

EXPERIMENTS & ERRORS

Date Planned : __ / __ / __	Daily Tutorial Sheet - 1	Expected Duration : 90 Min
Actual Date of Attempt : __ / __ / __	Level - 1	Exact Duration : _____
Topic covered : Dimensional Analysis, Significant Figure		

- The dimensions of electrical resistance are:
(A) $[ML^2T^{-3}A^{-2}]$ (B) $[ML^2T^{-2}A^{-2}]$ (C) $[ML^2T^{-3}A^{-1}]$ (D) $[ML^3T^{-3}A^{-2}]$
- The dimensions of electromagnetic inductance are:
(A) $[ML^2T^{-3}A^{-1}]$ (B) $[ML^2T^{-2}A^{-2}]$ (C) $[ML^3T^{-3}A^{-2}]$ (D) $[L^2T^{-1}A^{-3}]$
- The dimensions of bulk modulus are:
(A) $[ML^{-1}T^{-2}]$ (B) $[M^2LT^{-2}]$ (C) $[ML^3T^{-2}]$ (D) $[ML^{-2}T^{-2}]$
- The dimensions of angular acceleration are:
(A) $[LT^{-2}]$ (B) $[T^{-2}]$ (C) $[LT^2]$ (D) $[T^2]$
- The dimensions of electrical permittivity are:
(A) $[ML^{-3}T^2A^2]$ (B) $[M^{-1}L^{-1}T^3A]$ (C) $[M^{-2}L^{-1}T^3A^2]$ (D) $[M^{-1}L^{-3}T^4A^2]$
- The dimensions of thermal conductivity are:
(A) $[ML^{-2}T^{-3}\theta]$ (B) $[M^{-2}LT^{-3}\theta]$ (C) $[MLT^{-3}\theta^{-1}]$ (D) $[ML^2T^{-4}\theta^{-1}]$
- If σ denotes charge per unit area and r denotes a distance, then the dimensions of $\frac{\sigma^2 r^3}{\epsilon_0}$ are the same as:
(A) Momentum (B) Electrical conductivity (C) Force (D) Torque
- Three physical quantities are related as: $X = \sqrt{\frac{Y}{Z}}$. If in the formula, Y is replaced in mJ, and Z is replaced in g, X is obtained in units of:
(A) 10^{-3} m/s (B) $\frac{1}{10} \text{ m/s}$ (C) 1 m/s (D) 10^3 m/s
- In an Ohm's Law experiment, the potential difference across a wire is measured to be 97.52 V and the current through the wire is measured to be 2.50 A. The resistance of the wire is:
(A) 39.008Ω (B) 39.01Ω (C) 39.0Ω (D) 39.1Ω
- The value of $0.095 + 23.02 - 8.734$ is:
(A) 14.381 (B) 14.38 (C) 14.37 (D) 14.4

11. A particle is moving with constant speed. It travels a distance 9.86 m in 2.0 s. The speed of the particle (in m/s) is:
(A) 5 **(B)** 4 **(C)** 4.9 **(D)** 4.93
12. The value of $\frac{14.28}{0.714}$ is:
(A) 20 **(B)** 20.00 **(C)** 20.33 **(D)** 20.0
13. If $x = 0.72 + 0.8 + 3.87 - 1.089$, then the value of x is:
(A) 2.7 **(B)** 2.8 **(C)** 2.77 **(D)** 2.78
14. The value of $(1.45)(2.2)$ is: 
(A) 3.19 **(B)** 3.29 **(C)** 3.2 **(D)** 3.3
15. The value of $(2.9)^2 - 1.06$ is: 
(A) 7.4 **(B)** 7.35 **(C)** 7.34 **(D)** 7.3

Date Planned : __ / __ / __	Daily Tutorial Sheet - 2	Expected Duration : 90 Min
Actual Date of Attempt : __ / __ / __	Level - 1	Exact Duration : _____
Topic covered : Experiments and Errors		

16. The least count of a screw gauge can be decreased by:
- (A) Increasing both its pitch and the number of divisions on its circular scale
 (B) Decreasing both its pitch and the number of divisions on its circular scale
 (C) Increasing its pitch and decreasing the number of divisions on its circular scale
 (D) Decreasing its pitch and increasing the number of divisions on its circular scale
17. The main scale of a Vernier callipers instrument has divisions of 1 mm and 50 divisions of the Vernier scale coincide with 49 divisions of the main scale. The least count of the instrument is:
- (A) 0.1 mm (B) 0.05 mm (C) 0.02 mm (D) 0.01 mm
18. The main scale of a Vernier callipers instrument has divisions of 1 mm and 20 divisions of the Vernier scale coincide with 19 divisions of the main scale. A screw gauge has the same least count as this Vernier callipers instrument. The pitch (P) and number of circular scale divisions (N) of the screw gauge can be:
- (A) $P = 1$ mm, $N = 50$ (B) $P = 0.5$ mm, $N = 100$ (C) $P = 2$ mm, $N = 50$ (D) $P = 2$ mm, $N = 100$
19. The diameter of a cylinder is measured five times using a screw gauge of least count 0.01 mm, and the readings obtained are 12.35, 12.61, 12.42, 12.28 and 12.44 (all in mm). Then, the diameter of the cylinder is:
- (A) (12.42 ± 0.01) mm (B) (12.42 ± 0.08) mm
 (C) (12.39 ± 0.08) mm (D) (12.39 ± 0.12) mm
20. Three quantities x, y and z are related as: $z = \frac{1}{x+y}$. The absolute errors in the measurement of x and y are Δx and Δy . The absolute error in z is:
- (A) $\Delta z = \frac{\Delta x + \Delta y}{(x+y)^2}$ (B) $\Delta z = \frac{\Delta x + \Delta y}{(x+y)}$ (C) $\Delta z = \Delta x + \Delta y$ (D) $\Delta z = \frac{\Delta x}{x^2} + \frac{\Delta y}{y^2}$
21. Three quantities x, y and z are related as: $z = x y$. The absolute errors in the measurement of x and y are Δx and Δy . The fractional error in z is:
- (A) $\frac{\Delta z}{z} = \frac{\Delta x - \Delta y}{x - y}$ (B) $\frac{\Delta z}{z} = \frac{\Delta x - \Delta y}{x + y}$ (C) $\frac{\Delta z}{z} = \frac{\Delta x + \Delta y}{x - y}$ (D) $\frac{\Delta z}{z} = \frac{\Delta x + \Delta y}{x + y}$
22. The density of a sphere is to be determined by measuring its radius and its mass. If the fractional errors in the measurement of radius and mass are 1% and 0.5% respectively, the fractional error in the measurement of density is:
- (A) 1.5% (B) 2% (C) 2.5% (D) 3.5%

