QB365

# Important Questions - Units and Measurements

11th Standard CBSE

**Physics**

Reg.No. : | | | | | | |

Time : 01:00:00 Hrs

Total Marks : 50

## Section-A

1) Is it possible to have length and velocity both as fundamental quantities?Why? 1

2) How many astronomical units make one metre? 1

3) How many light years make 1 par sec? 1

4) Which of these is largest : astronomical unit, light year and par sec? 1

5) Which unit is used to measure size of a nucleus? 1

6) What is the difference between nm, mN and Nm? 1

7) How many amu make 1 kg? 1

8) Human heart is an inbuilt clock.comment 1

9) Define one Barn.How it is related with metre? 1

10) Calculate the length of the arc of a circle of radius 31. cm which subtends an angle of $\frac{\pi}{6}$ at the centre. 1

## Section-B

11) A new unit of length is chosen such that the speed of light in vacuum is unity. What is the distance between the sun and the earth in terms of the new unit, if light takes 8min and 20 s to cover this distance? 2

12) A jeweller put a diamond weighing 5.42 g in a box weighing 1.2 Kg. Find the total weight of the box and the diamond to correct number of significant figures. 2

13) Express an acceleration of 10 m/s$^2$ in km/h$^2$. 2

14) A student measures the thickness of a human hair by looking at it through a microscope of magnification 100. He makes 20 observations and finds that the average width of the hair in the field of view of the microscope is 3.5 mm. What is the estimate on the thickness of hair? 2

15) The photograph of a house occupies an area of 1.75 cm$^2$ on a 35 mm slide. The slide is projected on to a screen and area of the house on the screen is 1.55 m$^2$ . What is the linear magnification of the projector screen arrangement? 2

16) What is the technique used for measuring large time intervals? 2

17) It is claimed that the two cesium clocks, if allowed to run for 100 yr, free from any disturbance, may differ by only about 0.02 s. What does this imply for the accuracy of the standard cesium clock in measuring a time interval of 1s? 2

18) Find the relative error in Z if Z = $\frac{A^4B^{1/3}}{CD^{3/2}}$ 2

19) Which of the following length measurement is most accurate and why? 4.00 cm 2

20) Which of the following length measurement is most accurate and why? 0.004 mm 2

## Section-C

21) One mole of an ideal gas at standard temperature and pressure occupies 22.4 L(molar volume). What is the ratio of molar volume to the atomic volume of a mole of hydrogen? (Take the size of hydrogen molecule to be about 1$\mathring{A}$). Why is the ratio so large? 5

22) The sun is a hot plasma (ionised matter) with its inner core at a temperature exceeding $10^7$ K and its outer surface at a temperature of about 6000 K. At these high temperatures, no substance remains in a solid or liquid phase. In what range do you expect the mass densities of solids and liquids or gases? Check if your guess is correct from the following data. 5

Mass of the Sun =$2.0 \times 10^{30} kg$

and radius of the Sun =$7.0 \times 10^{8} m$.

23) Which of the following is the most precise device for measuring length? 5

i) A vernier callipers with 20 divisions on the sliding scale.

ii) A screw gauge of pitch 1 mm and 100 divisions on the circular scale.

iii) An optical instrument that can be measure length to within a wavelength of light.

24) The time period of oscillation of simple pendulum is given by $t = 2\pi\sqrt{\frac{l}{g}}$. What is the accuracy in the determination of g if 10 cm length is known to 1 mm accuracy and 0.5 s, time period is measured from time of 100 oscillation with a watch of 1 resolution? 5

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## Section-A

1) No, since length is fundamental quantity and velocity is the derived quantity. 1

2) 1 m = 6.67X10$^{-12}$ AU 1

3) 3.26 light years make 1 par sec 1

4) Par sec is larger than light year which in turn is larger than an astronomical unit. 1

5) The size of nucleus is measured in fermi 1 fermi=$10^{-15}$ m **1**

6) nm stands for nanometer, 1 nm=$10^{-9}$ m, mN stands for milli-newton, 1 mN=$10^{-3}$ N, Nm stands for newton metre. **1**

