 = \pm\left[2\left(\frac{\Delta a}{a}\times 100\right)+3\left(\frac{\Delta b}{b}\times 100\right)+\frac{5}{2}\left(\frac{\Delta c}{c}\times 100\right)+2\left(\frac{\Delta d}{d}\times 100\right)\right]$$

$$= \pm\left[2\,(1)+3\,(2)+\frac{5}{2}(3)+2\,(4)\right]\%$$

$$= \pm\left[2+6+\frac{15}{2}+8\right] = \pm 23.5\%$$

$\therefore$ Percentage error in quantity $X = \pm 23.5\%$

Mean absolute error in $X = \pm 0.235 = \pm 0.24$ [Rounding-off upto two significant digits]

The calculated value of x should be round-off upto two significant digits.

$\therefore$ $X = 2.8$

S15. (a) Precision is given by the least count of the instrument.

For 20 oscillations, precision = 0.1 s

For 1 oscillation, precision = 0.005 s.

(b) Average time $t = \dfrac{39.6+39.9+39.5}{3}\text{ s} = 39.6\text{ s}$

Period = $\dfrac{39.6}{20} = 1.995\text{ s}$

Max. observed error = (1.995 – 1.980) s = 0.015 s.

S16. We know that, Solid angle = $\dfrac{\text{Area}}{(\text{Distance})^2}$

$$= \frac{1\,\text{cm}^2}{(5\text{ cm})^2} = \frac{1}{25}$$

$= 4\times 10^{-2}$ steradian [$\because$ Area = 1 cm^2, distance = 5 cm]

Note: We should not confuse, solid angle with plane angle $\theta = \dfrac{l}{r}$ radian

S17. We know that angle $\theta = \dfrac{l}{r}$

Given, $\theta = \dfrac{\pi}{6} = \dfrac{l}{31}\text{ cm}$

Hence, Length = $l = 31\times\dfrac{\pi}{6}$ cm = $\dfrac{31\times 3.14}{6}$ cm = 16.22 cm

Rounding off to three significant figures it would be 16.2 cm.

S18. (a) $\theta = \dfrac{R_E}{60\,R_E} = \dfrac{1}{60}\text{ rad} = 1^\circ$.

$\therefore$ Diameter of the Earth as seen from the Moon is about 2°.

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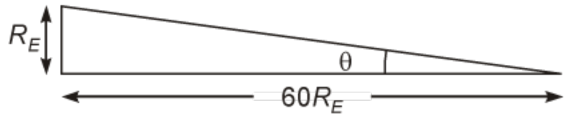
(b) At Earth-Moon distance, Moon is seen as $(1/2)°$ diameter and Earth is seen as $2°$ diameter. Hence, diameter of Earth is 4 times the diameter of Moon.

$$\frac{D_{\text{Earth}}}{D_{\text{Moon}}} = 4$$



(c) $$\frac{r_{\text{Sun}}}{r_{\text{Moon}}} = 400$$

(Here r stands for distance, and D for diameter.)

Sun and Moon both appear to be of the same angular diameter as seen from the Earth.

$$\therefore \quad \frac{D_{\text{Sun}}}{r_{\text{Sun}}} = \frac{D_{\text{Moon}}}{r_{\text{Moon}}}$$

$$\therefore \quad \frac{D_{\text{Sun}}}{D_{\text{Moon}}} = 400$$

But $$\frac{D_{\text{Earth}}}{D_{\text{Moon}}} = 4 \quad \therefore \quad \frac{D_{\text{Sun}}}{D_{\text{Earth}}} = 100.$$

S19. We know that, Dimensions of $(h) = [ML^2T^{-1}]$

Dimensions of $(c) = [LT^{-1}]$

Dimensions of gravitational constant $(G) = [M^{-1}L^3T^{-2}]$

Let $$T \propto c^x h^y G^z$$

$$\Rightarrow \quad T = kc^x h^y G^z \quad \text{... (i)}$$

where, k is a dimensionless constant.

Substituting dimensions of each term in Eq. (i), we get

$$[M^0L^0T] = [LT^{-1}]^x \times [ML^2T^{-1}]^y \times [M^{-1}L^3T^{-2}]^z$$
$$= [M^{y-z} L^{x+2y+3z} T^{-x-y-2z}]$$

Comparing powers of same terms on both sides, we get

$$y - z = 0 \quad \text{... (ii)}$$
$$x + 2y + 3x = 0 \quad \text{... (iii)}$$
$$-x - y - 2z = 1 \quad \text{... (iv)}$$

Adding Eqs. (ii), (iii) and (iv), we get

$$2y = 1 \quad \Rightarrow \quad y = \frac{1}{2}$$

Substituting value of y in Eq. (ii), we get

$$z = y = \frac{1}{2}$$

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From Eq. (iv)

$$x = -y - 2z - 1$$

Substituting values of y and z, we get

$$x = -\frac{1}{2} - 2\left(\frac{1}{2}\right) - 1 = -\frac{5}{2}$$

Putting values of x, y and z in Eq. (i), we get

$$T = kc^{-5/2}h^{1/2}G^{1/2}$$

$\Rightarrow$ $$T = k\sqrt{\frac{hG}{c^5}}.$$

S20. We know that, Dimensions of (h) = $[ML^2T^{-1}]$

Dimensions of (c) = $[LT^{-1}]$

Dimensions of gravitational constant (G) = $[M^{-1}L^3T^{-2}]$

Let $$L \propto c^x h^y G^z$$

$\Rightarrow$ $$L = kc^x h^y G^z \qquad \text{... (i)}$$

where, k is a dimensionless constant.

