PHYSICS

BOOKS - CENGAGE PHYSICS (ENGLISH)

DIMENSIONS & MEASUREMENT

Illustration

1. Convert Newton into dyne.

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2. The SI and CGS units of energy are joule and erg respectivel.

How many ergs are equal to one joule.

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3. Convert gravitational constant (G) from CGS to MKS system.

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4. In CGS system the magnitude of the force is 100 dynes. In another system where the fundamental phyical quamtities are kilogram , meter , and minute, find the magnitude of the force.

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5. To determine the young's modulus of a wire , the formula is $Y = \frac{F}{A} . \frac{L}{\Delta l}$, where L = l ength ,A = area of cross - section of the wire , ΔL = change in the length of the wire when streched

with a force F. Find the conversion factor to change it from CGS t o MKS system.

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6. A calorie is a unit of heat or energy and it equals about $4.2J, where 1J = 1kgm^2s^{-2}$. Suppose we employ a system of units in which the unit of mass equals αkg, the unit of length equals is βm , the unit of time is γs. Show tthat a calorie has a magnitude $4.2\alpha^{-1}\beta^{-1}\gamma^2$ in terms of the new units.

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7. Convert $54kmh^{-1}$ into ms^{-1}.

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8. Let us check the dimensional correctness of the relation $v = u + at$.

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9. Test dimensionally if the $v^2 = u^2 + 2ax$ may be correct.

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10. Check whether the relation $S = ut + \frac{1}{2}at^2$ is dimensionally correct or not , where symbols have their usual meaning .

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11. Find out the units and dimensions of the constants a and b in the vander waal.s equation $\left(P+\frac{a}{V^2}\right)(V-b)=RT.$

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12. A famous relation in physics relates the moving mass m to 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 the special theory of relativity due to Albert Einstein). A body 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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13. If the centripetal force is of the form $m^a v^b r^c$, find the valus of a,b, and c.

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14. Experiments reveal that the velocity v of water waves may depend on their wavelength λ, density of water ρ, and acceleration due to gravity g. Establish a possible relation between v and λ, g, ρ.

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15. If the velocity of light (c) , gravitational constant (G) , and Planck's constant (h) are chosen as fundamental units , then find the dimensions of mass in new system.

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16. If Velocity $(V), f$ or $ce(F),$ and $time(T)$ are chosen as fundamental quantities , express $(a)mass$ and (b) energy in terms of $V, F,$ and $T.$

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17. Each side of a cube is measured to be $7.203m$. Find the volume of the cube up to appropriate significant figures.

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18. The mass of a box is $2.3kg.$ Two marbles of masses $2.15g$ and $12.39g$ are added to it . Find the total mass of the box to the correct number of significant figures.

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19. Repeated observations in an experiment gave the values $1.29, 1.33, 1.34, 1.35, 1.32, 1.36, 1.30, \text{ and } 1.33$. Calculate the mean value, absolute eror , relative error, and percentage error.

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20. A physical parameter a can be determined by measuring the parameters $b, c, d, \text{ and } e$ using the relation $a = b^{\alpha}c^{\beta}/d^{\gamma}e^{\delta}$. If the maximum errors in the measurement of $b, c, d, \text{ and } eareb_1\,\%\,, c_1\,\%\,, d_1\,\%\,, \text{ and } e_1\,\%\,,$ then the maximum error in the value of a determined by the experminent.

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21. The relative density of material of a body is found by weighting it first in air and then in water . If the weight in air is $(5.00 \pm 0.05)N$ and the weight in water is $(4.00 \pm 0.05)N$. Find the relative density along with the maximum permissible percentage error.

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22. The period of oscillation of a simple pendulum in the experiment is recorded as $2.63s, 2.56s, 2.42s, 2.71s, \text{ and } 2.80s$. Find the average absolute error.

A. 0.06

B. 0.11

C. 0.20

D. 2.62

Answer: B

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23. If there is a positive error of 50% in the measurement of velocity of a body , find the error in the measurement of kinetic energy.

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24. The initial and final temperatures of water as recorded by an observer are $(40.6 \pm 0.2)^{\circ} C$ and $(78.9 \pm 0.3)^{\circ} C$. Calculate the rise in temperature with proper error limits.

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25. The length and breadth of a rectangle are $(5.7 \pm 0.1)cm$ and $(3.4 \pm 0.2)cm$, respectively calculate the area of rectangle with error limits.

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26. A physical quantity x is calculated from the relation $x = \frac{a^2 b^3}{c\sqrt{d}}$. If the percentage error in $a, b, c,$ and $dare 2\%, 1\%, 3\%,$ and 4%, respectively , what is the percentage error in x?

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27. The length and breadth of a field are measured as : $l = (120 \pm 2)m$ and $b = (100 \pm 5)m$, respectively. What is the area of the field?

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28. In an experiment of simple pendulum , the time period measured was $50sf$ or 25 vibrations when the length of the simple pendulum was taken $100cm$. If the least count of stop watch is $0.1s$ and that of meter scale is $0.1cm$. Calculate the maximum possible error in the measurement of value of g. If the actual value of g at the place of experiment is $9.7720ms^{-2}$, Calculate the percentage error.

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29. The displacement covered by a body in time $(5.0 \pm 0.6)sis(40.0 \pm 0.4)m$. Calculate the speed of the body . Also determine the percentage error in the speed.

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30. If all measurements in an experiment are taken up to the same number of significant figures , then mention two possible reasons for maximum error.

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31. In resonance tube experiment , the velocity of sound is given by $v = 2f_0(l_2 - l_1)$. We found $l_1 = 25.0cm$ and $l_2 = 75.0cm$. If there is no error in frequency, what will be the maximum permissible errror in the speed of sound ? (Take $f_0 = 325Hz$)

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32. If the measured value of resistance $R = 1.05\Omega$, wire diameter $d = 0.60mm$, and length $l = 75.3cm$, then find the maximum permissible error in resistivity ,

$\rho = \frac{R\left(\pi d^2/4\right)}{l}$.

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33. In Ohm's law experiment , the potential drop acros a resistance was as $V = 5.0V$ and the current was measured as $I = 2.00A$. Find the maximum permissible error in resistance.

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34. In Searle's exp to find Young's modulus, the diameter of wire is mesured as $D = 0.05cm$ length of wire is $L = 125cm$, and when a weight, $m = 20.0kg$ is put, extension in wire was found to be $0.100cm$. Find maximum permissible percentage error in Young's modulus (Y)

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35. To find the value of g using simple pendulum , $T = 2.00s$ and $l = 1.00m$ were measured . Estimate maximum permissible error in g . Also find the value of g.

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36. Consider the following data : $10MSDs = 1cm$, $10VSDs = 9MSDs$, zero of vernier scale is to the right of the zero marking of the main scale with $6VSDs$ coinciding with $MSDs$ and the actual reading for length measurement is $4.3cmwith2VSDs$ coinciding with main scale graduations . Estimate the length.

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37. The side of a cube is measured by vernier callipers (10 divisions of a vernier scale coincide with 9 divisions of main scale, where 1 division of main scale is $1mm$). The main scale reads $10mm$ and first division of vernier scale coincides with the main scale. Mass of the cube is $2.736g$. find the density of the cube in appropriate significant figures.

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38. 10 rotations of the cap of a srew gauge is equivalent to 5 mm . The cap has 100 divisons. Find the least count . A reading taken for the diameter of wire with the srew gauge shows four complete rotations and 35 divisions on the circular scale . Find the diameter of the wire.

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39. The following observations were taken for dtermining the surface tension of water by capillary tube method: diameter of capillary , $D = 1.25 \times 10^{-2} m$ and rise of water in capillary , $h = 1.45 \times 10^{-2} m$. Taking $g = 9.80 ms^{-2}$ and using the relation $T = (rgh/2) \times 10^3 Nm^{-1}$, what is the possible error in measurement of surface tension T?

(a) 2.4% (b) 15% (c) 1.6% (d) 0.15%`

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Exercise 1 1

1. If $x = at + bt^2$, where x is the distance rtravelled by the body in kilometer while t is the time in seconds , then find the units of b.

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2. A force F is given by $F = at + bt^2$, where t is time . What are the dimensions of a and b?

