PHYSICS

BOOKS - CHHAYA PHYSICS (BENGALI ENGLISH)

MEASUREMENT AND DIMENSION OF PHYSICAL QUANTITY

Numerical Examples

1. What will be the conversion factor when you change a value expressed in newton to dyne?

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2. Taking electric Potential V as a fundamental quantity instead of electric current find the dimension of electric current in terms of the dimension of the electric potential.

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3. Find the dimension of universal gravitational constant taking the units of density D velocity V and work W as base units instead of those of mass, distance and time.

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4. In a system of units the units of length is defined as the distance travelled by light in space in 1 s and the unit of time taken by the earth to revolve round the sun once. Find the velocity unit in CGS system.

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5. Find the screw pitch of a screw gauge having 100 circular scale divisions and a least count of 0.002 cm.

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6. A screw gauge has 50 circular scale divisions and a pitch of 0.1 cm. When this is used to measure the thickness of a plate the main scale reading is 0.2 cm and the circular scale reading is 35. What is the thickness of the plate?

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7. In an experiment of simple pendulum a student made several observations for the period of oscillation. His readings turned out to be 2.63s, 2.56s, 2.42s, 2.71s, and 2.80s. Find (i) mean time period of oscillations or most accurate value of time period, (ii)

absolute error in each reading (iii) mean absolute error (iv) fractional error and (v) percentage error.

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8. The measured length and breadth of a rectangle are written as (5.7 ± 0.1) cm and (3.4 ± 0.2) cm respectively. Calculate the area of the rectangle with error limits.

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9. The potential difference across the ends of a wire has been measured to be (100 ± 5) volt and the

current in the wire as (10 ± 0.2) ampere. What is the percentage error in the computed resistance of the wire?

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10. A student performing Searle's experiment for finding the Young's modulus Y of the material of a wire takes the following observations:

Length of the wire (L) =2.890 m, diameter of the wire (D) = 0.082cm, mass suspended from the wire (M) =3.00 kg, extension in the length of wire (l) = 0.087 cm. Calculate the maximum permissible error in the value of Y.

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Section Related Questions

1. What is meant by the term physical quantity ?

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2. Why are units required to measure a physical quantity?

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3. Define fundamental and derived units with examples.

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4. What are the conditions that make a unit suitable to measure a physical quantity?

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5. What is dimensional homogeneity?

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6. Find the value of 1 J in terms of erg, using dimensional analysis.

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7. Write dimensions of surface tension and co-efficient of viscosity.

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8. What is meant by the term dimensionless quantity ?

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9. Name any one natural dimensionless quantity and show that the quantity is dimensionless.

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10. Define length.

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11. Define least count of a screw gauge.

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12. Define standard mass.

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13. Define time.

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14. Discuss briefly about error in measurement.

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15. What is meant by an error?

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16. What is mean absolute error?

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17. Write down the expressions for fractional or relative error and percentage error.

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18. Substract 98.767 g from 172.4 kg , giving the result in appropriate significant figures.

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19. What do you mean by accuracy and precision of measuring instruments?

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Higher Order Thinking Skill Hots Questions

1. Name dimensionlesss physical quantity and show that it is dimensionless.

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2. What are (i) light year (ii) astronomical unit and (iii) parsec?

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3. Is light year a fundamental unit or a derived unit?

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4. Units of three physical quantities X,Y and Z are g. cm^2. s^{-5}, g. s^{-1} and cm .s^{-1} . Find the relationship between X,Y and Z.

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5. If force (F) Length (L) and time (T) have the basic units what would be the dimension of mass ?

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6. A famous relation in physics relates moving mass m with the rest mass m_0 of a particle in terms of its speed v and the speed of light c. This relation first arose as a consequence of special relativity by Albert Einstein. A boy recalls the relation almost correctly but forgets where to put the constant c. He writes : $m = \frac{m_0}{(1 - v^2)^{1/2}}$. Guess where to put the missing c.

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Exercise Multiple Choice Questions

1. X, Y, and Z are three physical quantities having units g. $cm^2.s^{-5}$, $g.s^{-1}$ and cm $.s^{-2}$. Relationship between X, Y and Z can be represented by

A. $X \propto YZ$

B. $X \propto YZ^2$

C. $X \propto Y^2Z$

D. $X \propto Y/Z$

Answer: B

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2. Steradian is the unit of

A. angle

B. solid angle

C. arc of a circle

D. circumference

Answer: B

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3. Dimension of electric potential is the same as that of

A. current

B. force

C. electromotive force

D. energy

Answer: C

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4. The dimensional formula of potential difference is

A. $ML^2T^{-3}A^{-1}$

B. $MLT^{-3}A^{-1}$

C. $ML^3T^{-3}A$

D. $ML^2T^{-3}A^{-2}$

Answer: A

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5. Which of the following is dimensionally correct?