Substituting dimensions of each term in Eq. (i), we get

$$[M^0LT^0] = [LT^{-1}]^x \times [ML^2T^{-1}]^y \times [M^{-1}L^3T^{-2}]^z$$
$$= [M^{y-z}L^{x+2y+3z}T^{-x-y-2z}]$$

Comparing powers of same terms on both sides, we get

$$y - z = 0 \qquad \text{... (ii)}$$
$$x + 2y + 3x = 1 \qquad \text{... (iii)}$$
$$-x - y - 2z = 0 \qquad \text{... (iv)}$$

Adding Eqs. (ii), (iii) and (iv), we get

$$2y = 1 \quad \Rightarrow \quad y = \frac{1}{2}$$

Substituting value of y in Eq. (ii), we get

$$z = \frac{1}{2}$$

From Eq. (iv)

$$x = -y - 2z$$

Substituting values of y and z, we get

$$x = -\frac{1}{2} - 2\left(\frac{1}{2}\right) = -\frac{3}{2}$$

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Putting values of x, y and z in Eq. (i), we get

$$L = kc^{-3/2}h^{1/2}G^{1/2}$$

$$\Rightarrow \qquad L = k\sqrt{\frac{hG}{c^3}}.$$

S21. We know that, Dimensions of $(h) = [ML^2T^{-1}]$

Dimensions of $(c) = [LT^{-1}]$

Dimensions of gravitational constant $(G) = [M^{-1}L^3T^{-2}]$

Let $\qquad m \propto c^x h^y G^z$

$$\Rightarrow \qquad m = kc^x h^y G^z \qquad \text{... (i)}$$

where, k is a dimensionless constant of proportionality.

Substituting dimensions of each term in Eq. (i), we get

$$[ML^0T^0] = [LT^{-1}]^x \times [ML^2T^{-1}]^y \times [M^{-1}L^3T^{-2}]^z$$
$$= [M^{y-z}L^{x+2y+3z}T^{-x-y-2z}]$$

Comparing powers of same terms on both sides, we get

$$y - z = 1 \qquad \text{... (ii)}$$
$$x + 2y + 3x = 0 \qquad \text{... (iii)}$$
$$-x - y - 2z = 0 \qquad \text{... (iv)}$$

Adding Eqs. (ii), (iii) and (iv), we get

$$2y = 1 \quad \Rightarrow \quad y = \frac{1}{2}$$

Substituting value of y in Eq. (ii), we get

$$z = -\frac{1}{2}$$

From Eq. (iv)

$$x = -y - 2z$$

Substituting values of y and z, we get

$$x = -\frac{1}{2} - 2\left(-\frac{1}{2}\right) = \frac{1}{2}$$

Putting values of x, y and z in Eq. (i), we get

$$m = kc^{1/2}h^{1/2}G^{-1/2}$$

$$\Rightarrow \qquad m = k\sqrt{\frac{ch}{G}}.$$

S22. By Kepler's third law, $\qquad T^2 \propto r^3 \quad \Rightarrow \quad T \propto r^{3/2}$

We know that T is a function of R and g.

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Let $$T \propto r^{3/2} R^a g^b$$

$\Rightarrow$ $$T = kr^{3/2} R^a g^b \quad \text{... (i)}$$

where k, is a dimensionless constant of proportionality.

Substituting the dimensions of each term in Eq. (i), we get

$$[M^0L^0T] = k[L]^{3/2}[L]^a[LT^{-2}]^b$$
$$= k[L^{a+b+3/2}T^{-2b}]$$

On comparing the powers of same terms, we get

$$a + b + 3/2 = 0 \quad \text{... (ii)}$$
$$-2b = 1 \quad \Rightarrow \quad b = -1/2 \quad \text{... (iii)}$$

From Eq. (ii), we get

$$a - 1/2 + 3/2 = 0 \quad \Rightarrow \quad a = -1$$

Substituting the values of a and b in Eq. (i), we get

$$T = kr^{3/2} R^{-1} g^{-1/2}$$

$\Rightarrow$ $$T = \frac{k}{R}\sqrt{\frac{r^3}{g}}.$$

Note: When we are applying formulae, we should be careful about r (radius of orbit) and R (radius of planet).