- 23.** Two methods are employed to find the area A of a given square. ▶
 Method 1: the side length a is measured and the area is found using $A = a^2$
 Method 2: the length of a diagonal L is measured and the area is found using $A = \frac{L^2}{2}$
 Both measurements are made using the same scale. If the fractional error in the measurement of area in the two methods is f_1 and f_2 , then the correct statement is:
(A) $f_2 = \frac{1}{2}f_1$ **(B)** $f_2 = \frac{1}{\sqrt{2}}f_1$ **(C)** $f_2 = f_1$ **(D)** $f_2 = \sqrt{2}f_1$
- 24.** In an experiment to find the focal length of a concave mirror, an object is placed in front of the mirror such that the image coincides with the object. The distance of both the object and the image from the mirror is measured to be 40.0 cm using a scale of least count 0.1 cm. The focal length of the mirror is: ▶
(A) $(20.00 \pm 0.05) \text{ cm}$ **(B)** $(20.00 \pm 0.10) \text{ cm}$
(C) $(40.00 \pm 0.10) \text{ cm}$ **(D)** $(20.0 \pm 0.2) \text{ cm}$
- 25.** In an experiment to determine the specific heat of a substance, a mass m of the substance is supplied an amount of heat Q and the rise in its temperature ΔT is recorded. If the fractional errors in the measures values of m , Q and ΔT are 1%, 5% and 2% respectively, the maximum fractional error in the calculated value of the specific heat is:
(A) 2% **(B)** 4% **(C)** 6% **(D)** 8%
- 26.** In an experiment to determine the acceleration due to gravity (g) using a simple pendulum, the length of the pendulum string is measured to be 64.0 cm using a tape measure with least count 1 mm, and the time taken for 20 oscillations is measured to be 8.0 seconds using a watch with least count 0.1 second. The percentage error in the measurement of g is close to: ▶
(A) 0.6% **(B)** 1.3% **(C)** 2.0% **(D)** 2.7%
- 27.** The sides of a rectangle are measured to be 8.0 cm and 6.0 cm using a tape measure of least count 0.1 cm. The length of a diagonal of the rectangle is: ▶
(A) $(10 \pm 0.14) \text{ cm}$ **(B)** $(10 \pm 0.22) \text{ cm}$ **(C)** $(10 \pm 0.30) \text{ cm}$ **(D)** $(10 \pm 0.38) \text{ cm}$
- 28.** Two unknown resistances R_1 and R_2 are connected respectively in the left and right gap of a meter bridge. The balance point is found at a distance 25 cm from the left end of the meter bridge wire. Now, a resistance 30 Ω is connected in parallel with R_2 , and the balance point is found to shift rightwards by 15 cm. The values of R_1 and R_2 are:
(A) 7.5 Ω , 30 Ω **(B)** 10 Ω , 30 Ω **(C)** 15 Ω , 45 Ω **(D)** 15 Ω , 60 Ω
- 29.** To find the area of a thin circular disc, its circumference is measured using a tape measure. If the fractional error in the circumference is 0.5%, the fractional error in the area is: ($\pi = 3.14$)
(A) 0.5% **(B)** 1.0% **(C)** 1.57% **(D)** 3.14%
- 30.** A spherical ball filled with air is deflating as the air escapes through a small orifice on its surface. The ball always maintains its spherical shape. At a particular instant, the radius of the sphere is R . Now, in the time the radius reduces by a very small amount ΔR , the surface area of the sphere decreases by:
(A) $(4\pi R^2)\Delta R$ **(B)** $(2\pi R^2)\Delta R$ **(C)** $(8\pi R)\Delta R$ **(D)** $(2\pi R)\Delta R$

EXPERIMENTS & ERRORS

Date Planned : __ / __ / __	Daily Tutorial Sheet - 3	Expected Duration : 90 Min
Actual Date of Attempt : __ / __ / __	Level - 2	Exact Duration : _____
Topic covered : Dimensional Analysis, Errors		