A. Pressure = energy per unit volume

B. Pressure = energy per unit area

C. Pressure = energy per unit length

D. Pressure = energy per unit time

Answer: A

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6. The unit of specific conductivity is

A. $\Omega . \mathrm{cm}^{-1}$

B. $\Omega^{-1} . \mathrm{cm}^{-1}$

C. $\Omega . \mathrm{cm}^{-2}$

D. $\Omega^{-1} . cm$

Answer: B

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7. As per quantum theory the energy E of a photon is related to its frequency ν as E = hν , where hν = Planck's constant. Then the dimension of h would be

A. ML^2T^{-2}

B. ML^2T^{-1}

C. MLT^{-2}

D. MLT^{-1}

Answer: B

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8. Which of the following quantities is dimensionless if v = speed , r = radius of a circular path and g = acceleration due to gravity?

A. $\frac{v^2 r}{g}$

B. $\frac{v^2}{rg}$

C. $\frac{v^2 g}{r}$

D. v^2rg

Answer: B

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Exercise Based On Dimensional Analysis

1. Considering force (F) length (L) and time (T) to be fundamental physical quantities find the dimension of mass.

A. $FL^{-1}T^{2}$

B. $FL^{-1}T^{-1}$

C. FLT^{-2}

D. $F^{-1}L^{-1}T^{2}$

Answer: A

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2. Time period of a pendulum (T) its length (l), mass of its bob (m) and acceleration due to gravity (g) are related as T = $km^x l^y g^z$ where,

A. $x = 1, y = \frac{1}{2}, z = \frac{1}{2}$

B. $x = 0, y = -\frac{1}{2}, z = \frac{1}{2}$

C. $x = 1, y = -\frac{1}{2}, z = \frac{1}{2}$

D. $x = 0, y = \frac{1}{2}, z = -\frac{1}{2}$

Answer: D

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3. The equation of state of a gas is given by $\left(p+\frac{a}{V^3}\right)(V-b^2)=cT$ where p, V and T are pressure volume and temperature respectively and a, b,c are constants. The dimensions of a and b are respectively

A. $ML^8T^{-2}\text{and}L^{3/2}$

B. $ML^5T^{-2}\text{and}L^3$

C. $ML^5T^{-2}\text{and}L^6$

D. $ML^6T^{-2}\text{and}L^{3/2}$

Answer: A

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4. The unit of t is s and that of x is m in the expression $y = A\cos\left(\frac{t}{p} - qx\right)$. Then

A. x and q have the same unit

B. x and p have the same unit

C. t and q have the same unit

D. t and p have the same unit

Answer: D

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5. The unit of both x and y is m in the expression $y = A\sin\left[\frac{2\pi}{\lambda}(ct - x)\right]$. Then

A. x, λ and A have the same unit

B. x and λ have the same unit but the unit of A is different

C. c and $\frac{2\pi}{\lambda}$ have the same unit

D. (ct-x) and $\frac{2\pi}{\lambda}$ have the same unit

Answer: A

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6. The dimension of ω in the expression $y = A\sin(\omega t - kx)$ is

A. M^0LT

B. $M^0L^{-1}T^0$

C. $M^0L^0T^{-1}$

D. M^0LT^{-1}

Answer: C

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Exercise Based On Errors In Measurement

1. If the error in the measurement of momentum of a particle is 50% then the error in the measurement of kinetic energy is

A. $75\ \%$

B. $100\ \%$

C. $125\ \%$

D. $200\ \%$

Answer: B

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2. Percentage error in the measurement of mass and speed are 2% and 3% respectively. The maximum error in the estimation of kinetic energy obtained by measuring mass and speed will be

A. $12\ \%$

B. $8\ \%$

C. $10\ \%$

D. $2\ \%$

Answer: B

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3. Choose the incorrect statement out of the following.

A. Every measurement by any measuring instrument has some errors

B. Every calculated physical quantity based on measured values has some error

C. A measurement can have more accuracy but less precision and vice versa

D. The percentage error is different from relative error

Answer: D

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4. A screw gauge has a pitch of 0.5 mm, and has 50 divisions on its circular scale. Its linear and circular scale readings are respectively 2 mm and 25 when the diameter of a sphere is measured by the gauge. The result of this measurement is

A. 1.2 mm

B. 1.25 mm

C. 2.20 mm

D. 2.25 mm

Answer: D

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5. The smallest main scale division of a vernier caliper = 1 mm. Here 20 vernier divisions = 16 main scale divisions. The vernier constant is

A. 0.02 mm

B. 0.05 mm

C. 0.1 mm

D. 0.2 mm

Answer: D

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6. The measured values of mass radius and length of a wire are respectively , $(0.3 \pm 0.003)g$, (0.5 ± 0.005) mm and (6 ± 0.06) cm. The maximum percentage error in the computed value of the density of the material of the wire would be

A. 1

B. 2

C. 3

D. 4

Answer: D

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7. The dimension of a quantity is $M^aL^bT^{-c}$. It the measurements of mass length and time involve errors of $\alpha\,\%\,,\beta\,\%\,,\gamma\,\%$ respectively then the maximum error in the measurement of the given quantity is

