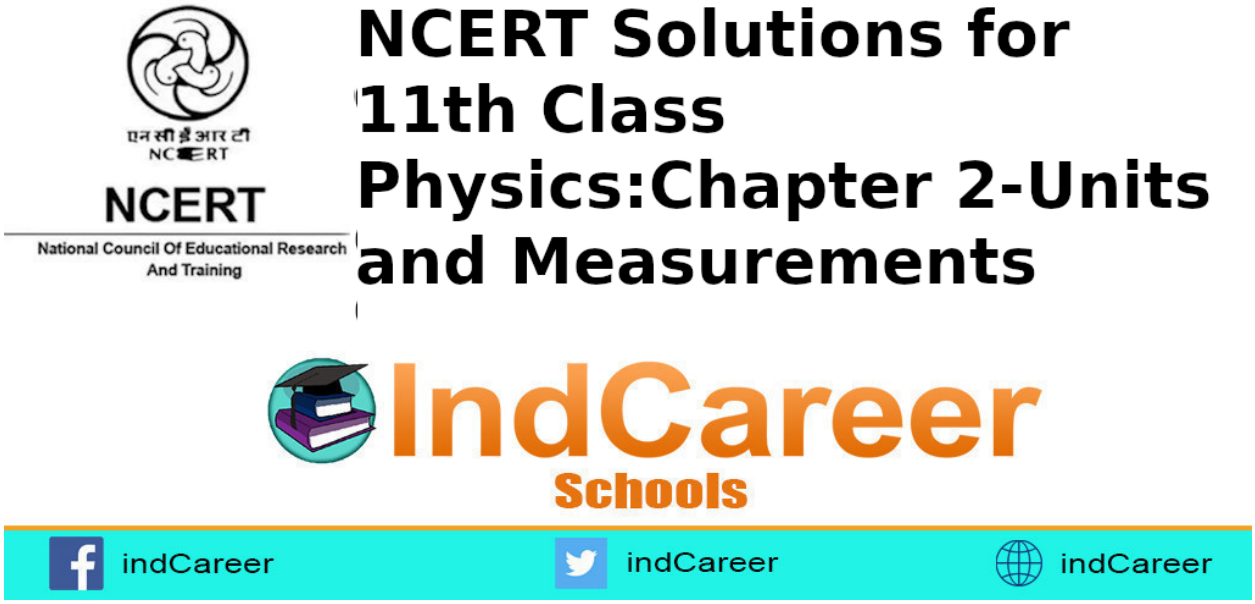

NCERT Solutions for 11th Class Physics: Chapter 2-Units and Measurements

Class 11: Physics Chapter 2 solutions. Complete Class 11 Physics Chapter 2 Notes.

NCERT Solutions for 11th Class Physics: Chapter 2-Units and Measurements

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Exercises

2.1. Fill in the blanks

(a) The volume of a cube of side 1 cm is equal to.....m^3

(b) The surface area of a solid cylinder of radius 2.0 cm and height 10.0 cm is equal to ... $(mm)^2$

(c) A vehicle moving with a speed of 18 km h^{-1}covers....m in 1 s

(d) The relative density of lead is 11.3. Its density is ....g cm^{-3}or . ...kg m^{-3}.

Answer

(a) Length of edge = 1cm = 1/100 m

Volume of the cube = $side^3$

Putting the value of side, we get

Volume of the cube = $(1/100\ m)^3$

$$\left(\frac{1}{100}\right)\left(\frac{1}{100}\right)\left(\frac{1}{100}\right) m^3 = \frac{1}{10^6} m^3 = 10^{-6} m^3$$

The volume of a cube of side 1 cm is equal to 10^{-6} m^3

(b) Given,

Radius, r = 2.0 cm = 20 mm (convert cm to mm)

Height, h = 10.0 cm =100 mm

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The formula of total surface area of a cylinder S = $2\pi r\ (r + h)$

Putting the values in this formula, we get

Surface area of a cylinder S = $2\pi r\ (r + h$ = 2 x 3.14 x 20 (20+100)

= 15072 = 1.5×10^4 mm^2

The surface area of a solid cylinder of radius 2.0 cm and height 10.0 cm is equal to 1.5 × 10

^{4} mm^2

(c) Using the conversion,

Given,

Time, t = 1 sec

speed = 18 km h^{-1} = 18 km / hour

1 km = 1000 m and 1hour = 3600 sec

Speed = 18 × 1000 /3600 sec = 5 m /sec

Use formula

Speed = distance / time

Cross multiply it, we get

Distance = Speed × Time = 5 × 1 = 5 m

A vehicle moving with a speed of 18 km h^{-1}covers 5

m in 1 s.