31. If h denotes Planck's constant, and c denotes the speed of light, the dimensions of hc are:
- (A) $[M^2 L^2 T^{-2}]$ (B) $[L^4 T^{-2}]$ (C) $[ML^2 T^{-1}]$ (D) $[ML^3 T^{-2}]$
32. A quantity C is related to quantities A and B by the relation: $C = Ae^{-Bt}$. Here, t denotes time. If the dimensions of C are the same as force, the dimensions of $\frac{A}{B}$ are the same as:
- (A) Force (B) Energy (C) Momentum (D) Power
33. If k_B denotes Boltzmann's constant, T denotes temperature and L denotes angular momentum, the dimensions of $\frac{L}{k_B T}$ are the same as:
- (A) Frequency (B) Time (C) Acceleration (D) Mass
34. The potential energy of a body is given as a function of its position as: $U(x) = px - qx^3$. If the value of x is replaced in units of mm in the formula, and the potential energy is to be calculated in units of μJ , the quantities p and q must respectively be replaced in units of:
- (A) $10^{-3} J, 10^6 Pa$ (B) $10^{-3} N, 10^3 Pa$
(C) $1 N/m, 10^3 N/m^3$ (D) $10^3 N, 10^{-3} Pa$

PARAGRAPH FOR QUESTIONS 35 - 36

In a new system of units, distance is measured in units of mm, time is measured in units of $10^{-2} s$, mass is measured in units of g, and current is measured in units of μA .

35. The unit of electric flux in this system will be:
- (A) $10^{-4} Wb$ (B) $\frac{1}{10} Wb$ (C) $1 Wb$ (D) $10^2 Wb$
36. The unit of magnetic flux in this system will be:
- (A) $10^{-3} T m^2$ (B) $\frac{1}{10} T m^2$ (C) $10 T m^2$ (D) $10^3 T m^2$
- *37. Which of the following quantities have the dimensions of time?
- (A) $\frac{\text{Force}}{(\text{Current})(\text{Electric field})}$ (B) $\frac{(\text{Resistivity})(\text{Capacitance})}{(\text{Area})}$
(C) $\frac{\text{Force}}{(\text{Thermal conductivity})(\text{Temperature})}$ (D) $\frac{\text{Magnetic permeability}}{(\text{Resistance})(\text{Length})}$

38. The dimensions of (Magnetic flux)(Current) are the same as:
 (A) Magnetic moment (B) Magnetic permeability
 (C) Energy (D) Angular momentum
39. Four quantities x, y, z and r are related as: $r = \frac{x^2}{y} - 2z$. If the absolute errors in the measurement of x, y and z are $\Delta x, \Delta y$ and Δz , the absolute error in r is: 
- (A) $\Delta r = \left(\frac{2x}{y}\right)\Delta x - \left(\frac{x^2}{y^2}\right)\Delta y - 2\Delta z$ (B) $\Delta r = \left(\frac{x^2}{y}\right)\Delta x + \left(\frac{x^2}{y}\right)\Delta y + 2\Delta z$
 (C) $\Delta r = \left(\frac{x^2}{y}\right)\Delta x + \left(\frac{x^2}{y}\right)\Delta y - 2\Delta z$ (D) $\Delta r = \left(\frac{2x}{y}\right)\Delta x + \left(\frac{x^2}{y^2}\right)\Delta y + 2\Delta z$
40. A quantity z depends on three quantities a, b and c as: $z = ab\sqrt{c}$. If the absolute errors in a, b and c are $\Delta a, \Delta b$ and Δc , the absolute error in z is: 
- (A) $(ab)\Delta c + (a\sqrt{c})\Delta b + (b\sqrt{c})\Delta a$ (B) $\left(\frac{ab}{2\sqrt{c}}\right)\Delta c + (a\sqrt{c})\Delta b + (b\sqrt{c})\Delta a$
 (C) $\left(\frac{ab}{\sqrt{c}}\right)\Delta c + (a\sqrt{c})\Delta b + (b\sqrt{c})\Delta a$ (D) $(ab)\Delta c + (ac)\Delta b + (bc)\Delta a$

Date Planned : __ / __ / __	Daily Tutorial Sheet - 4	Expected Duration : 90 Min
Actual Date of Attempt : __ / __ / __	Level - 2	Exact Duration : _____
Topic covered : Experiments and Errors		

