IIT PRAGATI CENTRE

Units and Measurements

Solutions

CLASS : XI CBSE

✓ Answer Key:

Multiple Choice Answers-

1. Answer: (c) energy
2. Answer: (b) distance
3. Answer: (b) impulse and momentum
4. Answer: (d) Work, energy, and torque
5. Answer: (a) $[M^0L^0TA^0]$
6. Answer: (c) 600
7. Answer: (d) a measure of the systematic errors
8. Answer: (b) length, mass, time, electric current, thermodynamic temperature, amount of substance, and luminous intensity
9. Answer: (d) reference standard for the physical quantity
10. Answer: (b) 216 m^3

Very Short Answers:

1. Answer: 10^{10} m.
2. Answer: It stands for Light Amplification by Stimulated Emission of Radiation.
3. Answer: 10^{-11} m (size of an atom.).
4. Answer: By a factor of 4.
5. Answer: 4.
6. Answer: 3% + 3 × 2% = 9%.

7. Answer: The second measurement is more accurate as it has been made to the second decimal point.
8. Answer: No.
9. Answer: Yes, because all the derived units in this system can be obtained by multiplying or dividing a certain set of basic units.
10. Answer: No, 1 A.U. = 1.496×10^{11} m and 1 Å = 10^{10} m.

Short Questions Answers:

1. Answer: The size of a nucleus is in the range of 10^{-15} m to 10^{-14} m. The tip of a sharp pain may be taken to be in the range of 10^{-5} m to 10^{-4} m. Thus, we are scaling up the size of the nucleus by a factor of $10^{-5}/10^{-15} = 10^{10}$. An atom roughly of size 10-10 m will be scaled up to a rough size of $10^{-10} \times 10^{10}$ = 1 m. Thus, nucleus in an atom is as small in size as the tip of a sharp pin placed at the center of a sphere of radius about a meter.
2. Answer: It is defined as a quantity that can be measured, e.g., mass, length, time, etc.

   (b)

   (i) They are defined as those quantities which cannot be expressed in terms of other quantities and are independent of each other, e.g., mass, length, time.

   (ii) They are defined as the quantities which can be expressed in terms of fundamental quantities, e.g., velocity, acceleration, density, pressure, etc.
3. Answer: It is defined as the reference standard used to measure a physical quantity.

   (b)

   (i) They are defined as the units of fundamental quantities. They are independent of each other and are expressed by writing the letter of the fundamental quantity in a parenthesis. e.g., Fundamental units of mass, length and time are [M], [L], [T] respectively.

(ii) They are defined as those units which can be derived from fundamental units. They are expressed by writing the symbol of a derived quantity in a parenthesis.

e.g., D.U. of velocity = [u]

acceleration = [a]

pressure = [P]

work = [W] and so on.

4. Answer: It is defined as the luminous intensity in a perpendicular direction of a surface of $\frac{1}{600,000}$ square meter area of a black body at a temperature of freezing platinum (1773°C) under a pressure of 101,325 N/m^2.

5. Answer:

- It can be easily made available in any standard laboratory as Krypton is available everywhere.
- It is well defined and does not change with temperature, time, place or pressure, etc.
- It is invariable.
- It increases the accuracy of the measurement of length (1 part in 10^9).

6. Answer: Any phenomenon that repeats itself regularly at equal intervals of time can be used to measure time.

The examples are:

- Rotation of earth – the time interval for one complete rotation is called a day.
- Oscillations of a pendulum.

7. Answer: In 0.8 s, the human heart makes one beat.

∴ In 1 s, the human heart makes = $\frac{1}{0.8} = \frac{10}{8}$ beats.

∴ In 10 years, the human heart makes

= $\frac{10}{8} \times 365 \times 24 \times 60 \times 60$ beats.

= 3.942×10^8 beats.

8. Answer: The dimensional analysis fails to derive a relation involving more than three unknown variables. The reason is

that there will be more than three unknown factors in that case whose values cannot be determined from the three relations which we get by comparing the powers of M, L, and T.