A. $(\alpha a-\beta b+\gamma c)\,\%$

B. $(\alpha a+\beta b+\gamma c)\,\%$

C. $(\alpha a+\beta b-\gamma c)\,\%$

D. $(\alpha a-\beta b-\gamma c)\,\%$

Answer: B

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Exercise Based On Significant Figures

1. The diameter of a circle is 2.486m. Calculate the area enclosed by the circle to appropriate significant figures. (π=3.1416)

A. 5

B. 2

C. 4

D. 7

Answer: B

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2. A bee of mass 0.000096kg sits on a flower of mass 0.0123kg . find the total mass in appropriate significant figures.

A. 7.202×10^3 cm

B. 72.0×10^2 cm

C. 0.72×10^4 cm

D. 7.20×10^2 cm

Answer: B

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3. A rectangle has a length = 4.234 m and breadth = 1.05 m. What is its area in m^2 ? Keep the significant digits only.

A. 4.4457

B. 4.45

C. 4.446

D. 4.44

Answer: B

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Very Short Answer Type Questions Based On Unit And Dimension

1. Write the number of base units in SI.

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2. Is mole a base unit or a derived unit in SI?

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3. What is the unit of thermal capacity in SI ?

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4. Express one parsec in terms of light year.

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5. Light year is a unit of _____ . [Fill in the blanks]

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6. Ampere is a unit of _____ in SI. [Fill in the blanks]

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7. Candela is a _____ unit in SI. [Fill in the blanks]

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8. Parsec is a unit of _____ [Fill in the blanks]

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9. What is the dimension of a dimensionless physical quantity ?

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10. The relative density of lead is 11.3 . What is its density in CGS and SI ?

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11. 1 kg $.m^2.\ s^{-2}$ = _____ g. $cm^2.\ S^{-2}$. [Fill in the blanks]

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12. 1 m = _____ light year. [Fill in the blanks]

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13. 3.0 m. s^{-2} = _____ km. h^{-2} . [Fill in the blanksb]

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14. G = $6.67 \times 10^{-11} N.m.kg^{-2}$ = _____ $cm^2.s^{-2}.g^{-1}$. [Fill in the blanks]

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Very Short Answer Type Questions Based On Dimensional Analysis

1. If x = a+bt+ct^2 , where x is in metres and t in seconds what are the dimensions of b and c?

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2. The equation of state of a real gas is $\left(p+\frac{a}{V^2}\right)(V-b)$= RT where p, V and T are pressure volume and absolute temperature respectively. Find out the dimension of b.

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Very Short Answer Type Questions Based On Significant Figures

1. The Avogadro number is 6.022×10^{23}. How many significant figures are there ?

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Short Answer Type Questions I

1. Is the measure of angle dependent upon the unit of length? Explain.

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2. The radius of an atom is of the order of $1\text{Å}\left(10^{-10}\right.$ m) and that of a nucleus is of the order of fermi $\left(10^{-15}\text{m}\right)$. By how many orders of magnitude is the volume of an atom higher than that of a nucleus?

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3. Show that the equation $v^2 = u^2 + 2$ as is dimensionally homogeneous.

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4. Find out the dimension of K in the equation, $W = \frac{1}{2}Kx^2$. Here x and W are the elongation and the potential energy respectively of a spring.

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5. The refractive index (μ) of glass is related to the wavelength (λ) of incident light as $\mu = A + \frac{B}{\lambda^2}$,

where A and B are constants. Find out the dimensions of A and B.

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6. The instantaneous position of a particle is given by $S(t) = V_0\left(1 - e^{-at}\right)/a$, where a and V_0 are constants and $a > 0$. What are the dimensions of a and V_0?

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Short Answer Type Questions Ii

1. If the force acting on a body at time t is F = $at^{-1} + bt^2$ then find out the dimensions of a and b.

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2. The expression for the velocity of a particle at time t is $v = at + \frac{b}{t+c}$, where the units of v and t are m. s^{-1} and s, respectively. What are the dimensions of a,b and c?

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3. Find out the dimension of $\frac{GIM^2}{E^2}$ where E = energy G = gravitational constant I =impulse of force and M = mass.

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4. An air bubble produced due to a mild explosion inside sea- water is executing a harmonic motion. The time period of this motion, $T \propto p^a d^b E^c$, where p = pressure d = density and E = energy released in the explosion. Determine the values of a,b and c from dimensional analysis.

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5. In the equation x = $Ka^m t^n$ where K is a dimensionless constant t is time and x and a are position coordinates and acceleration of a body respectively. What are the values of m and n ?

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6. What will be the dimension of $\frac{a}{b}$ in the equation p $= \frac{a - t^2}{bx}$? Here p = pressure x = distance and t = time.