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3. The position of a particle at time t is given by the relation $x(t) = \left(\frac{v_0}{\alpha}\right)\left(1 - c^{-at}\right)$, where v_0 is a constant and $\alpha > 0$. Find the dimensions of v_0 and α.

A. $\left[L^{-1}T^{-1}\right], \left[T^{-2}\right]$

B. $\left[L^{2}T^{-1}\right], \left[T^{-1}\right]$

C. $\left[LT^{-1}\right], \left[T^{-1}\right]$

D. $\left[LT^{-2}\right], \left[T^{1}\right]$

Answer: $\left[LT^{-1}\right], \left[T^{-1}\right]$

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4. Find the dimensions of physical quantity X in the equation $\text{Force} = \frac{X}{\text{Density}}$.

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5. The number of particles is given by $n = -D\frac{n_2 - n_1}{x_2 - x_1}$ crossing a unit area perpendicular to X - axis in unit time , where n_1 and n_2 are particles per unit volume for the value of x meant to x_2 and x_1 . Find the dimensions of D called diffusion constant.

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6. The equation of a wave is given by $Y = A\sin\omega\left(\frac{x}{v} - k\right)$, where ω is the angular velocity and v is the linear velocity. Find the dimension of k.

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7. The potential energy of a particle varies with distance x from a fixed origin as $U = \frac{A\sqrt{x}}{x^2 + B}$, where A and B are dimensional constants , then find the dimensional formula for AB.

A. $\left[ML^{11/2}T^{-1}\right]$

B. $\left[ML^{11}T^{-2}\right]$

C. $\left[ML^{7/2}T^{-2}\right]$

D. $\left[ML^{11/2}T^{-2}\right]$

Answer: $\left[ML^{11/2}T^{-2}\right]$

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8. You may not know integration , but using dimensional analysis you can check on some results . In the integral

$\int \frac{dx}{(2ax - x^2)^{1/2}} = a^n \sin^{-1}\left(\frac{x}{a} - 1\right)$, find the valiue of n .

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9. Convert $1MW$ power on a new system having basic units of mass , length , and time as $10kg, 1dm,$ and 1 min , respectively .

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10. If the persent units of length , time and mass (m, s, kg) are changed to $100m, 100s,$ and $\frac{1}{10}kg$, then how will the new unit of force change ?

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11. Suppose we employ a system in which in which the unit of mass equals $100kg$, the unit of length equals $1km$ and the unit of time $100s$ and call the unit of energy eluoj (joule written in reverse order), then what is the relation between eluoj and joule?

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12. If $1gcms^{-1} = xNs$, then what is the value of x?

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13. With the usual notations , check if the following equation $S_t = u + \frac{1}{2}a(2t - 1)$ is dimensionally correct or not.

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14. If the time period $(T)$of vibration of a liquid drop depends on surface tension (S) , radius(r) of the drop , and density (ρ) of the liquid , then find the expression of T.

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15. If P represents radiation pressure , C represents the speed of light , and Q represents radiation energy striking a unit area per second , then non - zero integers x, y, z such that $P^x Q^y C^z$ is dimensionless , find the values of $x, y,$ and z.

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16. If velocity (V) , force (F), and energy (E) are taken as fundamental units , then find the dimensional formula for mass.

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Exercise 1 2

1. The length , breadth , and thickness of a block are measured as $125.5cm, 5.0cm,$ and $0.32cm$, respectively .Which one of the measurement is most accurate?

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2. The length of a rectangular sheet is $1.5cm$ and breadth is $1.023cm$. Find the area of the face of a rectangular sheet to the correct number of significant figures.

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3. Each side of a cube is measured to be $5.402cm$. Find the total surface area and the volume of the cube in appropriate significant figures.

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4. Taking into account the figures , what is the value of $9.99m + 0.0099m$?

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5. Find the value of the multiplication 3.124×4.576 correct to three significant figures.

A. 14.295424

B. 14.30

C. 14.20

D. 14.29

Answer: B

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6. If the value of resistance is 10.845Ω and the value of current is $3.23A$, the potential difference is $35.02935V$. Find its value in significant number.

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Exercise 1 3

1. Which of the following length measurements is most precise and why?

(a) $2.0cm$, (b) $2.00cm$, (c) $2.000cm$

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2. In a number without decimal , what is the significant of zeros on the right of non - zero digits?

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3. A research worker takes 100 observations in an experiment . If he repeats the same experiment by taking 500 observation , how is the probable error affected?

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4. Which quantity in a given formula should be measured most accurately Why?

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5. A body travels uniformly a distance of $(13.8 \pm 0.2)m$ in a time $(4.0 \pm 0.3)s$. Find the velocity of the body within error limits and the percentage error.

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6. The error in the measurement of the radius of a sphere is 1% . Find the error in the measurement of volume.

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7. Given $R_1 = 5.0 \pm 0.2\Omega$, and $R_2 = 10.0 \pm 0.1\Omega$. What is the total resistance in parallel with possible $\%$ error?

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8. The value of resistance is 10.845Ω and the current is $3.23A$. On multiplying them , we get the potential difference in terms of significant figures?

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9. The length of one rod is $2.53cm$ and that of the other is $1.27cm$. The least count of the measuring instrument is $0.01cm$. If the two rods are put together end to end , find the combined length.

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10. The pressure on a square plate is measured by measuring the force on the plate and the length of the sides of the plate by using the formula $P = F/l^2$.If the maximum errors in the measurement of force and length are 4% and 2% respectively. If the maximum error in the measurement of pressure?

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11. The density of a cube is measured by measuring its mass and the length of its sides. If the maximum errors in the measurement of mass and length are 3% and 2%, respectively, then find the maximum error in the measurement of the density of cube.

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12. The pressure on a square plate is measured by measuring the force on the plate and the length of the sides of the plate . If the maximum error in the measurement of force and length are , respectively , 4% and 2%. Find the maximum error in the measurement of pressure.

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13. The resistance $R = V/i$, where $V = 100 \pm 5V$ and $I = 10 \pm 0.2A$. What is the total error in R?

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14. The length of a cylinder is measured with a meter rod having least count $0.1cm$. Its diameter is measured with Vernier calipers having least count $0.01cm$. Given that length is $5.0cm$ and radius is $2cm$. Find the percentage error in the calculated value of the volume.

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15. In an experiment , the following observations were recorded:

$L = 2.820m, M = 3.00kg, l = 0.087cm, diameter, D = 0.041cm$. Taking $g = 9.81ms^{-2}$ and using the formula , $Y = \frac{4MgL}{\pi D^2 l}$, find the maximum permissible error in Y.

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16. According to Joule's law of heating , heat produced $H = I^2Rt$, where I is current , R is resistance of I , R , and $tare 3\%, 4\%,$ and 6%, respectively , find error in the measurement of H.

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17. A physical quantity P is given by $P = \frac{A^3B^{1/2}}{C^{-4}D^{3/2}}$. Which quantity among $A, B, C,$ and D brings in the maximum percentage error in P?

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Subjective

1. $\frac{\alpha}{t^2} = Fv + \frac{\beta}{x^2}$

Find the dimension formula for $[\alpha]$ and $[\beta]$ (here t = time , F = force , v = velocity , x = distance).

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2. In two systems of relations among velocity , acceleration , and force are , respectively , $v_2 = \frac{\alpha^2}{\beta} v_1, a_2 = \alpha\beta a_1,$ and $F_2 = \frac{F_1}{\alpha\beta}.$ If α and β are constants , then make relations among mass , length , and time in two systems.

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3. With due regard to significant figures, add the following :

(a) 9.53 and 0.324 , (b) 953 and 0.625

(c) 953.0 and 0.324 ,(d) 953.0 and 0.374

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4. With due regard to significant figures, subtract

(a) 0.35 from 7 , (b) 0.65 from 7

(c) 0.35 from 7.0 ,(d) 0.65 from 7.0

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5. A diamond weighs $3.71g$. It is put into a box weighing $1.4kg$. Find the total weight of the box and diamond to the correct number of significant figures.

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6. (a). Calculate the area enclosed by a circle of radius $0.56m$ to the correct number of significant figures.

(b) . Calculate the area enclosed by a circle of diameter $1.12m$ to the correct number of significant figures.