41. A resonance column experiment is performed with a tube of diameter 4 cm. When a tuning fork of frequency 525 Hz is used, the first resonance is heard with an air column of length 18.8 cm. Now, if a tuning fork of frequency 1050 Hz is used, the second resonance will be heard with an air column of length:
- (A) 31.2 cm (B) 34.8 cm (C) 46.8 cm (D) 59.2 cm
42. To determine the resistivity of a metal cylinder, its resistance is measured to be 2.0Ω , its length is measured to be 10.0 cm using a tape measure of least count 0.1 cm, and its volume is measured by submerging it in water to be 20 cm^3 . The fractional error in the measurement of volume is 5%. The fractional error in the measurement of resistivity is:
- (A) 6% (B) 6.5% (C) 11.5% (D) 12%
43. In an experiment to determine the Young's modulus of a metallic alloy using Searle's method, a wire is loaded with a load of variable mass (m) and the elongation produced in it (Δl) is recorded. All the readings are plotted on a graph, with m on the X-axis and Δl on the Y-axis. The straight line that best fits all the readings is found to have a slope S . If the diameter of the wire is measured to be d and its length when it was unloaded was measured to be L , the Young's modulus of the alloy as derived from this experiment is:
- (A) $\frac{4SL}{\pi d^2 g}$ (B) $\frac{4gL^2}{\pi d^2 S^2}$ (C) $\frac{\pi d^2 S}{4gL}$ (D) $\frac{4gL}{\pi d^2 S}$
44. In the experiment to determine the value of acceleration due to gravity using a simple pendulum, the length of the pendulum string must be kept as large as possible because: 
- (A) it allows us to keep the angular amplitude low, as with a longer string, oscillations of small angular amplitude are easier to observe and count
- (B) it keeps the time period of the pendulum high and hence makes the fractional error in the recorded time period (due to the limitations in the precision of the watch used) smaller
- (C) it makes the error due to the finite size of the bob smaller
- (D) it makes the fractional error in the recorded length of the pendulum string (due to the limitations in the precision of the measuring scale) smaller
45. Three quantities x, y and z are related as: $\frac{1}{z} = \frac{1}{x} + \frac{1}{y}$. The absolute errors in the measurement of x and y are Δx and Δy . The absolute error in z is: 
- (A) $\Delta z = \frac{y^2}{x^2} \Delta x + \frac{x^2}{y^2} \Delta y$ (B) $\Delta z = \frac{\Delta x + \Delta y}{(x + y)^2}$
- (C) $\Delta z = \frac{y^2}{(x + y)^2} \Delta x + \frac{x^2}{(x + y)^2} \Delta y$ (D) $\Delta z = \frac{xy}{(x + y)^2} (\Delta x + \Delta y)$

46. A potentiometer circuit is used to determine the unknown emf of a battery E_2 . The main battery has an emf 60.0 V and an internal resistance 2.0Ω . The potentiometer wire AB has a length 100.0 cm and a total resistance 10.0Ω . The balancing point is found at a distance 40.0 cm from the end A of the potentiometer wire. The unknown emf of the battery E_2 is: 

- (A) $(2.0 \pm 0.032) V$ (B) $(2.0 \pm 0.044) V$
(C) $(2.0 \pm 0.062) V$ (D) $(2.0 \pm 0.086) V$

PARAGRAPH FOR QUESTIONS 47 - 49

In Searle's experiment to determine the Young's modulus of a metal, the original length of the test wire is measured to be $(50.0 \pm 0.1) \text{ cm}$ and its diameter is measured to be 2.00 mm using a screw gauge of least count 0.02 mm. When the test wire is loaded with an extra mass $(4.00 \pm 0.01) \text{ kg}$, the extension produced in it is measured to be 0.16 mm using a screw gauge of least count 0.01 mm.

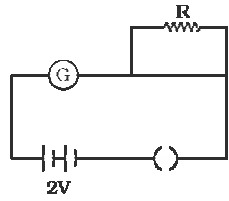
$\left(\text{Take } g = 10 \text{ m/s}^2 \text{ and } \pi = \frac{25}{8} \right)$

47. The measured value of Young's modulus of the metal is:
(A) $4 \times 10^{10} \text{ N/m}^2$ (B) $8 \times 10^{10} \text{ N/m}^2$
(C) $1.6 \times 10^{11} \text{ N/m}^2$ (D) $3.2 \times 10^{11} \text{ N/m}^2$
48. The fractional error in the measurement of Young's modulus is:
(A) 4.2% (B) 6.4% (C) 8.7% (D) 11.1%
49. If the experiment is repeated with a wire of twice the length as the original wire, then as compared to the first experiment: 
(A) The fractional error in the measurement of Young's modulus will be larger, but the absolute error will be smaller
(B) The fractional error in the measurement of Young's modulus will be smaller, but the absolute error will be larger
(C) The fractional error and the absolute error in the measurement of Young's modulus will both be smaller
(D) The fractional error and the absolute error in the measurement of Young's modulus will both be larger
50. A meter bridge is used to determine the unknown value of a resistance. If the meter scale has a least count of 1 mm and the balancing length is measured to be 25.0 cm, the fractional error in the measurement of the resistance is: 
(A) 0.4% (B) 0.53% (C) 0.9% (D) 1.47%