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7. The potential energy U of a particle varies with its distance x from a predefined origin as $U = \frac{A\sqrt{x}}{x+B}$, where A and B are constants . Find out the dimension of the quantity AB.

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8. The wave velocity (v) inside water depends on the wavelength (λ) of the wave the density (σ) of water and acceleration due to gravity (g). Work out the relation among the quantities from dimensional analysis.

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9. Young's modulus is Y = stress /strain. Here stress is the force of reaction per unit area and strain is the change of length per unit initial length. Find out dimension of Y. If velocity (V) acceleration (A) and force (F) are taken as the fundamental quantities in place of mass length and time then what will be the dimension of Y ?

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Problem Set I Based On Dimensional Analysis

1. A calorie is a unit of heat or energy and it equals about 4.2 j where 1 J = 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 βm and the unit of time is λs. Show the a calorie has a magnitude $4.2\alpha^{-1}\beta^{-2}\gamma^2$ in terms of the new units.

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2. Assuming that the frequency ν of a vibrating string may depend upon (i) applied load (F) (ii) length (l) and (iii) mass per unit length (m) of the string prove that $\nu = \frac{1}{l}\sqrt{\frac{F}{m}}$

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3. Dimensionally prove the expression $\frac{mv^2}{r}$ for the centripetal force F acting on a particle of mass m moving with velocity v in a circle of radius r.

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4. Check the correctness of the relation

$$V = \frac{\pi p r^4}{8\eta l}$$

where V is the volume per unit time of a liquid flowing through a tube of radius r and length l, η is the

coefficient of viscosity of the liquid and p is the pressure difference between the ends of the tube.

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5. For a planet the escape velocity (v) of a body depends upon the radius (R) of the planet and acceleration due to gravity (g) . Establish a relation among the above physical quantities.

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6. The velocity (v) of sound in a gas depends on the pressure (p) and density (σ) of the gas. Using

dimensional analysis establish a relation between v,p and σ.

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Problem Set I Based On Measurement

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

P = $a^3b^2 / \left(\sqrt{cd}\right)$

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?

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2. 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 20s to cover this distance?

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3. 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 microscope is 3.5 mm. What is the thickness of the hair?

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4. When the diameter of a wire is measured by a screw gauge the main scale and the circular scale readings are 0 mm and 52 respectively. Given screw pitch = 1mm and number of divisions on the circular scale = 100. Find out the diameter of the wire.

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5. The errors in the measurement of the effective length (l) and the time period (T) of a pendulum executing simple harmonic motion are 1% and 2% respectively. Estimate the error in the determination of acceleration due to gravity (g) using this pendulum. Given the relation among the relevant quantities, $T = 2\pi\sqrt{\frac{l}{g}}$.

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6. 20 vernier divisions are equal to 19 main scale division of an instrument of vernier constant 0.1 mm.

What is the length of its smallest main scale divisions ?

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7. A screw gauge of pitch 1.0 mm has 200 divisions on its circular scale. Find out its least count.

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8. The coefficient of viscosity of a liquid flowing through a narrow tube is given by $\eta = \frac{\pi p r^4}{8Vl}$ where r and l are the radius and the length of the tube p is the pressure difference between its two ends and V is

the volume of liquid flowing per unit time. Here the values of p,r,V and l are 75 cm Hg, 0.35 cm, 1.5 cm^3/s and 20.5 cm. respectively , the errors in their measurement are 0.1 cm Hg. 0.01 cm, 0.1 cm^3/s and 0.1 cm. respectively. Estimate the percentage error in the computed value of η.

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Problem Set I Based On Significant Figures

1. State the number of significant figures in the following readings :

$245.34cm, 0.00067s,\ 3.344km,\ 780g,$

$0.007m^2$, $2.64 \times 10^{24}kg$ $0.2370g.\,m^{-3}$, $6.320J$

,

$6.032N.\,m^2$, $0.0006032m^2$.

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2. The length breadth and thickness of a rectangular strip of metal are 3.335 m,1.025 m and 3.05 cm respectively. Find the area and volume of the strip to correct significant figures.

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3. Two forces (25 ± 0.2) dyn and (18 ± 0.3) dyn act simultaneously on a particle. Find their resultant when they act (i) in the same direction , (ii) in opposite directions.

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Problem Set I Miscellaneous

1. The circular scale of screw gauge after two complete rotations advances 1 mm along the linear scale. The circular scale has 50 equal divisions and the mechanical error of the screw gauge is -0.03 mm . The

linear scale reading =3 mm and the circular scale reading =35 when a student attempts to measure the diameter of a wire. Calculate the diameter from the given data.

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2. The circular scale of screw gauge has 100 equal divisions. Its screw pitch is 1 mm. This gauge measures the diameter of a wire of length 5.6 cm. The main scale and the circular scale readings are observed to be 1 mm and 47 respectively. Calculate the area in cm^2 of the curved surface of the wire keeping the significant figures only.