S23. Since E, l and G have dimensional formulas:

$$E \rightarrow ML^2T^{-2}$$
$$l \rightarrow ML^2T^{-1}$$
$$G \rightarrow L^3M^{-1}T^{-2}$$

Hence, $P = El^2 m^{-5} G^{-2}$ will have dimensions:

$$[P] = \frac{[ML^2T^{-2}][M^2L^4T^{-2}][M^2T^4]}{[M^5][L^6]}$$
$$= M^0L^0T^0.$$

Thus, P is dimensionless.

S24. The dimensional part in the expression is $\frac{Pr^4}{\eta l}$. Therefore, the dimensions of the right hand side comes out to be $\frac{[ML^{-1}T^{-2}][L^4]}{[ML^{-1}T^{-1}][L]} = \frac{[L^3]}{[T]}$, which is volume upon time. Hence, the formula is dimensionally correct.

S25. We know that dimension of energy = $[ML^2T^{-2}]$

Let M_1, L_1, T_1 and M_2, L_2, T_2 are units of mass, length and time in given two systems.

$\therefore$ $$M_1 = 1\,kg, \quad L_1 = 1\,m, \quad T_1 = 1\,s$$
$$M_2 = \alpha\,kg, \quad L_2 = \beta\,m, \quad T_2 = \gamma\,s$$

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The magnitude of a physical quantity remains the same, whatever be the system of units of its measurement *i.e.*,

$$n_1 u_1 = n_2 u_2$$

$$\Rightarrow \quad n_2 = n_1 \frac{u_1}{u_2} = n_1 \frac{[M_1 L_1^2 T_1^2]}{[M_2 L_2^2 T_2^{-2}]} = 5\left[\frac{M_1}{M_2}\right] \times \left[\frac{L_1}{L_2}\right]^2 \times \left[\frac{T_1}{T_2}\right]^{-2}$$

$$= 5\left[\frac{1}{\alpha}\text{kg}\right] \times \left[\frac{1}{\beta}\text{m}\right]^2 \times \left[\frac{1}{\gamma}\text{s}\right]^{-2}$$

$$= 5 \times \frac{1}{\alpha} \times \frac{1}{\beta^2} \times \frac{1}{\gamma^{-2}}$$

$$n_2 = \frac{5\gamma^2}{\alpha\beta^2}$$

Thus, new unit of energy will be $\frac{\gamma^2}{\alpha\beta^2}$.

S26. Dimensional formula of $\omega = T^{-1}$.

Dimensional formula of $k = L^{-1}$.

S27. (a) Because oleic acid dissolves in alcohol but does not dissolve in water.

(b) When lycopodium powder is spread on water, it spreads on the entire surface. When a drop of the prepared solution is dropped on water, oleic acid does not dissolve in water, it spreads on the water surface pushing the lycopodium powder away to clear a circular area where the drop falls. This allows measuring the area where oleic acid spreads.

(c) $\frac{1}{20}\text{mL} \times \frac{1}{20} = \frac{1}{400}\text{mL}$.

(d) By means of a burette and measuring cylinder and measuring the number of drops.

(e) If n drops of the solution make 1 mL, the volume of oleic acid in one drop will be $(1/400)n$ mL.

S28. (a) By definition of parsec

$$\therefore \quad 1\text{ parsec} = \frac{1\text{ A.U.}}{1\text{ arc sec}}.$$

$$1\text{ deg} = 3600\text{ arc sec}$$

$$\therefore \quad 1\text{ arc sec} = \frac{\pi}{3600 \times 180}\text{ radians}$$

$$\therefore \quad 1\text{ parsec} = \frac{3600 \times 180}{\pi}\text{ A.U.} = 206265\text{ A.U.} 5 \approx 2 \times 10\text{ A.U.}$$

(b) At 1 A.U. distance, sun is $(1/2^\circ)$ in diameter.

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Therefore, at 1 parsec, star is $\frac{1/2}{2\times10^5}$ degree in diameter = 15×10^{-5} arc min.

With 100 magnification, it should look 15×10^{-3} arc min. However, due to atmospheric fluctuations, it will still look of about 1 arc min. It can't be magnified using telescope.

(c) $$\frac{D_{\text{Mars}}}{D_{\text{Earth}}} = \frac{1}{2}, \quad \frac{D_{\text{Earth}}}{D_{\text{Sun}}} = \frac{1}{400}$$

$\therefore$ $$\frac{D_{\text{Mars}}}{D_{\text{Sun}}} = \frac{1}{800}.$$

At 1 A.U. Sun is seen as 1/2 degree in diameter, and Mars will be seen as 1/1600 degree in diameter.

At 1/2 A.U, mars will be seen as 1/800 degree in diameter. With 100 magnification mars will be seen as 1/8 degree $\frac{60}{8} = 7.5$ arc min.

This is larger than resolution limit due to atmospheric fluctuations. Hence, it looks magnified.

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