EXPERIMENTS & ERRORS

JEE Main (Archive)	Level -1
1. Dimensions of $\frac{1}{\mu_0 \epsilon_0}$, where symbols have their usual meaning, are: [2003]	
(A) $[L^{-1}T]$ (B) $[L^{-2}T^2]$ (C) $[L^2T^{-2}]$ (D) $[LT^{-1}]$	
2. The physical quantities not having same dimensions are:  [2003]	
(A) torque and work (B) momentum and Planck's constant	
(C) stress and Young's modulus (D) speed and $(\mu_0 \epsilon_0)^{-1/2}$	
3. Which one of the following represents the correct dimensions of the coefficient of viscosity? [2004]	
(A) $ML^{-1}T^{-2}$ (B) MLT^{-1} (C) $ML^{-1}T^{-1}$ (D) $ML^{-2}T^{-2}$	
4. Out of the following pair, which one does NOT have identical dimensions [2005]	
(A) angular momentum and Planck's constant (B) impulse and momentum	
(C) moment of inertia and moment of a force (D) work and torque	
5. Which of the following units denotes the dimensions ML^2/Q^2 , where Q denotes the electric charge?  [2006]	
(A) Weber (Wb) (B) Wb/m^2 (C) Henry (H) (D) H/m^2	
6. The dimension of magnetic field in M, L, T and C (Coulomb) is given as: [2008]	
(A) $MLT^{-1}C^{-1}$ (B) MT^2C^{-2} (C) $MT^{-1}C^{-1}$ (D) $MT^{-2}C^{-1}$	
7. An experiment is performed to find the refractive index of glass using a travelling microscope. In this experiment distance are measured by: [2008]	
(A) a vernier scale provided on the microscope	
(B) a standard laboratory scale	
(C) a meter scale provided on the microscope	
(D) a screw gauge provided on the microscope	
8. Two full turns of the circular scale of a screw gauge cover a distance of 1 mm on its main scale. The total number of divisions on the circular scale is 50. Further, it is found that the screw gauge has a zero error of -0.03 mm while measuring the diameter of a thin wire, a student notes the main scale reading of 3 mm and the number of circular scale divisions in line with the main scale as 35. The diameter of the wire is:  [2008]	
(A) 3.32 mm (B) 3.73 mm (C) 3.67 mm (D) 3.38 mm	
9. A body of mass $m = 3.513$ kg is moving along the x -axis with a speed of 5.00 ms^{-1} . The magnitude of its momentum is recorded as: [2008]	
(A) 17.6 $kg\ ms^{-1}$ (B) 17.565 $kg\ ms^{-1}$ (C) 17.56 $kg\ ms^{-1}$ (D) 17.57 $kg\ ms^{-1}$	
10. The respective number of significant figures for the numbers 23.023, 0.0003 and 2.1×10^{-3} are [2009]	
(A) 5, 1, 2 (B) 5, 1, 5 (C) 5, 5, 2 (D) 4, 4, 2	

11. In an experiment the angles are required to be measured using an instrument. 29 divisions of the main scale exactly coincide with the 30 division of the vernier scale. If the smallest division of the main scale is half-a-degree ($= 0.5^\circ$), then the least count of the instrument is:  [2009]
(A) one degree (B) half degree (C) one minute (D) half minute
12. A screw gauge gives the following reading when used to measure the diameter of a wire. [2011]
Main scale reading : 0 mm
Circular scale reading : 52 divisions
Given that 1 mm on main scale corresponds to 100 divisions of the circular scale.
The diameter of wire from the above data is:
(A) 0.052 cm (B) 0.026 cm (C) 0.005 cm (D) 0.52 cm
13. Let $[\epsilon_0]$ denote the dimensional formula of the permittivity of vacuum. If M = mass, L = length, T = time and A = electric current, then: [2013]
(A) $[\epsilon_0] = [M^{-1}L^{-3}T^4A^2]$ (B) $[\epsilon_0] = [M^{-1}L^2T^{-1}A^{-2}]$
(C) $[\epsilon_0] = [M^{-1}L^2T^{-1}A]$ (D) $[\epsilon_0] = [M^{-1}L^{-3}T^2A]$
14. The dimensions of angular momentum, latent heat and capacitance are respectively. [2013]
(A) $ML^2T^1A^2, L^2T^{-2}, M^{-1}L^{-2}T^2$ (B) $MLT^{-2}, L^2T^2, M^{-1}L^{-2}T^4A^2$
(C) $ML^2T^{-1}, L^2T^{-2}, ML^2TA^2$ (D) $ML^2T^{-1}, L^2T^{-2}, M^{-1}L^{-2}T^4A^2$
15. In terms of resistance R and time T , the dimensions of ratio $\frac{\mu}{\epsilon}$ of the permeability μ and permittivity ϵ is:  [2014]
(A) $[R^2T^2]$ (B) $[RT^{-2}]$ (C) $[R^2T^{-1}]$ (D) $[R^2]$
16. From the following combination of physical constants (expressed through their usual symbols) the only combination, that would have the same value in different systems of units is:  [2014]
(A) $\frac{ch}{2\pi\epsilon_0^2}$ (B) $\frac{e^2}{2\pi\epsilon_0 G m_e^2}$ (m_e = mass of electron)
(C) $\frac{\mu_0\epsilon_0}{c^2} \frac{G}{he^2}$ (D) $\frac{2\pi\sqrt{\mu_0\epsilon_0}}{c^2} \frac{h}{\epsilon^2 G}$
17. A student measured the length of a rod and wrote it as 3.50 cm. Which instrument did he use to measure it?  [2014]
(A) A screw gauge having 100 divisions in the circular scale and pitch as 1 mm.
(B) A screw gauge having 50 divisions in the circular scale and pitch as 1 mm.
(C) A meter scale
(D) A vernier calliper where the 10 divisions in vernier scale matches with 9 division in main scale and main scale has 10 divisions in 1 cm.
18. The current voltage relation of diode is given by $I = (e^{1000V/T} - 1)\text{mA}$, where the applied voltage V is in volts and the temperature T is in Kelvin. If a student makes an error measuring $\pm 0.01\text{ V}$ while measuring the current of 5 mA at 300 K, what will be the error in the value of current in mA? [2014]
(A) 0.5 mA (B) 0.05 mA (C) 0.2 mA (D) 0.02 mA 