7) 1 amu=1.66X$10^{-27}$ kg ∴ 1 kg = (1/1.66X$10^{-27}$) amu = 0.6X$10^{27}$ amu **1**

8) True, because human heart beats at a regular rate. **1**

9) One Barn is a small unit of area used to measure area of nuclear cross-section ∴ 1 barn=$10^{-28}$ $m^2$. **1**

10) Hence, length of the arc=? Radius=31.0 cm, $\theta = \frac{\pi}{6}$ From, legnth of the arc of a circle(l)=r$\theta$ $31.0 \times \frac{\pi}{6} = 16.2 \quad cm$ **1**

## Section-B

11) The speed of light (c) = 1 new unit of length $s^{-1}$ **2**

Time taken by light to reach the earth

t = 8 min + 20 s = (8 X 60 X 20) s = 500 s

Distance between the sun and the earth

= speed of light X time

x = c X t = 1 new unit of length $s^{-1}$ X 500 s

= 500 new unit of length

12) Weight of diamond = 5.42 g = 0.00542 Kg **2**

Total weight = 1.2 + 0.00542

= 1.20542 kg = 1.2 kg

13) Acceleration= (10 m/(1s)$^2$) **2**

=(10X$10^{-3}$/[1/60X60])$^2$

=(3600)$^2$ X $10^{-2}$ km/h$^2$

=1.29X$10^5$ km/h$^2$.

14) Given, Magnification of microscope = 100 **2**

Observed width of the hair = 3.5 mm

Estimates on the thickness of hair is given by,

Magnification = $\frac{observed \quad width}{Real \quad width}$

or Real width = $\frac{Observed \quad width}{Magnification} = \frac{3.5}{100}$

=0.035 mm

15) Given, Area of object = 1.75 X $10^{-4}$ $m^2$ **2**

Area of image = 1.55 $m^2$

Areal magnification = $\frac{Area \quad of \quad image}{Area \quad of \quad object}$

$\frac{1.55}{1.74X10^{-4}} \approx 8857$

Linear magnification = $\sqrt{Areal \quad maginification}$

$\sqrt{8857}$

= 94.1

16) **2**

For measuring large time intervals, we use the technique of radioactive dating. Large time intervals are measured by studying the ratio of number of radioactive atoms decayed to the number of surviving atoms in the specimen.

17) Given, Total time (t) = 100 yr **2**

= 100 X 365$\frac{1}{4}$ days

= 100 X 365 $\frac{1}{4}$ X 24 h

= 100 X 365 $\frac{1}{4}$ X 24 X 60 X 60 s

Difference in time (Δ t) = 0.02 s

Error in 1s = $\frac{0.02}{100X365\frac{1}{4}X24X60X60} = \frac{2X10^{-2}X4}{1461X24X36X10^4} = 6.34X10^{-12}s \approx 10^{-12}s$

Therefore, the accuracy of the standard cesium clock in measuring a time interval of 1 s is $10^{-12}$ s.

18) Here, Z = $\frac{A^4B^{1/3}}{CD^{3/2}}$ **2**

Relative error, $\frac{\Delta Z}{Z} = \pm \left[4\left(\frac{\Delta A}{A}\right) + \frac{1}{3}\left(\frac{\Delta B}{B}\right) + \left(\frac{\Delta C}{C}\right) + \frac{3}{2}\left(\frac{\Delta D}{D}\right)\right]$

19) $\frac{\Delta x}{x} = \frac{0.01}{4.00} = 0.0025$ **2**

20) $\frac{\Delta x}{x} = \frac{0.001}{0.004} = 0.25$ **2**

## Section-C

21) Given, molar volume of one mole of hydrogen **5**

= 22.4 L = $22.4 \times 10^{-3} m^3$

Diameter of hydrogen molecules (d) = $1\mathring{A}$ = $10^{-10}$m

∴ Radius of hydrogen molecule (r) = $\frac{d}{2} = \frac{10^{-10}}{2}$

$= 0.5 \times 10^{-10} m$

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

$= \frac{4}{3} \times 3.14 \times (0.5 \times 10^{-10}) = 5.234 \times 10^{-31} m^3$