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3. Four different expressions for displacement of a particle executing simple harmonic motion are printed on a book:

Here a = maximum displacement of the particle , v =its velocity and T = its time period. Check from dimensional analysis which of these expressions involve (s) some printing mistake.

A. $y = a \sin \frac{2\pi t}{T}$

B. $y = \frac{a}{T} \sin \left(\frac{t}{a} \right)$

C. $y = a \sin vt$

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

Answer: A::B::C::D

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4. 20 vernier divisions coincide with 19 main scale divisions of a vernier. The smallest main scale division is 0.5 mm. When it measures the side of a cube the main scale and the vernier readings are 10 mm and 2, respectively. If the mass of the cube is 2.736 g, find out the density of its material keeping the significant digits only.

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Entrance Corner Assertion Reason Type

1. These questions have statement I and statement II. Of the four choices given below, choose the one that best describes the two statements.

Statement I: It is obvious that dimensions of all the terms must be the same in any mathematical relation between physical quantities.

Statement II: Dimensions of a physical quantity are the powers to which the fundamental units should be raised to represent the unit of that physical quantity.

A. Statement I is true statement II is true, statement II is a correct explanation for

statement I.

B. Statement I is true statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true , statement II is false.

D. Statement I is false, statement II is true.

Answer: B

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2. Statement I: The quantity $\frac{1}{\sqrt{\mu_0 \in_0}}$ is dimensionally equal to velocity and also numerically equal to the

velocity of light.

Statement II: μ_0 is the permeability and $\in_0$ is the permittivity of free space.

A. Statement I is true statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true , statement II is false.

D. Statement I is false, statement II is true.

Answer: B

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3. Statement I: If $y = a \times b$ and $Y = \frac{a}{b}$ then the fractional error of the both y and Y is $\pm\left(\frac{\Delta a}{a} + \frac{\Delta b}{b}\right)$.

Statement II: When two quantities are multiplied or divided their maximum relative errors are added up.

A. Statement I is true statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true , statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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4. Statement I: Pressure has the dimensions of energy density.

Statement II: Energy density = $\frac{\text{energy}}{\text{volume}} = \frac{ML^2T^{-2}}{L^3} = ML^1T^{-2}$

A. Statement I is true statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true , statement II is false.

D. Statement I is false, statement II is true.

Answer: B

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5. Statement I: L/R and CR both have the same dimensions.

Statement II: L/R and CR both have the dimension of time.

A. Statement I is true statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true , statement II is false.

D. Statement I is false, statement II is true.

Answer: B

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6. Statement I: The measurements of mass and length of a side of a cube involve errors of 3% and 2% respectively. The error in the densisty of its material computed from this data would be 9%.

Statement II: If u $= \frac{x^a y^b}{z^c}$ the fractional error in the computation of u is $\frac{\Delta u}{u} = a\frac{\Delta x}{x} + b\frac{\Delta y}{y} + c\frac{\Delta z}{z}$.

A. Statement I is true statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true , statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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7. Statement I: On a body of mass m moving with a speed v in a circular path of radius r the centripetal force is F = $\frac{mv^2}{rg}$.

Statement II : In a mathematical expression involving physical quantities each term on both sides of the equation must have the same dimension.

A. Statement I is true statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true , statement II is false.

D. Statement I is false, statement II is true.

Answer: D

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Multiple Correct Answers Type

1. Photon is the quantum of radiation with energy E = hν where ν is frequency and h is Planck's constant. The dimension of h is the same as that of

A. linear impulse

B. angular impulse

C. linear momentum

D. angular momentum

Answer: B::D

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2. Choose the correct statements:

A. If a physical equation is dimensionally correct it always expresses the correct relation among the quantities involved.

B. Even if a physical equation is dimensionally correct it may not express the correct relation among the quantities involved.

C. If a physical equation is dimensionally incorrect cannot express the correct relation among the quantities involved.

D. Even if a physical equation is dimensionally incorrect it may express the correct relation among the quantities involved.

Answer: B::C

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3. The wave progresses along the x-axis with time t. The instantaneous displacement from the mean position is given by y = a sin $[(\omega t - kx) + \theta]$. Then the dimensions are

A. $[\omega] = T^{-1}$

B. [a] = L

C. $[\theta]$=1

D. [k]= L^{-1}

Answer: A::B::C::D

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4. The dimension of pressure is equal to that of

A. force exerted per unit area

B. energy density

C. change in momentum per unit area per second

D. momentum per unit volume

Answer: A::B::C

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5. If P,Q, R are physical quantities having different dimensions which of the following can never be a meaningful quantity?

A. (P-Q)/R

B. PQ -R

C. PQ/R

D. (R+Q)/P

Answer: A::D

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Comprehension Type

1. For real gases van der Waals equation of state can be expressed as $\left(p+\frac{a}{V^2}\right)(V-b)=RT$

where p is the pressure V is the molar volume and T is the absolute temperature of the given sample of gas and a,b, and R are constants.