19. 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 wrist watch of 1 s resolution. The accuracy in the determination of g is: [2015]
(A) 3% (B) 1% (C) 5% (D) 2%
20. Diameter of a steel ball is measured using a Vernier callipers which has divisions of 0.1 cm on its main scale (MS) and 10 divisions of its Vernier scale (VS) match 9 divisions on the main scale. Three such measurements for a ball are given as: [2015]
- | S.No. | MS(cm) | VS divisions |
|-------|--------|--------------|
| 1. | 0.5 | 8 |
| 2. | 0.5 | 4 |
| 3. | 0.5 | 6 |
- If the zero error is -0.03 cm then mean corrected diameter is:
(A) 0.53 cm (B) 0.59 cm (C) 0.56 cm (D) 0.52 cm
21. If the capacitance of a nano-capacitor is measured in terms of a unit ' u ' made by combining the electronic charge ' e ', Bohr radius ' a_0 ', Plank's constant ' h ' and speed of light ' c ' then : [2015]
- (A) $u = \frac{e^2 c}{h a_0}$ (B) $u = \frac{h c}{e^2 a_0}$ (C) $u = \frac{e^2 a_0}{h c}$ (D) $u = \frac{e^2 h}{c a_0}$
22. 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 Aluminium. 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? [2016]
(A) 0.80 mm (B) 0.70 mm (C) 0.50 mm (D) 0.75 mm
23. 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: [2016]
(A) 92 ± 5.0 s (B) 92 ± 1.8 s (C) 92 ± 3 s (D) 92 ± 2 s
24. A galvanometer has a 50 division scale. Battery has no internal resistance. It is found that there is deflection of 40 divisions when $R = 2400\Omega$. Deflection becomes 20 division when resistance taken from resistance box is 4900Ω . Then we can conclude: [2016]
- (A) Current sensitivity of galvanometer is 20 mA/division.
(B) Resistance of galvanometer is 200Ω
(C) Resistance required on R.B. for a deflection of 10 divisions is 9800Ω
(D) Full scale deflection current is 2 mA.
- 
25. 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: [2018]
(A) 6% (B) 2.5% (C) 3.5% (D) 4.5%
26. Expression for time in terms of G (universal gravitational constant), h (Planck constant) and c (speed of light) is proportional to : [2019]
(A) $\sqrt{\frac{c^3}{Gh}}$ (B) $\sqrt{\frac{hc^5}{G}}$ (C) $\sqrt{\frac{Gh}{c^5}}$ (D) $\sqrt{\frac{Gh}{c^3}}$

27. The pitch and the number of divisions, on the circular scale, for a given screw gauge are 0.5 mm and 100 respectively. When the screw gauge is fully tightened without any object, the zero of its circular scale lies 3 divisions below the mean line. The readings of the main scale and the circular scale, for a thin sheet, are 5.5 mm and 48 respectively, the thickness of this sheet is : [2019]
(A) 5.725 mm (B) 5.755 mm (C) 5.950 mm (D) 5.740 mm
28. The diameter and height of cylinder are measured by a meter scale to be $12.6 \pm 0.1 \text{ cm}$ and $34.2 \pm 0.1 \text{ cm}$, respectively. What will be the value of its volume in appropriate significant figures?  [2019]
(A) $4264 \pm 81 \text{ cm}^3$ (B) $4264.4 \pm 81.0 \text{ cm}^3$ (C) $4260 \pm 80 \text{ cm}^3$ (D) $4300 \pm 80 \text{ cm}^3$
29. The density of a material in SI units is 128 kg m^{-3} . In certain units in which the unit of length is 25 cm and the unit of mass is 50 g, the numerical value of density of the material is:  [2019]
(A) 16 (B) 40 (C) 410 (D) 640
30. The force of interaction between two atoms is given by $F = \alpha\beta \exp\left(-\frac{x^2}{\alpha kT}\right)$; where x is the distance, k is the Boltzmann constant and T is temperature and α and β are two constant. The dimension of β is:
(A) $M^2 L T^{-4}$ (B) $M^2 L^2 T^{-2}$ (C) $M L T^{-2}$ (D) $M^0 L^2 T^{-4}$  [2019]
31. Let L, r, c and v represent inductance, resistance, capacitance and voltage, respectively. The dimension of $\frac{L}{rcv}$ in SI units will be: [2019]
(A) $[L T^2]$ (B) $[L A^{-2}]$ (C) $[A^{-1}]$ (D) $[L T A]$
32. The least count of the main scale of a screw gauge is 1 mm. The minimum number of divisions on its circular scale required to measure $5 \mu\text{m}$ diameter of a wire is: [2019]
(A) 50 (B) 500 (C) 200 (D) 100
33. If speed (V), acceleration (A) and force (F) are considered as fundamental units, the dimension of Young's modulus will be: [2019]
(A) $V^{-4} A^2 F$ (B) $V^{-2} A^2 F^{-2}$ (C) $V^{-2} A^2 F^2$ (D) $V^{-4} A^{-2} F$
34. A load of mass M kg is suspended from a steel wire of length 2 m and radius 1.0 mm in Searle's apparatus experiment. The increase in length produced in the wire is 4.0 mm. Now the load is fully immersed in a liquid of relative density 2. The relative density of the material of load is 8. The new value of increase in length of the steel wire is : [2019]
(A) zero (B) 4.0 mm (C) 3.0 mm (D) 5.0 mm
35. A resonance tube is old and has jagged end. It is still used in the laboratory to determine velocity of sound in air. A tuning fork of frequency 512 Hz produces first resonance when the tube is filled with water to a mark 11 cm below a reference mark, near the open end of the tube. The experiment is repeated with another fork of frequency 256 Hz which produces first resonance when water reaches a mark 27 cm below the reference mark. The velocity of sound in air, obtained in the experiment, is close to:  [2019]
(A) 335 ms^{-1} (B) 341 ms^{-1} (C) 328 ms^{-1} (D) 322 ms^{-1}
36. If Surface tension (S), Moment of Inertia (I) and Planck's constant (h), were to be taken as the fundamental units, the dimensional formula for linear momentum would be :  [2019]
(A) $S^{1/2} I^{3/2} h^{-1}$ (B) $S^{1/2} I^{1/2} h^{-1}$ (C) $S^{1/2} I^{1/2} h^0$ (D) $S^{3/2} I^{1/2} h^0$