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7. (a).Add $3.8 \times 10^{-6} \rightarrow 4.2 \times 10^{-5}$ with due regard to significant figures.

(b). Subtract $3.2 \times 10^{-6} om 4.7 \times 10^{-4}$ with regard to significant figures.

(c). Subtract $1.5 \times 10^{3} om 4.8 \times 10^{4}$ with due regard to significant figures.

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

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9. The diameter of a sphere is $3.34m$. Calculate its volume with due regard to significant figures.

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10. Solve with due regard to significant figures:

$$\frac{5.42 \times 0.6753}{0.085}$$

A. 43.06030

B. 43.1

C. 43

D. 43.0

Answer: C

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11. In an experiment the refractive index of glass was observed to be $1.45, 1.56, 1.54, 1.44, 1.54, \text{ and } 1.53$. Calculate

(a). Mean value of refractive index

(b). Mean absolute error

(c) Fractional error

(d) Percentage error

(e) Express the result in terms of absolute error and percentage error

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12. (a). Two plates have lengths measured as $(1.9 \pm 0.3)m$ and $(3.5 \pm 0.2)m$. Calculate their combined length with error limits.

(b) The initial and final temperatures of a liquid are measured to be $67.7 \pm 0.2^{\circ}C$ and $76.3 \pm 0.3^{\circ}C$. Calculate the rise in temperature with error limits.

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13. The sides of a rectangle are $(10.5 \pm 0.2)cm$ and $(5.2 \pm 0.1)cm$. Calculate its perimeter with error limits .

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14. The length and breadth of a rectangle are $(5.7 \pm 0.1)cm$ and $(3.4 \pm 0.2)cm$, respectively calculate the area of rectangle with error limits.

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15. A body travels uniformly a distance of $(13.8 \pm 0.2)m$ in a time $(4.0 \pm 0.3)s$. Find the velocity of the body within error limits and the percentage error.

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16. The radius of a sphere is measured to be $(2.1 \pm 0.02)cm$. Calculate its surface area with error limits.

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17. Calculate the percentage error in specific resistance , $\rho = \pi r^2 R/l$, where r = radius of wire $= 0.26 \pm 0.02cm$, l = length of wire $= 156.0 \pm 0.1cm$, and R = resistance of wire $= 64 \pm 2\Omega$.

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18. The time period of a pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. The length of pendulum is $20cm$ and is measured up to $1mm$ accuracy. The time period is about $0.6s$. The time of 100 oscillations is measured with a watch of $1/10s$ resolution. What is the accuracy in the determination of g?

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19. Two resistances $R_1 = 100 \pm 3\Omega$ and $R_2 = 200 \pm 4\Omega$ are connected in series . Find the equivalent resistance of the series combination.

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20. The initial and final temperatures of liquid in a container are observed to be $7.63 \pm 0.4^\circ C$ and $67.7 \pm 0.3^\circ C$. Determine the fall in the temperature of the liquid.

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21. A capacitor of capacitance $C = 2.0 \pm 0.1\mu F$ is charged to a voltage $V = 20 \pm 0.2V$. What will be the charge Q on the capacitor ? Use $Q = CV$.

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22. The resistance $R = \frac{V}{I}$, where $V = (100 \pm 5.0)V$ and $I = (10 \pm 0.2)A$. Find the percentage error in R.

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23. The value of acceleration due to gravity is $980 cms^{-2}$. What will be its value if the unit of length is kilometer and that of time is minute?

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24. A body of mass m hung at one end of the spring executes simple harmonic motion . The force constant of a spring is k while its period of vibration is T. Prove by dimensional method

that the equation $T = 2\pi\sqrt{m/k}$ is correct. Dervive the correct equation , assuming that they are related by a power law.

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25. The radius of the earth is $6.37 \times 10^6 m$ and its mass is $5.975 \times 10^{24} kg$. Find the earth's average density to approopriate significant figures.

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26. A man runs $100.5m$ in $10.3\,\text{sec}$. Find his average speed up to appropriate significant figures.

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27. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. L is about $10cm$ and is known to $1mm$ accuracy . The period of oscillation is about $0.5s$. The time of 100 oscillation is measured with a wrist watch of $1s$ resolution . What is the accuracy in the determination of g ?

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28. The error in the measurement of the radius of a sphere is $0.5\,\%$. What is the permissible percentage error in the measurement of its (a) surface area and (b) volume ?

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29. It has been observed that velocity of ripple waves produced in water (ρ) , and surface tension (T) . Prove that $V^2 \propto T/\lambda\rho$.

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30. In an experiment on the determination of young's Modulus of a wire by Searle's method , following data is available:

Normal length of the wire $(L) = 110cm$

Diameter of the wire $(d) = 0.01cm$

Elongation in the wire $(l) = 0.125cm$

This elongation is for a tension of $50N$. The least counts for corresponding quantities are $0.01cm, 0.00005cm,$ and $0.001cm$, respectively. Calculate the maximum error in calculating the value of Young's modulus (Y)`.

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31. In an experiment for determining the value of acceleration due to gravity (g) using a simpe pendulum , the following observations were recorded:

Length of the string $(l) = 98.0cm$

Diameter of the bob $(d) = 2.56cm$

Time for $10oscillations(T) = 20.0s$

Calculate the value of g with maximum permissible absolute error and the percentage relative error.

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Single Correct

1. The equation of a stationary wave is $y = 2A\sin\left(\frac{2\pi ct}{\lambda}\right)\cos\left(\frac{2\pi x}{\lambda}\right)$

Which of the following is wrong?

A. The unit of ct is same as that of λ.

B. The unit of x is same as that of λ.

C. The unit of $2\pi c/\lambda$ is same as that of $2\pi x/\lambda t$.

D. The unit of c/λ is same as that of x/λ.

Answer: D

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2. Given that $y = A\sin\left[\left(\frac{2\pi}{\lambda}(ct - x)\right)\right]$,where y and x are measured in metres. Which of the following statement is true?

A. The unit of λ is same as that of x and A.

B. The unit of λ is same as that of x but may not be same as that of A.

C. The unit of c is same as that of $2\pi / \lambda$.

D. The unit of $(ct - x)$ is same as that of $2\pi / \lambda$.

Answer: B

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3. In the relation $\frac{dy}{dt} = 2\omega \sin(\omega t + \phi_0)$, the dimensional formula for $\omega t + \phi_0$ is

A. MLT

B. MLT^0

C. ML^0T^0

D. $M^0L^0T^0$

Answer: D

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4. A physical quantity depends upon five factors , all of which have dimensions, then method of dimensional analysis

A. Can be applied

B. Cannot be applied

C. Depends upon factors involved

D. Both (a) and (c)`

Answer: B

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5. A student when discussing the properties of a medium (except vaccum) writes

Velocity of light in vaccum = Velocity of light in medium

This formula is

A. Dimensionally correct

B. Dimensionally incorrect

C. Numerically incorrect

D. Both a and c

Answer: D

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6. Given that T stands for time and l stands for the length of simple pendulum . If g is the acceleration due to gravity , then which of the following statements about the relation $T^2 = (l/g)$ is correct?

A. It is correct both dimensionally as well as numerically.

B. It is neither dimensionally correct nor numerically.

C. It is dimensionally correct but not numerically.

D. It is numerically correct but not dimensionally.

Answer: C

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7. Refractive index mu is given as $\mu = A + \frac{B}{\lambda^2}$, where A and B are constants and lambda is wavelength, then dimensions of B are same as that of

A. Wavelength

B. Volume

C. Pressure

D. Area

Answer: D

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8. A physical quantity x depends on quantities y and z as follows : $x = Ay + B\tan(Cz)$, where A, B and C are constants. Which of the followings do not have the same dimensions?