(d) Density of lead = Relative density of lead × Density of water

Density of water = 1 g/cm^3

Putting the values, we get

Density of lead = 11.3 × 1 g/ cm^3

= 11.3 g cm^{-3}

1 cm = (1/100 m) =10^{-2} m3

1 g = 1/1000 kg = 10^{-3} kg

Density of lead = 11.3 g cm^{-3} = 11.3

Putting the value of 1 cm and 1 gram

11.3 g/cm^3 = 11.3 × 10^{-3} kg $(10^{-2}m)^{-3}$ = 11.3 ×10^{-3} × 10^6 kg m^{-3} =1.13 × 10^3 kg m^{-3}

The relative density of lead is 11.3. Its density is 11.3

g cm^{-3} g cm^{-3} or 1.13 × 10

^{3} kg m^{-3}.

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2.2. Fill in the blanks by suitable conversion of units:

(a) 1 kg m^2s^{-2}= ....g cm^2 s^{-2}

(b) 1 m =..... ly

(c) 3.0 m s^{-2}=.... km h^{-2}

(d) G= 6.67 × 10^{-11} N m^2 $(kg)^{-2}$=.... $(cm)^3s^{-2}$ g^{-1}.

Answer

(a) 1 kg = 10^3 g

1 m^2 = 10^4 cm^2

1 kg m^2 s^{-2} = 1 kg × 1 m^2 × 1 s^{-2}

=10^3 g × 10^4 cm^2 × 1 s^{-2} = 10^7 g cm^2 s^{-2}

1 kg m^2s^{-2}= 10

^{7} g cm^2 s^{-2}

(b) Distance = Speed × Time

Speed of light = 3 × 10^8 m/s

Time = 1 year = 365 days = 365 × 24 hours = 365 × 24 × 60 × 60 sec

Putting these values in above formula we get

1 light year distance = (3 × 10^8 m/s) × (365 × 24 × 60 × 60 s) = 9.46 × 10^{15} m

9.46 × 10^{15} m = 1 ly

So that 1 m = 1/ 9.46 × 10^{15} ly = 1.06 × 10

$^{-16}$ ly

(c) 1 hour = 3600 sec so that 1 sec = 1/3600 hour

1 km = 1000 m so that 1 m = 1/1000 km

3.0 m s^{-2} = 3.0 (1/1000 km)(1/3600 hour)$^{-2}$ = 3.0 × 10^{-3} km × ((1/3600)$^{-2}$ h–2)

= 3.0 × 10^{-3} km × $(3600)^2$ h^{-2} = 3.88 × 10^4 km h^{-2}

3.0 m s^{-2}= 3.88 × 10

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^{4} km h^{-2}

(d) Given,

$G = 6.67 \times 10^{-11}$ N m^2 $(kg)^{-2}$

We know that

1 N = 1 kg m $s^{-}2$

1 kg = 10^3 g

1 m = 100 cm = 10^2 cm

Putting above values, we get

6.67×10^{-11} N m^2 kg^{-2} = $6.67 \times 10^{-11} \times (1$ kg m $s^{-2})$ $(1$ $m^2)$ $(1Kg^{-2})$

Solve and cancel out the units we get

$\Rightarrow 6.67 \times 10^{-11} \times (1$ $kg^{-1} \times 1$ $m^3 \times 1$ $s^{-2})$

Putting above values to convert Kg to g and m to cm

$\Rightarrow 6.67 \times 10^{-11} \times (10^3$ $g)^{-1} \times (10^2$ $cm)^3 \times (1$ $s^{-2})$

$\Rightarrow 6.67 \times 10^{-11} \times 10^{-3}$ $g^{-1} \times 10^6$ $cm^3 \times (1$ $s^{-2})$

$\Rightarrow 6.67 \times 10^{-8}$ cm^3 s^{-2} g^{-1}

$G = 6.67 \times 10^{-11}$ N m^2 $(kg)^{-2} = 6.67 \times 10$

$^{-8}$ $(cm)^3 s^{-2}$ g^{-1}.

2.3. A calorie is a unit of heat or energy and it equals about 4.2 J where 1J = 1 kg $m^2 s^{-2}$. Suppose we employ a system of units in which the unit of mass equals α kg, the unit of length equals β m,

the unit of time is γ s. Show that a calorie has a magnitude 4.2 α^{-1} β^{-2} γ^{2} in terms of the new units.