Dimension of a is

A. ML^5T^{-2}

B. $L^{-1}T^{-2}$

C. L^3

D. L^6

Answer: A

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2. For real gases van der Waals equation of state can be expressed as $\left(p+\frac{a}{V^2}\right)(V-b)=RT$ where p is the pressure V is the molar volume and T is the absolute temperature of the given sample of gas and a,b, and R are constants.

Dimension of b is

A. ML^5T^{-2}

B. $ML^{-1}T^{-2}$

C. L^3

D. L^6

Answer: C

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3. For real gases van der Waals equation of state can be expressed as $\left(p+\frac{a}{V^2}\right)(V-b)=RT$ where p is the pressure V is the molar volume and T is the absolute temperature of the given sample of gas and a,b, and R are constants.

Which of the following does not have the same dimension as that of RT?

A. pV

B. pb

C. $\frac{a}{V^2}$

D. $\frac{ab}{V^2}$

Answer: C

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4. For real gases van der Waals equation of state can be expressed as $\left(p+\frac{a}{V^2}\right)(V-b)=RT$ where p is the pressure V is the molar volume and T is the absolute temperature of the given sample of gas and a,b, and R are constants.

Dimension of $\frac{ab}{RT}$ is

A. ML^5T^{-2}

B. $M^0L^3T^0$

C. $ML^{-1}T^{-2}$

D. none of these

Answer: D

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5. For real gases van der Waals equation of state can be expressed as $\left(p+\frac{a}{V^2}\right)(V-b)=RT$ where p is the pressure V is the molar volume and T is the absolute temperature of the given sample of gas and a,b, and R are constants.

Dimension of RT is the same as that of

A. energy

B. force

C. specific heat

D. latent heat

Answer: A

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6. It two physical quantities a and b are related by the equation a = kb where k is dimensionless constant, then the principle of dimensional homogeneity demands that a and b have the same dimension. However the proportionality constant k cannot be determined by dimensional analysis only. It may at

most be written that a $\propto$ b if a and b are of the same dimension.

Time period (T) of oscillation of a liquid drop depends on its radius r the density ρ and the surface tension σ of the liquid. Then T is proportional to

A. $\sqrt{\frac{\rho r^2}{\sigma}}$

B. $\sqrt{\frac{r^2}{\rho\sigma}}$

C. $\sqrt{\frac{r^3\rho}{\sigma}}$

D. $\sqrt{\frac{\rho\sigma}{r^3}}$

Answer: C

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7. It two physical quantities a and b are related by the equation a= kb where k is dimensionless constant, then the principle of dimensional homogeneity demands that a and b have the same dimension. However the proportionality constant k cannot be determined by dimensional analysis only. It may at most be written that a $\propto$ b if a and b are of the same dimension.

If a particle of mass m executes simple harmonic motion with amplitude A and frequency f, then its energy is proportional to

A. $\frac{mf}{A^2}$

B. mfA^{-2}

C. mf^2A^{-2}

D. mf^2A^2

Answer: D

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8. If two physical quantities a and b are related by the equation a= kb where k is dimensionless constant, then the principle of dimensional homogeneity demands that a and b have the same dimension. However the proportionality constant k cannot be determined by dimensional analysis only. It may at most be written that a $\propto$ b if a and b are of the same

dimension.

A coil of inductance L stores an amount of energy $\frac{1}{2}Ll^2$ when a current I passes through it. The dimension of L is

A. $ML^2T^{-1}l^2$

B. $ML^2T^{-1}l^{-2}$

C. $ML^2T^{-2}l^2$

D. $ML^2T^{-2}l^{-2}$

Answer: D

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Integer Answer Type

1. The value of two resistors are $(5.0 \pm 0.2)k\Omega$ and $(10.0 \pm 0.1)k\Omega$. What is the percentage error in the equivalent resistance when they are connected in parallel?

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2. In a circuit, the generation of heat depends on resistance,current and time for which the current flows. If the error in measuring resistance, current and time are 1%, 2% and 1% respectively, find the maximum percentage error in measuring the heat.

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3. The period of oscillation of a simple pendulum is T = $2\pi\sqrt{\frac{l}{g}}$. Length l is adout 10 cm and is Known to 1 mm accuracy. The period of oscillation is about 0.5 s. The time of 100 oscillations is measured with a wristwatch that shows the minimum interval of time as Is (i.e. least count = 1s). What is the percentage of accuracy in the determination of g?

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Examination Archive With Solutions Wbchse

1. To determine an unknown resistance R in the laboratory, readings of potential difference V and electric current I are taken. From these readings percentage error is calculated and V and I are obtained as V= (100 ± 5) volt $I = (10 \pm 0.2)$ amp. The percentage error in the value of R determined from these V and I will be

A. $3\ \%$

B. $4.8\ \%$

C. $5.2\ \%$

D. $7\ \%$

Answer: D

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2. How many significant digits are there in 0.06900?