A. x and B

B. C and z^{-1}

C. y and B/A

D. x and A

Answer: D

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9. If L and R denote inductance and resistance , respectively , then the dimensions of L/R are

A. $M^1L^0T^0Q^{-1}$

B. $M^0L^0TQ^0$

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

D. $M^{-1}LT^0Q^{-1}$

Answer: B

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10. The best method to reduce random error is

A. a. To change the instrument used for measurement

B. b. To take help of experienced observer

C. c. To repeat the experiment many times and to take the average results

D. d. None of the above

Answer: C

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11. A length is measured as $7.60m$. This is the same as

A. $7600mm$

B. $0.0076mm$

C. $760cm$

D. $0.76dm$

Answer: C

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12. Force F is given in terms of time t and distance x by $F = A\sin Ct + B\cos Dx$. Then the dimensions of A/B and C/D are

A. $\left[M^0L^0T^0\right], \left[M^0L^0T^{-1}\right]$

B. $\left[MLT^{-2}\right], \left[M^0L^{-1}T^0\right]$

C. $\left[M^0L^0T^0\right], \left[M^0LT^{-1}\right]$

D. $\left[M^0L^1T^{-1}\right], \left[M^0L^0T^0\right]$

Answer: C

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13. The dimensional formula for resistivity of conductor is

A. $\left[ML^2T^{-2}A^{-2}\right]$

B. $\left[ML^3T^{-3}A^{-2}\right]$

C. $\left[ML^{-2}T^{-2}A^2\right]$

D. $\left[ML^2T^{-2}A^{-3}\right]$

Answer: B

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14. The dimensional formula for electric potential is

A. $\left[ML^2T^{-3}A^{-1}\right]$

B. $\left[MLT^{-3}A^{-1}\right]$

C. $\left[ML^2T^{-3}K^{-1}\right]$

D. none of these

Answer: A

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15. The effictive length of a simple pendulum is the sum of the following three : length of string , radius of bob , and length of hook.

In a simple pendulum experiment , the length of the string , as measured by a meter scale , is $92.0cm$. The radius of the bob combined with the length of the hook , as measured by a vernier callipers , is $2.15cm$. The effictive length of the pendulum is

A. a. $94.1cm$

B. b. $94.2cm$

C. c. $94.15cm$

D. d. $94cm$

Answer: B

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16. The frequency (n) of vibration of a string is given as $n = \frac{1}{2l}\sqrt{\frac{T}{m}}$, where T is tension and l is the length of vibrating string , then the dimensional formula for m is

A. $\left[M^0L^1T^1\right]$

B. $\left[M^0L^0T^0\right]$

C. $\left[M^1L^{-1}T^0\right]$

D. $\left[ML^0T^0\right]$

Answer: C

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17. In the relation $y = r\sin(\omega t - kx)$, the dimensions of ω/k are

A. $[M^0L^0T^0]$

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

C. $[M^0L^0T^1]$

D. $[M^0L^1T^0]$

Answer: B

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18. The dimensions of $\varepsilon_0\mu_0$ are

A. $\left[LT^{-1}\right]$

B. $\left[LT^{-2}\right]$

C. $\left[L^2T^{-2}\right]$

D. $\left[L^{-2}T^2\right]$

Answer: D

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19. Which of the following quantities has its unit as newton - second?

A. Energy

B. Torque

C. Momentum

D. Angular momentum

Answer: C

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20. If frequency F, velocity V , and density D are considered fundamental units , the dimensional formula for momentum will be

A. DVF^2

B. DV^2F^{-1}

C. $D^2V^2F^2$

D. DV^4F^{-3}

Answer: D

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21. If force F, acceleration a, and $time$T` are taken as the fundamental physical quantities , the dimensions of length on this systemof units are

A. FAT^2

B. FAT

C. FT

D. AT^2

Answer: D

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22. If the percentage errors of $A, B, \text{ and } C$ are $a, b, \text{ and } c$, respectively ,then the total percentage error in the product ABC is

A. abc

B. $a + b + c$

C. $\frac{1}{a} + \frac{1}{b} + \frac{1}{c}$

D. $ab + bc + ca$

Answer: B

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23. Which of the following numbers has least number of significant figures?

A. 0.80760

B. 0.80200

C. 0.08076

D. 80.267

Answer: C

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24. The dimensional formula for magnetising field H is

A. $\left[M^0L^{-1}T^0A\right]$

B. $\left[M^0LT^{-3}A\right]$

C. $\left[M^0LTA^{-1}\right]$

D. $\left[M^0L^1T^{-1}A\right]$

Answer: A

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25. The dimensions of intensity of wave are

A. $\left[ML^2T^{-3}\right]$

B. $\left[ML^0T^{-3}\right]$

C. $\left[ML^{-2}T^{-3}\right]$

D. $\left[M^1L^2T^3\right]$

Answer: B

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26. Find the dimensions of capacitance.

A. $\left[M^{-1}L^{-2}TA^{2}\right]$

B. $\left[M^{-1}L^{-2}T^{3}A^{2}\right]$

C. $\left[M^{-1}L^{-2}T^{4}A^{2}\right]$

D. $\left[M^{-1}L^{-2}T^{2}A^{2}\right]$

Answer: C

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27. What are the dimensions of gas constant ?

A. $\left[MLT^{-2}K^{-1}\right]$

B. $\left[M^{0}LT^{-2}K^{-1}\right]$

C. $\left[ML^{2}T^{-2}K^{-1}mol^{-1}\right]$

D. $\left[M^{0}L^{2}T^{-2}K^{-1}\right]$

Answer: C

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28. The order of magnitude of $499 is 2$, then the order of magnitude of 501 will be

A. 1

B. 2

C. 1

D. 3

Answer: D

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29. The order of magnitude of 0.00701 is

A. -2

B. -1

C. 2

D. 1

Answer: A

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30. The order of magnitude of 379 is

A. 1

B. 2

C. 3

D. 4

Answer: B

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31. If $X = a + b$, the maximum percentage error in the measurement of X will be

A. $\left(\frac{\Delta a}{a} + \frac{\Delta b}{b}\right) \times 100\,\%$

B. $\left(\frac{\Delta a}{a+b} - \frac{\Delta b}{a+b}\right) \times 100\,\%$

C. $\left(\frac{\Delta a}{a+b} + \frac{\Delta b}{a+b}\right) \times 100\,\%$

D. $\left(\frac{\Delta a}{a} \times \frac{\Delta b}{b}\right) \times 100\,\%$

Answer: C

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32. Which of the following is the most precise instrument for measuring length?

A. Meter rod of least count $0.1cm$

B. Vernier callipers of least count $0.01cm$

C. Screw gauge of least count $0.001cm$

D. Data is not sufficient to decide

Answer: C

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33. The number of significiant figures in $5.69 \times 10^{15} kg$ is

A. 1

B. 2

C. 3

D. 18

Answer: C

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34. The position of a particle at time t is given by the relation $x(t) = \left(\frac{v_0}{\alpha}\right)\left(1 - c^{-at}\right)$, where v_0 is a constant and $\alpha > 0$. Find the dimensions of v_0 and α.

A. M^0LT^{-1} and T^{-1}

B. M^0LT^1 and T^{-1}

C. M^0LT^{-1} and LT^{-2}

D. M^0LT^{-1} and T

Answer: A

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35. The time dependence of a physical quantity P is given by $P = P_0 e^{-\alpha t^2}$, where α is a constant and t is time . Then constant α is//has

A. Dimensionless

B. Dimensions of T^{-2}

C. Dimensions of P

D. Dimensions of T^2

Answer: B

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36. Of the following quantities , which one has the dimensions different from the remaining three?

A. Energy density

B. Force per unit area

C. Product of charge per unit volume and voltage

D. Angular momentum per unit mass

Answer: D

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37. The frequency f of vibrations of a mass m suspended from a spring of spring constant k is given by $f = Cm^x k^y$, where C is a dimensionnless constant. The values of x and y are, respectively,

A. $\frac{1}{2}, \frac{1}{2}$

B. $-\frac{1}{2}, -\frac{1}{2}$

C. $\frac{1}{2}, -\frac{1}{2}$

D. $-\frac{1}{2}, \frac{1}{2}$

Answer: D

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38. If C (the velocity of light) g , (the acceleration due to gravity), P (the atmospheric pressure) are the fundamental quantities in MKS system , then the dimensions of length will be same as that of

A. C/g

B. C/P

C. PCg

D. C^2 / g

Answer: D

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39. The quantities A and B are related by the relation $A / B = m$, where m is the linear mass density and A is the force , the dimensions of B will be

A. Same as that of pressure

B. Same as that of work

C. That of momentum

D. Same as that of learnt heat

Answer: D

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40. A physical quantity X is represented by $X = \left(M^x L^{-y} T^{-z}\right.$. The maximum percantage errors in the measurement of $M, L,$ and $T,$ respectively , are $a\%, b\%$ and $c\%$. The maximum percentage error in the measurement of X will be

A. $(ax + by - cz)\ \%$

B. $(ax - by - cz)\ \%$

C. $(ax + by + cz)\ \%$

D. $(ax - by + cz)\ \%$

Answer: C

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41. The velocity of transverse wave in a string is $v = \sqrt{T/m}$ where T is the tension in the string and m is the mass per unit length . If $T = 3.0kgf$, the mass of string is 25g and length of the string is$v = 1.000m$, then the percentage error in the measurement of velocity is

A. 0.5

B. 0.7

C. 2.3

D. 3.6

Answer: D

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42. Write the dimensions of a/b in the relation $P = \frac{a - t^2}{bx}$, where P is the pressure , x is the distance , and t is the time .