37. In a simple pendulum experiment for determination of acceleration due to gravity (g), time taken for 20 oscillation is measured by using a watch of 1 second least count. The mean value of time taken comes out to be 30 s. The length of pendulum is measured by using a meter scale of least count 1 mm and the value obtained is 55.0 cm. The percentage error in the determination of g is close to : [2019]
(A) 0.7% (B) 6.8% (C) 3.5% (D) 0.2%
38. In the density measurement of a cube, the mass and edge length are measured as $(10.00 \pm 0.10) \text{ kg}$ and $(0.10 \pm 0.01) \text{ m}$, respectively. The error in the measurement of density is: [2019]
(A) 0.01 kg/m^3 (B) 0.10 kg/m^3 (C) 0.07 kg/m^3 (D) 0.31 kg/m^3
39. The area of a square is 5.29 cm^2 . The area of 7 such squares taking into account the significant figures is: [2019]
(A) 37.030 cm^2 (B) 37 cm^2 (C) 37.03 cm^2 (D) 37.0 cm^2
40. In the formula $X = 5YZ^2$, X and Z have dimensions of capacitance and magnetic field, respectively. What are the dimensions of Y in SI units? [2019]
(A) $[M^{-2}L^{-2}T^6A^3]$ (B) $[M^{-2}L^0T^{-4}A^{-2}]$
(C) $[M^{-3}L^{-2}T^8A^4]$ (D) $[M^{-1}L^{-2}T^4A^2]$
41. In SI units, the dimensions of $\sqrt{\frac{\epsilon_0}{\mu_0}}$ is : [2019]
(A) $AT^{-3}ML^{3/2}$ (B) $A^{-1}TML^3$ (C) $AT^2M^{-1}L^{-1}$ (D) $A^2T^3M^{-1}L^{-2}$
42. Which of the following combinations has the dimension of electrical resistance (ϵ_0 is the permittivity of vacuum and μ_0 is the permeability of vacuum)? [2019]
(A) $\sqrt{\frac{\epsilon_0}{\mu_0}}$ (B) $\sqrt{\frac{\mu_0}{\epsilon_0}}$ (C) $\frac{\mu_0}{\epsilon_0}$ (D) $\frac{\epsilon_0}{\mu_0}$
43. A moving coil galvanometer has a coil with 175 turns and area 1 cm^2 . It uses a torsion band of torsion constant 10^{-6} N-m/rad . The coil is placed in a magnetic field B parallel to its plane. The coil deflects by 1° for a current of 1 mA . The value of B (in Tesla) is approximately: [2019]
(A) 10^{-1} (B) 10^{-4} (C) 10^{-3} (D) 10^{-2}
44. The dimension of $\frac{B^2}{2\mu_0}$, where B is magnetic field and μ_0 is the magnetic permeability of vacuum, is: [2020]
(A) ML^2T^{-2} (B) $ML^{-1}T^{-2}$ (C) ML^2T^{-1} (D) MLT^{-2}
45. The dimension of stopping potential V_0 in photoelectric effect in units of Planck's constant ' h ', speed light ' c ' and gravitational constant ' G ' and ampere A is : [2020]
(A) $h^{2/3}c^{5/3}G^{1/3}A^{-1}$ (B) $h^2G^{3/2}c^{1/3}A^{-1}$
(C) $h^{1/3}G^{2/3}c^{1/3}A^{-1}$ (D) $h^{-2/3}c^{-1/3}G^{4/3}A^{-1}$
46. A quantity f is given by $f = \sqrt{\frac{hc^5}{G}}$ where c is the speed of light, G universal gravitational constant and h is the Planck's constant. Dimension of f is that of: [2020]
(A) volume (B) area (C) momentum (D) energy