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3. Assuming velocity (V) time (T) and force (F) as the fundamental quantities find the dimension of density.

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4. The velocity of a particle in time t is v = $at + \frac{b}{t+c}$. The dimension of a, b and c are

A. L^2, T, LT

B. LT^{-2},L,T

C. LT^2,LT,L

D. L,LT,T^2

Answer: B

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5. If the error in measurement of radius of a sphere is 2% then the error in the determination of volume of the sphere will be

A. 4%

B. 6%

C. 8%

D. 2%

Answer: B

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6. If the error in the measurement of radius of a sphere is 2% then the error in the determination of volume of the sphere will be

A. 4%

B. 2%

C. 6%

D. 8%

Answer: C

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7. Given $Z = \frac{A^4 b^{1/3}}{CD^{3/2}}$ where A,B,C and D are physical quantity. What will be the maximum percentage error in Z.

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8. What will be the dimension of Young's modulus if velocity (v) acceleration (A) and force (F) are taken as fundamental quantity?

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9. The number of significant figures in 6.0025 is

A. 1

B. 4

C. 5

D. 2

Answer: C

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10. If velocity (v) acceleration (A) and force (F) are three fundamental quantities in a system then what will be the dimension of linear momentum in this system?

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11. For a moving particle the relation between the distance (S) and time (t) is S = a+bt + $ct^2 + dt^3$, which

one among a,b,c and d will represent the dimension of acceleration ?

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12. If the error in the measurement of the radius of a circular disc is 2% the error in determining the area of the disc will be

A. 4%

B. 2%

C. 6%

D. 8%

Answer: A

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13. What are the significant figures in the result of addition of 9.8 and 15.298 ?

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14. Which two of the following physical quantities are dimensionally alike?

(a) Surface tension , (b) pressure , (c) coefficent of viscosity, (d) coefficient of elasticity.

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15. If n denotes a positive integer h the Planck's constant q the charge and B the magnetic field then the quantity $\frac{nh}{2\pi qB}$ has the dimension of

A. area

B. length

C. speed

D. acceleration

Answer: A

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Examination Archive With Solutions Wbjee

1. In which of the following pairs the two physical quantities have different dimensions?

A. Planck's constant and angular momentum

B. Impulse and linear momentum

C. Moment of inertia and moment of a force

D. Energy and torque

Answer: C

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2. If x = at + bt^2 where x is in metre (m) and t is in hour (h) then unit of b will be

A. m^2 / h

B. m

C. m / h

D. m / h^2

Answer: D

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3. The dimension of universal constant of gravitation G is

A. ML^2T^{-1}

B. $M^{-1}L^3T^{-2}$

C. $M^{-1}L^2T^{-2}$

D. ML^3T^{-2}

Answer: B

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4. A spherical liquid drop is placed on a horizontal plane. A small disturbance causes the volume of the drop to oscillate. The time period of oscillation (T) of the liquid drop depends on radius (r) of the drop

density (ρ) and surface tension (s) of the liquid. Which among the following will we be a possible expression for T (where k is a dimensionless constant)?

A. $k\sqrt{\frac{\rho r}{s}}$

B. $k\sqrt{\frac{\rho^2 r}{s}}$

C. $k\sqrt{\frac{\rho r^3}{s}}$

D. $k\sqrt{\frac{\rho r^3}{s^2}}$

Answer: C

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Examination Archive With Solutions Jee Main

1. The current voltage relation of diode is given by $I = \left(e^{1000\frac{V}{T}} - 1\right)$mA where the applied voltage V is in volt and the temperature T is in kelvin. If a student makes an error ± 0.01 V in voltage while measuring the current of 5 mA at 300 K, what will be the error in the value of current in mA?

A. 0.2 mA

B. 0.02 mA

C. 0.5 mA

D. 0.05 mA

Answer: A

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2. A student measured the length of a rod and wrote it as 3.50 cm. Which instrument did he use to measure it ?

A. A meter scale

B. A vernier calliper where 10 divisions in vernier scale matches with 9 divisions in main scale has 10 divisions in 1 cm (i.e. 1 smallest main scale division is 0.1 cm)

C. A screw gauge having 100 divisions in the circular scale and pitch as 1mm

D. A screw gauge having 50 divisions in the circular scale and pitch as 1 cm

Answer: B

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3. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Measured value of L is 20.0 cm known to 1 mm accuracy and time for 100 oscillations of the pendulum is found to be 90 s using a wrist watch of 1 s resolution. The accuracy in the determination of g is

A. $2\ \%$

B. 3%

C. 1%

D. 5%

Answer: B

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4. A student measures the time period of 100 oscillations of a simple pendulum four times. The data set is 90s, 91s, 95s and 92s. If the minimum division in the measuring clock is 1s then the reported mean time should be

A. $92 \pm 2s$

B. $92 \pm 5.0s$

C. $92 \pm 1.8s$

D. $92 \pm 3s$

Answer: A

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5. A screw gauge with a pitch of 0.5 mm and a circular scale with 50 divisions is used to measure the thickness of a thin sheet of Aluminum. Before starting the measurement it is found that when the two jaws

of the screw gauge are brought in contact the 45th division coincides with the main scale line and that the zero of the main scale is barely visible. What is the thickness of the sheet if the main scale reading is 0.5 mm and the 25th division coincides with the main scale line?