A. $M^{-1}L^0T^{-2}$

B. ML^0T^{-2}

C. ML^0T^2

D. MLT^{-2}

Answer: B

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43. Write the dimensions of $a \times b$in the relation $E = \frac{b - x^2}{at}$, where E is the energy , x is the displacement , and t is the time.

A. ML^2T

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

C. ML^2T^{-2}

D. MLT^{-2}

Answer: B

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44. If the velocity of light (c) , gravitational constant (G) , and Planck's constant (h) are chosen as fundamental units , then find the dimensions of mass in new system.

A. $h^{1/2}C^{1/2}G^{-1/2}$

B. $h^{-1}C^{-1}G$

C. hCG^{-1}

D. hCG

Answer: A

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45. In the relation $V = \frac{\pi}{8}\frac{Pr^4}{nl}$, where the letters have their usual meanings , the dimensions of V are

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

B. $M^0L^3T^{-1}$

C. $M^0L^{-3}T^{-1}$

D. $M^1L^3T^0$

Answer: B

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46. The length l , breadth b, and thickness t of a block of wood were measured with the help os a measuring scale. The results with permissible errors (in cm) are

$l = 15.12 \pm 0.01, b = 10.15 \pm 0.01$, and $t = 5.28 \pm 0.01.$

The percentage error in volume up to proper significant figures is

A. $0.28\ \%$

B. $0.35\ \%$

C. $0.48\ \%$

D. $0.64\ \%$

Answer: B

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47. The relative density of a material of a body is found by weighing it first in air and then in water. If the weight of he body in air is $W_1 = 8.00 \pm N$ and the weight in water is $W_2 = 6.00 \pm 0.05N$, then the relative density $\rho_r = W_1/(W_1 - W_2)$ with the maximum permissible eror is

A. $4.00 \pm 0.62\,\%$

B. $4.00 \pm 0.82\,\%$

C. $4.00 \pm 3.2\,\%$

D. $4.00 \pm 5.62\,\%$

Answer: D

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48. The number of particles is given by $n = -D\frac{n_2 - n_1}{x_2 - x_1}$ crossing a unit area perpendicular to X - axis in unit time , where n_1 and n_2 are particles per unit volume for the value of x meant to x_2 and x_1 . Find the dimensions of D called diffusion constant.

A. $[M^0LT^{-2}]$

B. $[M^0L^2T^{-4}]$

C. $[M^0L^2T^{-2}]$

D. $[M^0L^2T^{-1}]$

Answer: D

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49. If $E, M, J,$ and G , respectively , denote energy , mass , angular momentum , and gravitational constant , then $EJ^2 / M^5 G^2$ has the dimensions of

A. Time

B. Angle

C. Mass

D. Length

Answer: B

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50. If $L, R, C,$ and V, respectively , represent inductance , resistance , capacitance and potential difference , then the dimensions of L / RCV are the same as those of

A. a. Charge

B. b. $1/\text{Charge}$

C. c. Current

D. d. $1/\text{Current}$

Answer: D

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51. The momentum of inertia of a body rotating about a given axis is $12.0 kgm^2$ in the SI system . What is the value of the moment of inertia in a system of units in which the unit of lengths is $5cm$ and the unit of mass is $10g$?

A. a. 2.4×10^3

B. b. 6.0×10^3

C. c. 5.4×10^5

D. d. 4.8×10^5

Answer: D

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52. If speed (V),acceleration (A) and force (F) are considered as fundamental units, the dimesnion of Young 's modulus will be :

A. FA^2V^{-4}

B. FA^2V^{-5}

C. FA^2V^{-3}

D. FA^2V^{-2}

Answer: A

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

A. 5%

B. 1%

C. 8%

D. 11%

Answer: C

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54. An experiment from $X = \frac{a^{1/2}b^2}{c^3}$. If the percentage errors in $a, b,$ and $care \pm 1\%$, $\pm 3\%$, and $\pm 2\%$, respectively , then the percentage error in X can be

A. $\pm 12.5\%$

B. $\pm 7\%$

C. $\pm 1\%$

D. $\pm 4\%$

Answer: A

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55. The resistance of a metal is given by $R = V/I$, where V is potential difference and I is current . In a circuit , the potential difference across resistance is $V = (8 \pm 0.5)V$ and current in

resistance , $I = (4 \pm 0.2)A$. What is the value of resistance with its percentage error?

A. $(2 \pm 5.6\ \%\ )\Omega$

B. $(2 \pm 0.7\ \%\ )\Omega$

C. $(2 \pm 35\ \%\ )\Omega$

D. $(2 \pm 11.25\ \%\ )\Omega$

Answer: D

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56. Which of the following product of e, h, μ, G (where μ is permeability) be taken so that the dimensions of the product are same as that of the speed of light ?

A. $he^{-2}\mu^{-1}G^0$

B. $h^2eG^0\mu$

C. $h^0e^2G^{-1}\mu$

D. $he^{-2}\mu^0$

Answer: A

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57. Which of the following does not have the dimensions of velocity ? (Given ε_0 is the permittivity of free space , μ_0 is the permeability of free space , v is frequency , λ is wavelength , P is the pressure , and ρ is density , k is wave number , ω is the the angular frequency) (1)$\omega\, k$ (2)$v\lambda$ (3)$1/\sqrt{\varepsilon_0\mu_0}$ (4)$\sqrt{\frac{P}{\rho}}$

A. ωk

B. $v\lambda$

C. $\frac{1}{\sqrt{\varepsilon_0 \mu_0}}$

D. $\sqrt{\frac{P}{\rho}}$

Answer: A

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58. The mass of the liquid flowing per second per unit area of cross-section of the tube is proportional to $(\text{pressure difference across the ends})^n$ and $(\text{average velocity})^m$ of the liquid. Which one of the following relation is correct?

A. $x = y$

B. $x = -y$

C. $y^2 = x$

D. $y = -x^2$

Answer: B

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59. A physical quantity x is calculated from $x = ab^2 / \sqrt{c}$. Calculate the percentage error in measuring x when the percentage errors in measuring a , b , and c are 4 , 2 , and 3%, respectively .

A. 7%

B. 9%

C. 11%

D. 9.5%

Answer: D

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60. Given that $Y = a\sin\omega t + bt + ct^2\cos\omega t$. The unit of abc is same as that of

A. y

B. y/t

C. $(y/t)^2$

D. $(y/t)^3$

Answer: D

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61. The potential energy of a particle varies with distance x from a fixed origin as $U = \frac{A\sqrt{x}}{x^2 + B}$, where A and B are dimensional constants , then find the dimensional formula for AB.