Answer

Given that,

1 Calorie=4.2 J = 4.2 Kg m^2 s^{-2} ..... (i)

As new unit of mass = α Kg

∴ 1 Kg = 1/α new unit of mass

Similarly, 1 m = β^{-1} new unit of length

1 s = γ^{-1} new unit of time

Putting these values in (i), we get

1 calorie = 4.2 (α^{-1} new unit of mass) (β^{-1} new unit of length)2 (γ^{-1} new unit of time)-2

= 4.2 α^{-1} β^{-2} γ^{2} new unit of energy (Proved)

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2.4. Explain this statement clearly:

"To call a dimensional quantity 'large' or 'small' is meaningless without specifying a standard for comparison". In view of this, reframe the following statements wherever necessary:

(a) atoms are very small objects

(b) a jet plane moves with great speed

(c) the mass of Jupiter is very large

(d) the air inside this room contains a large number of molecules

(e) a proton is much more massive than an electron

(f) the speed of sound is much smaller than the speed of light.

Answer

The given statement is true because a dimensionless quantity may be large or small in comparision to some standard reference. For example, the coefficient of friction is dimensionless. The coefficient of sliding friction is greater than the coefficient of rolling friction, but less than static friction.

(a) An atom is a very small object in comparison to a soccer ball.

(b) A jet plane moves with a speed greater than that of a bicycle.

(c) Mass of Jupiter is very large as compared to the mass of a cricket ball.

(d) The air inside this room contains a large number of molecules as compared to that present in a geometry box.

(e) A proton is more massive than an electron.

(f) Speed of sound is less than the speed of light.

2.5. 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 8 min and 20 s to cover this distance?

Answer

Distance between the Sun and the Earth = Speed of light x Time taken by light to cover the distance

Given that in the new unit, speed of light = 1 unit

Time taken, t = 8 min 20 s = 500 s

∴ Distance between the Sun and the Earth = 1 x 500 = 500 units

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2.6. Which of the following is the most precise device for measuring length:

(a) a vernier callipers with 20 divisions on the sliding scale

(b) a screw gauge of pitch 1 mm and 100 divisions on the circular scale

(c) an optical instrument that can measure length to within a wavelength of light?

Answer

(a) Least count of this vernier callipers = 1SD - 1 VD = 1 SD - 19/20 SD = 1/20 SD

= 1.20 mm = 1/200 cm = 0.005 cm

(b) Least count of screw gauge = Pitch/Number of divisions = 1/1000 = 0.001 cm.

(c) Wavelength of light, $\lambda \approx 10^{-5}$ cm = 0.00001 cm

Hence, it can be inferred that an optical instrument is the most suitable device to measure length.

2.7. 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?

Magnification of the microscope = 100

Average width of the hair in the field of view of the microscope = 3.5 mm

∴ Actual thickness of the hair is 3.5/100 = 0.035 mm.

2.8. Answer the following:

(a) You are given a thread and a metre scale. How will you estimate the diameter of the thread?

Answer

Wrap the thread on a uniform smooth rod in such a way that the coils thus formed are very close to each other. Measure the length of the thread using a metre scale. The diameter of the thread is given by the relation,

Diameter = Length of thread/Number of turns

(b) A screw gauge has a pitch of 1.0 mm and 200 divisions on the circular scale. Do you think it is possible to increase the accuracy of the screw gauge arbitrarily by increasing the number of divisions on the circular scale?

Answer

It is not possible to increase the accuracy of a screw gauge by increasing the number of divisions of the circular scale. Increasing the number divisions of the circular scale will increase its accuracy to a certain extent only.

(c) The mean diameter of a thin brass rod is to be measured by vernier callipers. Why is a set of 100 measurements of the diameter expected to yield a more reliable estimate than a set of 5 measurements only?

Answer

A set of 100 measurements is more reliable than a set of 5 measurements because random errors involved in the former are very less as compared to the latter.

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

Answer

Area of the house on the slide = 1.75 cm^2

Area of the image of the house formed on the screen = 1.55 m^2 = 1.55 × 104 cm^2

$$\text{Arial Magnification, } m_a = \frac{Area\ of\ Image}{Area\ of\ object} = \frac{1.55}{1.75} \times 10^4 = 8857$$

$$\text{Linear Magnification} = \sqrt{8857} = 94.11$$

2.10. State the number of significant figures in the following:

(a) 0.007 m^2

► 1

(b) 2.64 x 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

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2.11. The length, breadth and thickness of a rectangular sheet of metal are 4.234 m, 1.005 m, and 2.01 cm respectively. Give the area and volume of the sheet to correct significant figures.