A. 0.75 mm

B. 0.80 mm

C. 0.70 mm

D. 0.50 mm

Answer: B

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6. The following observations were taken for determining surface tension T of water by capillary method:

diameter of capillary, D $= 1.25 \times 10^{-2}$m

rise of water h = 1.45×10^{-2} m.

Using g =$9.80, m/s^2$ and the simplified relation $T = \frac{rhg}{2} \times 10^3 N/m$, the possible error in surface tension is closest to:

A. $0.15\ \%$

B. $1.5\ \%$

C. $2.4\ \%$

D. $10\ \%$

Answer: B

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7. The density of a material in the shape of a cube is determined by measuring three sides of the cube and its mass. If the relative errors in measuring the mass and length are respectively 1.5% and 1% the maximum error in determining the density is

A. $4.5\ \%$

B. $6\ \%$

C. $2.5\ \%$

D. $3.5\ \%$

Answer: A

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Examination Archive With Solutions Aipmt

1. If energy (E), velocity (V) and time (T) are chosen as the fundamental quantities the dimensional formula of surface tension will be

A. $EV^{-2}T^{-1}$

B. $EV^{-1}T^{-2}$

C. $EV^{-2}T^{-2}$

D. $EV^{-2}T^{-3}$

Answer: C

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Examination Archive With Solutions Neet

1. A student performing an experiment of measuring the thickness of a slab with a vernier calliper whose 50 divisions of the vernier scale are equal to 49 divisions of the main scale. He noted that zero of the vernier scale is between 7.00 cm and 7.05 cm mark of the main

scale and 23rd division of the vernier scale exactly coincides with the main scale. The measured value of the thickness of the given slab using the calliper will be

A. 7.73 m

B. 7.23 cm

C. 7.023 cm

D. 7.073 cm

Answer: C

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2. A student measured the diameter of a small steel ball using a screw gauge of least count 0.001 cm. The main scale reading is 5 mm and zero of circular scale division coincides with 25 divisions above the reference level. If screw gauge has a zero error of -0.004 cm, the correct diameter of the ball is

A. 0.053 cm

B. 0.525 cm

C. 0.521 cm

D. 0.529 cm

Answer: D

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Cbse Scanner

1. Percentage error in the measurement of height and radius of cylinder are x and y respectively. Find percentage error in the measurement of volume. Which of the two measurements height or radius need more attention?

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2. The length and breadth of a rectangle are measured as $(a \pm \Delta a)$ and $(b \pm \Delta b)$ respectively. Find : (i)

relative error, (ii) absolute error in the measurement of area.

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

$$P = \frac{a^3 b^3}{\sqrt{cd}}$$

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 given relation turns out to be 3.763, to what value should the result be rounded off?

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4. Define relative error and percentage error in a measurement .

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5. Write the dimensions of 'light year'.

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6. If A = (12.0 ± 0.1)cm and B = (8.5 ± 0.5) cm, find the value of (A-B).

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7. Name two physical quantities having dimension MLT^{-1}.

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8. A potential difference of V = (20 ± 1) volt is applied across a resistance of (8 ± 2) ohm. Calculate the current with error limits.

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9. If x= a+bt+ct^2 , where x is in metre and t is in second , what is the dimensional formula of c?

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10. A physical quantity X is connected from X = ab^2 / c. Calculate percentage error in X, when $\%$ error in a,b,c are 4,2 and 3 respectively.

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11. Consider a simple pendulum having a bob attached to a string that oscillates under the action of the force

of gravity. Suppose that the period of oscillation of the simple pendulum depends on its length (l) , mass of the bob (m) and acceleration due to gravity (g). Derive the expression for its time period using the method of dimensions.

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12. Write the dimensional formula of (i) pressure and (ii) impulse.

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13. Write the dimensional formula for (a) Planck's constant and (b) Surface Tension.

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14. A physical quantity $P = \frac{a^3 b^2}{\sqrt{cd}}$ the percentage errors in measurement in a,b,c,d are 1%, 3%,4% and 2% respectively. What is the percentage error in measurement of quantity P?

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15. Name the forces having the longest and shortest range of operation.

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16. What is the difference between mN and N . M?

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17. If heat dissipated in a resistance can be determined from the relation: H = I^2Rt joule

If the maximum error in the measurement of current resistance and time are 2%, 1% and 1% respectively,

what would be the maximum error in the dissipated heat?

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18. The frequency (ν) of transverse wave on a string may depend upon (i) length L of string (ii) tension T in the string and (iii) mass per unit length m of the string Derive the formula for frequency with the help of dimensions.

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