A. $M^1L^{7/2}T^{-2}$

B. $M^1L^{11/2}T^{-2}$

C. $M^1L^{5/2}T^{-2}$

D. $M^1L^{9/2}T^{-2}$

Answer: B

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62. If x and a stand for distance , then for what value of n is the given equation dimensionally correct? The equation is

$$\int \frac{dx}{\sqrt{a^2 - x^n}} = \frac{\sin^{-1}(x)}{a}$$

A. 0

B. 2

C. -2

D. 1

Answer: B

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63. The specific resistance ρ of a circular wire of radius r, resistance R, and length l is given by $\rho = \pi r^2 R/l$. Given : $r = 0.24 \pm 0.02cm$, $R = 30 \pm 1\Omega$, and $l = 4.80 \pm 0.01cm$. The percentage error in ρ is nearly

A. $7\,\%$

B. $9\,\%$

C. $13\,\%$

D. $20\,\%$

Answer: D

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64. Using mass (M) , length (L) , time (T) , and electric current (A) as fundamental quantities , the dimensions of permitivity will be

A. $\left[MLT^{-1}A^{-1}\right]$

B. $\left[MLT^{-2}A^{-1}\right]$

C. $\left[M^{-1}L^{-3}T^{4}A^{2}\right]$

D. $\left[M^{2}L^{-2}T^{-2}A\right]$

Answer: C

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65. Assuming that the mass m of the largest stone that can be moved by a flowing river depends upon the velocity v of the water , its density ρ , and the acceleration due to gravity g . Then m is directly proportinal to

A. v^3

B. v^4

C. v^5

D. v^6

Answer: D

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66. A sperical body of mass m and radius r is allowed to fall in a medium of viscosity η. The time in which the velocity of the body

increases from zero to 0.63 times the terminal velocity (v) is called constant (τ). Dimensionally , τ can be represented by

A. $\frac{mr^2}{6\pi\eta}$

B. $\sqrt{\frac{6\pi mr\eta}{g^2}}$

C. $\frac{m}{6\pi\eta rv}$

D. None of these

Answer: D

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67. A student writes four different expressions for the displacement y in a periodic motion . Which of the following can be correct?

A. $y = aT\frac{\sin(2\pi t)}{T}$

B. $y = a \sin Vt$

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

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

Answer: D

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68. The relation $\tan\theta = v^2 / rg$ gives the angle of banking of the cyclist going round the curve . Here v is the speed of the cyclist , r is the radius of the curve , and g is the acceleration due to gravity . Which of the following statements about the relation is true ?

A. It is both dimensionally as well as numerically correct.

B. It is neither dimensionally correct correct.

C. It is dimensionally correct but not numerically.

D. It is numerically correct but not dimensionally.

Answer: A

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69. A liquid drop of density ρ , radius r, and surface tension σ oscillates with time period T . Which of the following expressions for T^2 is correct?

A. $\frac{\rho r^3}{\sigma}$

B. $\frac{\rho\sigma}{r^3}$

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

D. None of these

Answer: A

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70. A highly rigid cubical block A of small mass M and side L is fixed rigidly on the other cubical block of same dimensions and of modulus of rigidity η such that the lower face of A completely covers the upper face of B. The lower face of B is rigidly held on a horizontal surface . A small force F is applied perpendicular to one of the side faces of A. After the force is withdrawn , block A executes faces of A. After the force is withdrawn , block A exceutes small oscillations , the time period of which is given by

A. $2\pi\sqrt{M\eta L}$

B. $2\pi\sqrt{M\eta/L}$

C. $2\pi\sqrt{ML/\eta}$

D. $2\pi\sqrt{M/\eta L}$

Answer: D

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71. The mass of a body is $20.000g$ and its volume is $10.00cm^3$. If the measured values are expressed to the correct significant figures , the maximum error in the value of density is

A. $0.001gcm^{-3}$

B. $0.010gcm^{-3}$

C. $0.100gcm^{-3}$

D. None of these

Answer: D

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72. The length of a strip measured with a meter rod is 10.0cm. Its width measured with a venier calipers is 1.00cm. The least count of the meter rod is 0.1 cm and that of vernier calipers 0.01cm. What will be error in its area?

A. $\pm 0.01 cm^2$

B. $\pm 0.1 cm^2$

C. $\pm 0.11 cm^2$

D. $\pm 0.2 cm^2$

Answer: D

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73. While measuring the acceleration due to gravity by a simple pendulum , a student makes a positive error of 1% in the length of the pendulum and a negative error of 3% in the value of time period . His percentage error in the measurement of g by the relation $g = 4\pi^2\left(l/T^2\right)$ will be

A. 2%

B. 4%

C. 7%

D. 10%

Answer: C

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74. While measuring acceleration due to gravity by a simple pendulum , a student makes a positive error of 2% in the length of the pendulum and a positive error of 1% in the measurement of the value of g will be

A. 3%

B. 0%

C. 4%

D. 5%

Answer: B

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75. The relative density of a material is found by weighing the body first in air and then in water . If the weight in air is

$(10.0 \pm 0.1)gf$ and the weight in water is $(5.0 \pm 0.1)gf$, then the maximum permissible percentage error in relative density is

A. 1

B. 2

C. 3

D. 5

Answer: D

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76. The dimensional formula for a physical quantity x is $\left[M^{-1}L^{3}T^{-2}\right]$. The errors in measuring the quantities $M, L,$ and $T,$ respectively are $2\%, 3\%,$ and 4%. The maximum percentage of error that occurs in measuring the quantity x is

A. 9

B. 10

C. 14

D. 19

Answer: D

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77. The heat generated in a circuit is given by $Q = I^2Rt$, where I is current , R is resistance , and t is time . If the percentage errors in measuring $I, R,$ and $tare2\,\%$, $1\,\%$, and $1\,\%$, respectively , then the maximum error in measuring heat will be

A. $2\,\%$

B. $3\,\%$

C. 4%

D. 6%

Answer: D

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78. The internal and external diameters of a hollow cylinder are measured with the help of a Vernier callipers . Their values are $4.23 \pm 0.01cm$ and $3.87 \pm 0.01cm$, respectively . The thickness of the wall of the cylinder is

A. $0.36 \pm 0.02cm$

B. $0.18 \pm 0.02cm$

C. $0.36 \pm 0.01cm$

D. $0.18 \pm 0.01cm$

Answer: B

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79. Which of the following pairs has the same dimensions?

A. Torque and work

B. Angular momentum and Planck's constant

C. Energy momentum and Planck's constant

D. Light year and wavelength

Answer: A::B::D

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80. Which of the following pairs have different dimensions?

A. `Frequency and angular velocity.

B. Tension and surface tension.

C. Density and energy density.

D. Linearmomentum and angular momentum.

Answer: B::C::D

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81. Pressure is dimensionally

A. Force per unit area

B. Energy per unit volume

C. Momentum per unit area per second

D. Momentum per unit Volume

Answer: A::B::C

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82. Which of the following pairs have the same dimensions ?

(L = inductance , C = capacitance , R = resistance)

A. $\frac{L}{R}$ and CR

B. LR and CR

C. $\frac{L}{R}$ and $\sqrt{LC}$

D. RC and $\frac{1}{LC}$

Answer: A::C

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83. Choose the correct statement(s).

A. A dimensionally correct equation must be correct.

B. A dimensionally correct equation may br incorrect.

C. ` A dimensionally incorrect equation must be correct.

D. A dimensionally incorrect equation may be correct.

Answer: B::D

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84. Which of the following pairs have the same dimensions?

A. h/e and magnetic flux

B. h/e and electric flux

C. Electric fux and q/ε_0

D. Electric flux and $\mu_0 I$

Answer: A::C

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85. The values of measurement of a physical quantity in five trails were found to be $1.51, 1.53, 1.53, 1.52, \text{ and } 1.54.$

A. Average absolute error is $0.01.$

B. Relative error is $0.01.$

C. Percentage error is $0.01\ \%$.

D. Percentage error is $1\ \%$.

Answer: A::B::D

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86. If S and V are one main scale and one Vernier scale and $n-1$ divisions on the main scale are equivalent to n divisions of the Vernier , then

A. The least count is S/n.

B. The Vernier constant is S/n.

C. The same Vernier constant can be used for circular Vernier also.

D. The same vernier constant cannot be used for circular Verniers.

Answer: A::B::C

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87. Consider three quantities:

$x = \frac{E}{b}, y = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}, \text{ and } z = \frac{l}{CR}.$

Here , l is the length of a wire , C is the capacitance , and R is a resistance. All other symbols have usual meanings. Then

A. x and y have the same dimensions.

B. x and z have the same dimensions.

C. y and z have the same dimensions.

D. None of the above three pairs have the same dimensions.

Answer: A::B::C

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88. The van der Waal's equation of state for some gases 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.

The dimensions of a are

A. ML^5T^{-2}

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

C. L^3

D. L^6

Answer: A

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89. The van der Waal's equation of state for some gases 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.