Long Questions Answers:

1. Answer: While writing the units of physical quantities following rules are followed with S.L units:

   (1) The S.l. units are written in the form of symbols after the number i.e., number of time, the unit is contained in the physical quantity so that physical quantity = nu

   With symbols, certain rules are laid down:

   - Units in symbols are never written in plural i.e., meters is only m and not ms, years is y.
   - The units based on the name of the scientists are written beginning with small letters and with capital letters in symbolic form viz, weber (Wb), newton (N), etc.
   - No full stop is used at the end of the symbol.
   - Symbols of units not based on the name of scientists are written as small letters viz. kilogram (kg), second (s), etc.

   (2) Bigger and smaller number of units are represented with symbols corresponding to the power of 10 viz. 106 is mega (M), 10^{12} is Tera (T), 10^{-3} is milli (m), 10^{-9} is nano (n), etc.

   (3) All units are written in numerator viz. kg/m^3 is kg m, Nm^2c^2.

   (4) The units are written within parenthesis in graphs below the corresponding taxes viz. (ms^{-1}) and (s) in the velocity-time graph.

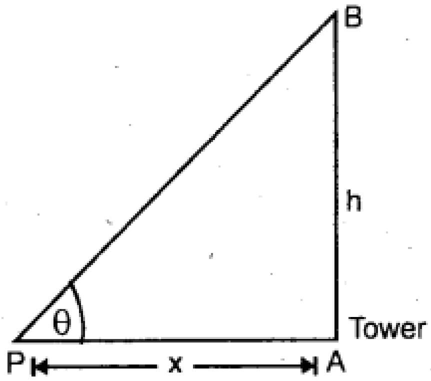
   (5) Units of a similar physical quantity can be added or subtracted.

2. Answer: It is used to measure the distance of an accessible or inaccessible hill or a tower by measuring the angle which the object makes at point P (say)

Let x = distance y of point P from the foot of tower = PA .

∴ h = x tan θ

It is also used to measure the distance of an inaccessible object eg. a tree on the other bank of a river.



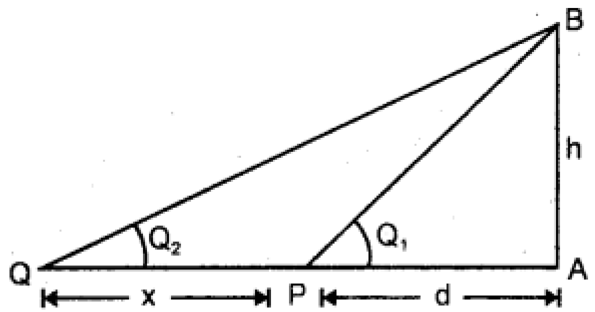
Let h = height of the inaccessible object.

Let θ1, θ2 = be the angle made at P and Q by the object.

Let PA = d, PQ = x.

∴ In ΔPAB and ΔQAB,

	$d = h \cot \theta_i$	... (*i*)
and	$d + x = h \cot\theta_2$	... (*ii*)
(*ii*) and (*i*) gives,	$x = h\,(\cot\theta_2 - \cot\theta_1)$	
∴	$h = x/(\cot\theta_2 - \cot\theta_1)$.	



3. Answer:

   Dimensional analysis is used for:

   (a) checking the dimensional correctness of the given physical equation or relation.

   (b) converting one system of units to another system.

   (c) deriving the relationship between various physical quantities.

   (a) checking of the dimensional correctness of a physical relationship is done by using the principle of homogeneity of dimensions. If the dimensions of M, L, T of each term on R.H.S. are equal to the dimensions of M, L, T of each term on L.H.S., then the given- physical relation is dimensionally correct, otherwise wrong.