Number of molecules in one mole hydrogen = Avogadro's number (N) = $6.023 \times 10^{23}$

∴ Atomic volume of one mole of hydrogen = Number of molecules in one mole of hydrogen × Volume of one molecule of hydrogen

$= 6.023 \times 10^{23} \times 5.234 \times 10^{-31} = 3.152 \times 10^{-7} m^3$

∴ $\frac{Molar\ \ Volume}{Atomic\ \ Volume} = \frac{22.4 \times 10^{-3}}{3.152 \times 10^{-7}} = \ \ 7.1 \times 10^4$

This ratio is very large, which shows that the intermolecular separation in a gas is much larger than the size of a molecule.

22) **5**

Given, Mass of the Sun =$2.0 \times 10^{30} kg$

Radius of the Sun =$7.0 \times 10^8 m$

Density of the Sun = $\frac{Mass\ \ of\ \ the\ \ Sun\ \ (M)}{Volume\ \ of\ \ the\ \ Sun\ \ (S)}$

$\left[ \therefore Density = \frac{Mass}{Volume} \right]$

$\rho = \frac{M}{\frac{4}{3}\pi R^3} = \frac{3}{4}\frac{M}{\pi R^3} = \frac{3 \times 2.0 \times 10^{30}}{4 \times 3.14 \times (7.0 \times 10^8)^3} = \frac{3 \times 10^{30}}{6.28 \times 343 \times 10^{24}} = 1.392 \times 10^3 \rho \approx 1.4 \times 10^3 kg/m^3$

This density is the order of density of solids and liquids and not of gases.

The temperature of inner core of the sun is $10^7$ K while the temperature of the outer layers is nearly 6000 K. At so high temperature, no matter can be exist in its solid or liquid state.

Every matter is highly ionised and present as a mixture of nucleus, fr4ee electr4onbs and ions which is called plasma. The density of plasma is so high due to inward gravitational attraction on outer layers due o inner layers of the sun.

23) **5**

The instrument whose least count is minimum, is called the most precise device.

i) Number of divisions on vernier scale = 20

Main scale Division (MSD) = 1mm

As 20 divisions on vernier scale will be equal to the 19 divisions on the vernier scale will be equal to the 19 division on main scale.

∴ $vernier\ \ scale\ \ Division\ \ (VSD) = \frac{19}{20} MSD Least\ \ count\ \ of\ \ vernier\ \ callipers \quad = 1MSD - 1VSD \quad = 1MSD - \frac{19}{20}MSD = \frac{1}{20}MSD \quad =$

ii) Pitch of screw guage = 1mm

Number of divisions on circular scale = 100

Least count of screw guage

$= \frac{Pitch}{Number\ \ of\ \ division\ \ on\ \ circular\ \ scale} = \frac{1}{100} mm = \frac{1}{1000} cm = 0.001 cm$

iii) Wavelength of light ($\lambda$) $\approx 10^{-7} m$

= $10^{-5}$cm = 0.00001 cm

∴ As the given optical instrument can measure length to within a wavelength of light, therefore, least count of the given optical instrument

= Wavelength of light

= 0.00001 cm

The least count is minimum for the given optical instrument. Therefore, the given optical instrument is the most precise.

24) It is given that, $\frac{\Delta l}{l} = \frac{0.1}{10}$, $\Delta t = 1s$ and **5**

Time of 100 oscillation, $t = 100 \times 0.5 = 50s$

∴ $\frac{\Delta t}{t} = \frac{1}{50}$

From, $t = 2\pi\sqrt{\frac{l}{g}}, \quad t^2 = 4\pi^2 \frac{1}{g},$

$g = 4\pi^2 \frac{1}{t^2}$

∴ $\frac{\Delta g}{g} = \pm \left[ \frac{\Delta l}{l} + 2\frac{\Delta t}{t} \right]$

Percentage error,

$\frac{\Delta g}{g} = \pm \left[ \frac{0.1}{10} + \frac{2 \times 1}{50} \right] \times 100$

$= \pm 5\%.$