The dimensions of constant b are

A. ML^5T^{-2}

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

C. L^3

D. L^6

Answer: C

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90. The van der Waal's equation of state for some gases 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 $a, b, \text{ and } R$ are constants.

Which of the following does not have the same dimensional formula as that for RT ?

A. PV

B. Pb

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

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

Answer: C

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91. The van der Waal's equation of state for some gases 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.

The dimensionsal representation of 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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92. The van der Waal's equation of state for some gases 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 $a, b, \text{ and } R$ are constants.

In the above problem , the dimensional formula for RT is same as that of

A. Energy

B. Force

C. Specific heat

D. Latent heat

Answer: A

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93. Dimensionsal methods provide three major advantages in verification , deviation , and changing the system of units . Any empirical formula that is derived based on this method has to be verified and propportionality constants found by experimental means . The presence or absence of certain factors - non dimensional constants or variables - cannot be identified by this method . So every dimensionally correct relation cannot be taken as perfectly correct.

If α kilogram , β meter , and γ second are the fundamental units , $1cal$ can be expressed in new units as $[1cal = 4.2J]$

A. $\alpha^{-1}\beta^{2}\gamma$

B. $\alpha^{-1}\beta^{-2}\gamma$

C. $4.2\alpha^{-1}\beta$

D. $4.2\alpha^{-1}\beta^{-2}\gamma^{2}$

Answer: D

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Multiple Correct

1. Dimensionsal methods provide three major advantages in verification , deviation , and changing the system of units . Any empirical formula that is derived based on this method has to be verified and propportionality constants found by experimental means . The presence or absence of certain factors - non dimensional constants or variables - cannot be identified by this method . So every dimensionally correct relation cannot be taken as perfectly correct.

The time period of oscillation of a drop depends on surface tension σ , density of the liquid ρ , and radius r . The relation is

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

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

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

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

Answer: C

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2. The energy E of an oscillating body in simple harmonic motion depends on its mass m, frequency n and amplitude a using the method of dimensional analysis find the relation between E ,m, n and a .

A. Mna^2

B. Mna^{-2}

C. Mn^2a^{-2}

D. Mn^2a^2

Answer: D

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Linked Comprehension

1. The accuracy of measurement also lies in the way the results is expressed. The number of digits to which a value is to be expressed is one digit more than number of digits after after an operation is carried out on the given values. The error can be minimised by many trials and using the correct methods are

instruments.

If the length and breadth are measured as 4.234 and $1.05m$, the area of the rectangle is

A. $4.4457m^2$

B. $4.45m^2$

C. $4.446m^2$

D. $0.4446m^2$

Answer: B

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2. The accuracy of measurement also lies in the way the results is expressed. The number of digits to which a value is to be expressed is one digit more than number of digits after after an operation is carried out on the given values. The error can be

minimised by many trials and using the correct methods are instruments.

The order of magnitude of 147 is

A. 1

B. 2

C. 3

D. 4

Answer: B

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3. The accuracy of measurement also lies in the way the results is expressed. The number of digits to which a value is to be expressed is one digit more than number of digits after after an operation is carried out on the given values. The error can be

minimised by many trials and using the correct methods are instruments.

The number of significant figures can reduce in

A. Addition

B. Subtraction

C. Multiplication

D. Division

Answer: B

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Archives Subjective

1. Give the MKS units for each of the following quantities .

(a) Young's modulus (b) Magnetic induction (c) power of a lens

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2. A gas bubble from an explosion under water oscillates with a period T proportional to $p^a d^b E^c$ where p is the static pressure d is the density of water and E is the total energy of explosion. Find the value of a,b and c.

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3. Write the dimensions of the following in the terms of $\text{mass, time, length and charge}$

(a) Magnetic flux (b) Rigidity modulus.

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4. N divisions on the main scale of a vernier callipers coincide with $N+1$ divisions on the vernier scale. If each division on the main scale is of a units, determine the least count of the instrument.

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Fill In The Blanks

1. Plancks' constant has the dimensions of

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2. If the formula, $X = 3yz^2$, X and Z have dimensions of capacitance and magnetic induction. The dimensions of Y in MKSQ system are

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3. The dimensions of electrical conductivity are .....

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4. In van der Waal's equations $\left(P + \frac{a}{V^2}\right)(V - b) = RT$, what are the dimensions of the constants a and b?

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Single Correct Answer Type

1. The dimension of $\left(\frac{1}{2}\right)\varepsilon_0 E^2$ (ε_0 : permittivity of free space, E electric field

A. MLT^{-1}

B. ML^2T^{-2}

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

D. ML^2T^{-1}

Answer: C

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2. A quantity$X$ is given by $\varepsilon_p L\frac{\delta V}{\delta t}$, where ε_p is the permitivity of free space ,L is a length , δV is a potential difference and δt is a

time interval . The dimensional formula for X is the same as that of

A. Resistance

B. Charge

C. Voltage

D. Current

Answer: D

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3. A cube has a side of length $1.2 \times 10^{-2} m$. Its volume upto correct significant figures is

A. a.$1.7 \times 10^{-6} m^3$

B. b. $1.73 \times 10^{-6} m^3$

C. c. $1.70 \times 10^{-6} m^3$

D. d. $1.732 \times 10^{-6} m^3$

Answer: A

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4. In the relation: $P = \frac{\alpha}{\beta} e^{-\frac{\alpha Z}{k\theta}}$, P is pressure Z is distance k is Boltzmann constant and θ is the temperature. The dimensional formula of β will be

A. $M^0 L^0 T^0$

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

C. $M^0 L^2 T^0$

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

Answer: C

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5. A wire of length $l = 6 \pm 0.06cm$ and radius $r = 0.5 \pm 0.005cm$ and mass $m = 0.\ 3 \pm 0.003gm$. Maximum percentage error in density is

A. a. 4

B. b. 2

C. c. 1

D. d. 6.8

Answer: A

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6. Which of the following sets have different dimensions ?

A. Pressure , Young's modulus , stress

B. Emf , potential difference , electric potential

C. Heat , work done , energy

D. Dipole moment , electric flux , electric field

Answer: D

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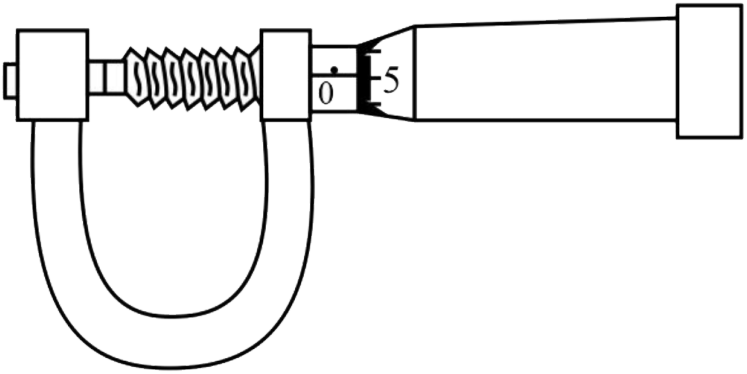
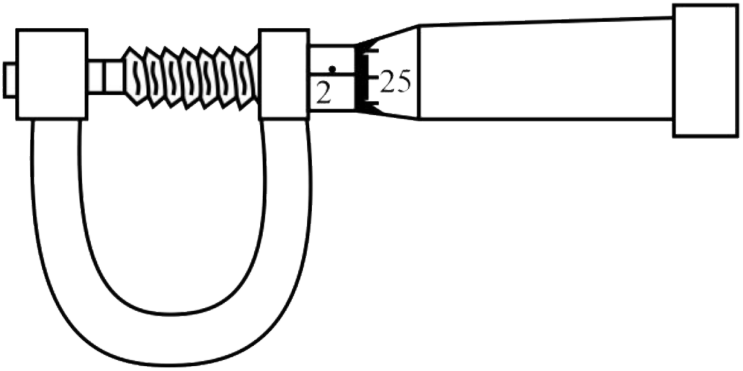
7. The number of circular divisions of shown screw gauge are 50.