(b) conversion: It is based on the fact that the magnitude of a physical quantity remains the same whatever may be the system of units, i.e., $n_1u_1 = n_2u_2$.

or $$n_2 = n_1 \frac{u_1}{u_2}$$

where $$u_1 = M^a{}_1 L^b{}_1 T^c{}_1$$

and $$u_2 = M^a{}_2 L^b{}_2 T^c{}_2$$

are the units of M, L, T in the first and second system of units of a physical quantity having dimensions of M, L, T, and a, b, c respectively.

$$\therefore \quad n_2 = n_1 \left[\frac{M_1}{M_2}\right]^a \left[\frac{L_1}{L_2}\right]^b \left[\frac{T_1}{T_2}\right]^c \qquad ...(1)$$

Thus, if fundamental units of both systems, dimensions of the quantity, and its numerical value n1 in one system, are known then we can easily calculate n2 in another system.

(c) Derivation of a relationship between various physical quantities is based on the principle of homogeneity of dimensions.

Following are the steps used:

- We must Know the physical quantities (say p, q, r) upon which a physical quantity say x depends.
- We must know the dimensions of p, q, r say a, b, c respectively.
- [illegible]
- Now, write the dimensions of each physical quantity on both sides of the equation
- and compare the powers of M, L, T to find a, b, c. Putting values of a, b, c in the equation
- we get the required relation.

Assertion Reason Answer:

1. (c) Assertion is correct, reason is incorrect

Explanation:

Dimensional constants are not dimensionless.

2. (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.

Explanation:

As the distance of star increases, the parallax angle decreases, and great degree of accuracy is required for its measurement. Keeping in view the practical limitation in measuring the parallax angle, the maximum distance of a star we can measure is limited to 100 light years.

Case Study Answer:

1. i (d) Either (a) or (b)

Explanation:

A screw gauge and a spherometer can be used to measure length accurately as less as

$10m^{-5}$

ii (c) Spring oscillator

Explanation:

Spring oscillator cannot be used to measure time intervals.

iii (a) 4.9 cm

Explanation:

Given, length, l = 5cm Now, checking the errors with each options one-by-one, we get

$$\Delta l_1 = 5 - 4.9 = 0.1 \text{ cm}$$
$$\Delta l_2 = 5 - 4.805 = 0.195 \text{ cm}$$
$$\Delta l_3 = 5.25 - 5 = 0.25 \text{ cm}$$
$$\Delta l_4 = 5.4 - 5 = 0.4 \text{ cm}$$

Error Δl_1 is least.

Hence, 4.9cm is most precise or accurate.

iv (a) $22.0cm^2$

Explanation:

Area of rectangle, A = Length´ Breadth

So, A lb = 10. × 5 = 22. 05cm^2

Minimum possible measurement of

scale = 01. cm.

So, area measured by scale = 22 0. cm^2

v (c) 8.6 s

Explanation:

Magnification in time $= \frac{Age\ of\ mankind}{Age\ of\ universe}$

$$= \frac{10^6}{10^{10}} = 10^{-4}$$

Apparent age of mankind $= 10^{-4} \times 1$ day

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

$$= 8.64 \text{ s} \approx 8.6 \text{ s}$$

2. i (a) 2

Explanation:

As, we know that the terminal or trailing zero(s) in a number without a decimal point are not significant. So, 4700m has two significant figures.

ii (b) ab × 10^b

Explanation:

Every number is expressed as ab × 10^b, where a is a number between 1 & 10 and b is any

positive or negative exponent (or power) of 10.

iii (c) 4.8 g cm^{-3}

Explanation:

There are 3 significant figures in the measured mass whereas there are only 2 significant figures in the measured volume. Hence, the density should be expressed to only 2 significant figures.

Density $= \frac{5.74}{1.2} = 4.8 \text{ g cm}^{-3}$

iv (a) Change in unit does not change the significant figure.

Explanation:

There is no change in number of significant figures on changing the units. For it, the convention is that we write,

4700 m = 4700 $\times$ 10^3m

This convention ensures no change in number of significant numbers.

v (a) I and II

Explanation:

Following rules of significant figures are

I. All the non-zero digits are significant.

II. All the zeroes between two non-zero digits are significant, no matter where the decimal point is, if at all.

III. The terminal or trailing zero(s) in a number without a decimal point are not significant. Thus, 123m =12300cm =123000 mm has three significant figures, the trailing zero(s) being not significant.