Answer

Given that,

length, l = 4.234 m

breadth,b = *1*.005 m

thickness, t = 2.01 cm = 2.01 × 10^{-2} m

Area of the sheet = 2 (l × *o* + b × t + t × l) = 2 (4.234 × 1.005 + 1.005 × 0.0201 + 0.0201 × 4.234)

= 2 (4.3604739) = 8.7209478 m2

As area can contain a maximum of three significant digits, therefore, rounding off, we get

Area = 8.72 m^2

Also, volume = $l \times b \times t$

$V = 4.234 \times 1.005 \times 0.0201 = 0.0855289 = 0.0855\ m^3$ (Significant Figures = 3)

2.12. The mass of a box measured by a grocer's balance is 2.300 kg. Two gold pieces of masses 20.15 g and 20.17 g are added to the box. What is (a) the total mass of the box, (b) the difference in the masses of the pieces to correct significant figures?

Answer

Mass of grocer's box = 2.300 kg

Mass of gold piece I = 20.15g = 0.02015 kg

Mass of gold piece II = 20.17 g = 0.02017 kg

(a) Total mass of the box = 2.3 + 0.02015 + 0.02017 = 2.34032 kg

In addition, the final result should retain as many decimal places as there are in the number with the least decimal places. Hence, the total mass of the box is 2.3 kg.

(b) Difference in masses = 20.17 - 20.15 = 0.02 g

In subtraction, the final result should retain as many decimal places as there are in the number with the least decimal places.

2.13. A physical quantity P is related to four observables a, b, c and d as follows:

$$P \quad a^3b^2 / \sqrt{c}\, d$$

The percentage errors of measurement in a, b, c and d are 1%, 3%, 4% and 2%, respectively. What is the percentage error in the quantity P? If the value of P calculated using the above relation turns out to be 3.763, to what value should you round off the result?

Answer

$$P = \frac{a^3\, b^2}{(\sqrt{c}\, d)}$$

Maximum fractional error in P is given by

$$\frac{\Delta P}{P} = \pm\left[3\frac{\Delta a}{a} + 2\frac{\Delta b}{b} + \frac{1}{2}\frac{\Delta c}{c} + \frac{\Delta d}{d}\right] = \pm\left[3\left(\frac{1}{100}\right) + 2\left(\frac{3}{100}\right) + \frac{1}{2}\left(\frac{4}{100}\right) + \frac{2}{100}\right]$$

$$= \pm\frac{13}{100} = \pm 0.13$$

$$\text{Percentage error in } P = \frac{\Delta P}{P} \times 100 = \pm 0.13 \times 100 = \pm 13\%$$

Percentage error in P = 13 %

Value of P is given as 3.763.

By rounding off the given value to the first decimal place, we get P = 3.8.

2.14. A book with many printing errors contains four different formulas for the displacement y of a particle undergoing a certain periodic motion:

(i) $y = a \sin \frac{2\pi t}{T}$

(ii) $y = a \sin v\, t$

(iii) $y = \frac{a}{T} \sin \frac{t}{a}$

(iv) $y = \frac{a}{\sqrt{2}} \left[\sin \frac{2\pi t}{T} + \cos \frac{2\pi t}{T}\right]$

(a = maximum displacement of the particle, v = speed of the particle. T = time-period of motion). Rule out the wrong formulas on dimensional grounds.

Answer

The displacement y has the dimension of length, therefore, the formula for it should also have the dimension of length. Trigonometric functions are dimensionless and their arguments are also dimensionless. Based on these considerations now check each formula dimensionally.

(i) $\frac{2\pi t}{T} = \frac{T}{T} = 1 = (M^0 L^0 T^0)$ ... dimensionless

(ii) $v\, t = (LT^{-1})(T) = L = [M^0\ L^0\ T^0]$ ... not dimensionless

(iii) $\frac{t}{a} = \frac{T}{L} = [L^{-1}\ T^1]$ ... not dimensionless

(iv) $\frac{2\pi t}{T} = \frac{T}{T} = 1 = [M^0\ L^0\ T^0]$ ... dimensionless

The formulas in (ii) and (iii) are dimensionally wrong.

Chapterwise NCERT Solutions for Class 11 Physics:

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