It moves 0.5 mm on main scale in one rotation. The diameter of

the ball is:





A. a. $1.2mm$

B. b. $1.25mm$

C. c. $2.20mm$

D. d. $2.25mm$

Answer: A

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8. As student performs an experiment for determine of $g\left[=\frac{4\pi^2 L}{T^2}\right]$. $L \approx 1m$, and has commits an error of ΔL for T he tajes the teime of n osciollations wityh the stop watch of least count ΔT. For which of the following data the measurement of g will be most accurate?

A. $\Delta L = 0.5, \Delta T = 0.1, n = 20$

B. $\Delta L = 0.5, \Delta T = 0.1, n = 50$

C. $\Delta L = 0.5, \Delta T = 0.01, n = 20$

D. $\Delta L = 0.5, \Delta T = 0.05, n = 50$

Answer: D

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9. A student performs an experiment to determine the Young's modulus of a wire, exactly$2m$ long, by Searle's method. In a partcular reading, the student measures the extension in the length of the wire to be $0.8mmwithanuncerta\int yof$+- 0.05mm $ataloadofexactly$1.0kg

, $thestudentalsomeasuresthediameterofthewire \rightarrow be$ 04mm$withanuncerta\int yof$+-0.01mm. $Take$g=9.8m//s^(2)` (exact). the Young's modulus obtained from the reading is

A. $(2.0 \pm 0.3) \times 10^{11} Nm^{-2}$

B. $(2.0 \pm 0.2) \times 10^{11} Nm^{-2}$

C. $(2.0 \pm 0.1) \times 10^{11} Nm^{-2}$

D. $(2.0 \pm 0.5) \times 10^{11} Nm^{-2}$

Answer: B

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10. Student $I, II,$ and III perform an experiment for measuring the acceleration due to gravity (g) usinf a simple pendulum. They use lengths of the pendulum and // or record time for different number of oscillations . The observations are shown in the following table . Least count for length $= 0.1cm$

Student	Length of Pendulam (cm)	Number of n Oscillation (n)	Time Period (s)
I	64.0	8	16.0
II	64.0	4	16.0
III	20.0	4	9.0

Least count for time $= 0.1s.$

If E_I, E_{II} , and E_{III} are the percentage errors in g , i.,e., $\left(\frac{\Delta g}{g} \times 100\right)$ for students I,II , and III, respectively , then

A. $E_I = 0$

B. $E_I is \min i\mu m$

C. $E_I = E_{II}$

D. $E_{II} is \max i\mu m$

Answer: B

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11. A vernier calipers has $1mm$marks on the main scale. It has 20 equal divisions on the Verier scale which match with 16 main scale divisions. For this Vernier calipers, the least count is

A. a. $0.02mm$

B. b. $0.05mm$

C. c. $0.1mm$

D. d. $0.2mm$

Answer: D

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12. The density of a solid ball is to be determined in an experiment. The diameter of the ball is measured with a screw gauge, whose pitch is 0.5 mm and there are 50 divisions on the circular scale. The reading on the main scale is 2.5 mm and that on the circular scale is 20 divisions. If the measured mass of the ball has a relative error of 2%, the relative percentage error in the density is

A. a. 0.9%

B. b. 2.4%

C. c. 3.1%

D. d. 4.2%

Answer: C

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13. In the determination if Young's modulus $\left(\left(Y = \frac{4MLg}{\pi ld^2}\right.\right.$ by using searle's method, a wire of length $L = 2m$ and diameter $d = 0.5mm$ is used. For a load $M = 2.5kg$, an extension $l = 0.25mm$ in the length of the wire is observed. Quantites D and l are measured using a screw gauge and a micrometer, respectively. they have the same pitch of $0.5mm$. the number of divisions on their circular scale is 100. the contrubution to the maximum probable error of the Y measurement

A. due to the error in the measurements of d and l are the same.

B. due to the error in the measurements of d is twice that due to the error in the measurement of l.

C. due to the error in the measurements of l is twice that due to the error in the measurement of d.

D. due to the error in the measurements of d is four times that due to the error in the measurement of l.

Answer: A

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14. The diameter of a cylinder is measured using a Vernier callipers with no zero error. It is found that the zero of the Vernier scale lies between $5.10cm$ and $5.15cm$ of the main scale. The Vernier scale has 50 divisions equivalent to $2.45cm$.

The 24^{th} division of the Vernier scale exactly coincides with one of the main scale divisions. the diameter of the cylinder is

A. (a)$5.112cm$

B. (b)$5.124cm$

C. (c)$5.136cm$

D. (d)$5.148cm$

Answer: B

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15. Using the expression $2d\sin\theta = \lambda$, one calculates the values of d by measuring the corresponding angles θ in the range $0 \rightarrow 90\circ$. The wavelength λ is exactly known and error in θ is constant for all values of θ. As θ increases from $0\circ$

A. (a)the absolute error in d remains constant.

B. (b)the absolute error in d increases.

C. (c)the fractional error in d remain constant.

D. (d)the fractional error in d decreases.

Answer: D

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Multiple Correct Answer Type

1. L,C and R represent the physical quantities inductance, capacitance and resistance respectively. Which of the following combinations have dimensions of frequency?

A. (a)$1/RC$

B. (b) R / L

C. (c) $1 / \sqrt{LC}$

D. (d) C / L

Answer: A::B::C

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2. The dimensions of the quantities in one (or more) of the following pairs are the same . Identify the pair(s)

A. Torque and work

B. Angular momentum and work

C. Energy and young's modulus

D. Light year and wavelength

Answer: A::D

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3. Let $[\varepsilon_0]$ denote the dimensional formula of the permittivity of the vacuum, and $[\mu_0]$ that of the permeability of the vacuum. If $M = mass, L = \ \leq n > h, T = time$ and $I = e \leq ctriccurrent$,

A. $[\varepsilon_0] = M^{-1}L^{-3}T^2I$

B. $[\varepsilon_0] = M^{-1}L^{-3}T^4I^2$

C. $[\varepsilon_0] = M^{-1}L^{-3}T^4I^2$

D. $[\varepsilon_0] = ML^2T^{-1}I$

Answer: B::C

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4. The SI unit of the inductance , the henry can by written as

A. Weber/ampere

B. Volt -second/ ampere

C. $\text{Joule}/(\text{ampere})^2$

D. Ohm - second

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

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5. The pairs of physical quantities that have the same dimensions is (are)

A. Reyond number and coefficient of light wave

B. Curie and frequency of light wave

C. Latent heat and gravitational potential

D. Planck's constant and torque

Answer: A::B::C

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6. A student uses a simple pendulum of exactly 1 m length to determine g, the acceleration due to gravity. He uses a stopwatch with the least count of 1 second for this and records 40 seconds for 20 oscillations. For this observation, which of the following statements is true?

A. Error ΔT in measuring T , the time period , is $0.05s$

B. Error ΔT in measuring T , the time period , is $1s$

C. Percentage error in the determination of $gis5\ \%$

D. Percentage error in the determination of $gis2.5\ \%$

Answer: A::C

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7. Planck's constant h, speed of light c and gravitational constant $G$are used to form a unit of length L and a unit of mass M. Then the correct option (s) is (are)

A. $M \propto \sqrt{c}$

B. $M \propto \sqrt{G}$

C. $L \propto \sqrt{h}$

D. $L \propto \sqrt{G}$

Answer: A::C::D

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8. In terms of potential difference V, electric current$I$, permittivity ε_0, permeability μ_0 and speed of light c, the dimensionally correct equation (s) is (are)

A. $\mu_0 I^2 = \varepsilon V^2$

B. $\mu_0 I = \mu_0 V$

C. $I = \varepsilon_0 V$

D. $\mu_0 cI = \varepsilon_0 V$

Answer: A::C

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Integer

1. To find the distance d over which a signal can be seen clearly in foggy conditions, a railways-engineer uses dimensions and assumes that the distance depends on the mass density ρ of the fog, intensity (power/area) S of the light from the signal and its frequency f. the engineer finds that d is proportional to $S^{1/n}$. the value of n is

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2. The energy of a system as a function of time t is given as $E(t) = A^2 \exp(-\alpha t), \alpha = 0.2s^{-1}$. The measurement of A has an error of 1.25%. If the error In the measurement of time is 1.50%, the percentage error in the value of $E(t)$ at t = 5 s` is

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