47. A simple pendulum is being used to determine the value of gravitational acceleration g at a certain place. The length of the pendulum is 25.0 cm and a stop watch with 1s resolution measures the time taken for 40 oscillations to be 50 s. The accuracy in g is: [2020]
(A) 3.40% (B) 2.40% (C) 5.40% (D) 4.40%
48. If the screw on a screw gauge is given six rotations, it moves by 3 mm on the main scale. If there are 50 divisions on the circular scale the least count of the screw gauge is : [2020]
(A) 0.01 cm (B) 0.02 mm (C) 0.001 cm (D) 0.001 mm
49. For the four sets of three measured physical quantities as given below. Which of the following options is correct ?  [2020]
(i) $A_1 = 24.36, B_1 = 0.0724, C_1 = 256.2$ (ii) $A_2 = 24.44, B_2 = 16.082, C_2 = 240.2$
(iii) $A_3 = 25.2, B_3 = 19.2812, C_3 = 236.183$ (iv) $A_4 = 25.2, B_4 = 236.191, C_4 = 19.5$
(A) $A_1 + B_1 + C_1 = A_2 + B_2 + C_2 = A_3 + B_3 + C_3 = A_4 + B_4 + C_4$
(B) $A_4 + B_4 + C_4 < A_1 + B_1 + C_1 = A_2 + B_2 + C_2 = A_3 + B_3 + C_3$
(C) $A_4 + B_4 + C_4 < A_1 + B_1 + C_1 < A_3 + B_3 + C_3 < A_2 + B_2 + C_2$
(D) $A_1 + B_1 + C_1 < A_3 + B_3 + C_3 < A_2 + B_2 + C_2 < A_4 + B_4 + C_4$
50. If speed V , area A and force F are chosen as fundamental units, then the dimension of Young's modulus will be:  [2020]
(A) FA^2V^{-1} (B) $FA^{-1}V^0$ (C) FA^2V^{-2} (D) FA^2V^{-3}
51. The least count of the main scale of a Vernier callipers is 1mm. Its Vernier scale is divided into 10 divisions and coincide with 9 divisions of the main scale. When jaws are touching each other, the 7th division of Vernier scale coincides with a division of main scale and the zero of Vernier scale is lying right side of the zero of main scale. When this Vernier is used to measure length of a cylinder the zero of the Vernier scale between 3.1 cm and 3.2 cm and 4th VSD coincides with a main scale division. The length of the cylinder is (VSD is Vernier scale division)  [2020]
(A) 3.07 cm (B) 3.21 cm (C) 2.99 cm (D) 3.2 cm
52. If momentum (P), area (A) and time (T) are taken to be the fundamental quantities then the dimensional formula for energy is: [2020]
(A) $[PA^{1/2}T^{-1}]$ (B) $[PA^{-1}T^{-2}]$ (C) $[P^{1/2}A T^{-1}]$ (D) $[P^2A T^{-2}]$
53. In a radioactive material, fraction of active material remaining after time t is $9/16$. The fraction that was remaining after $t/2$ is : [2020]
(A) $\frac{3}{4}$ (B) $\frac{4}{5}$ (C) $\frac{3}{5}$ (D) $\frac{7}{8}$
54. Using screw gauge of pitch 0.1 cm and 50 divisions on its circular scale, the thickness of an object is measured. It should correctly be recorded as : [2020]
(A) 2.125 cm (B) 2.123 cm (C) 2.121 cm (D) 2.124 cm

55. Amount of solar energy received on the earth's surface per unit area per unit time is defined a solar constant. Dimension of solar constant is:  [2020]
(A) $M^2 L^0 T^{-1}$ (B) MLT^{-2} (C) $ML^2 T^{-2}$ (D) $ML^0 T^{-3}$
56. Dimensional formula for thermal conductivity is (here K denotes the temperature) : [2020]
(A) $MLT^{-3} K^{-1}$ (B) $MLT^{-3} K$ (C) $MLT^{-2} K$ (D) $MLT^{-2} K^{-2}$
57. A quantity x is given by (IFv^2 / WL^4) in terms of moment of inertia I , force, F , velocity v , work W and length L . The dimensional formula for x is same as that of : [2020]
(A) Force constant (B) Coefficient of viscosity
(C) Planck's constant (D) Energy density
58. A physical quantity z depends on four observables a , b , c and d , as $z = \frac{a^2 b^{\frac{2}{3}}}{\sqrt{c} d^3}$. The percentages of error in the measurement of a , b , c and d are 2%, 1.5%, 4% and 2.5% respectively. The percentage of error in z is:  [2020]
(A) 13.5% (B) 14.5% (C) 12.25% (D) 16.5%
59. The quantities $x = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$, $y = \frac{E}{B}$ and $z = \frac{l}{CR}$ are defined where C -capacitance, R -resistance, l -length, E -electric field, B -magnetic field and ϵ_0 , μ_0 , - free space permittivity and permeability respectively. Then:  [2020]
(A) x , y and z have the same dimension (B) only x and z have the same dimension
(C) only x and y have the same dimension (D) only y and z have the same dimension
60. A screw gauge has 50 divisions on its circular scale. The circular scale is 4 units ahead of the pitch scale marking, prior to use. Upon one complete rotation of the circular scale, a displacement of 0.5 mm is noticed on the pitch scale. The nature of zero error involved, and the least count of the screw gauge, are respectively:  [2020]
(A) negative, $2\mu\text{m}$ (B) Positive, $0.1\mu\text{m}$
(C) Positive, $10\mu\text{m}$ (D) Positive, 0.1mm
61. The density of a solid metal sphere is determined by measuring its mass and its diameter. The maximum error in the density of the sphere is $\left(\frac{x}{100}\right)\%$. If the relative errors in measuring the mass and the diameter are 6.0% and 1.5% respectively, the value of x is _____. [2020]
62. A student measuring the diameter of a pencil of circular cross-section with the help of a vernier scale records the following four readings 5.50 mm, 5.55 mm, 5.45 mm; 5.65 mm. The average of these four readings is 5.5375 mm and the standard deviation of the data is 0.07395 mm. The average diameter of the pencil should therefore be recorded as :  [2020]
(A) $(5.5375 \pm 0.0740)\text{mm}$ (B) $(5.54 \pm 0.07)\text{mm}$
(C) $(5.538 \pm 0.074)\text{mm}$ (D) $(5.5375 \pm 0.0739)\text{mm}$

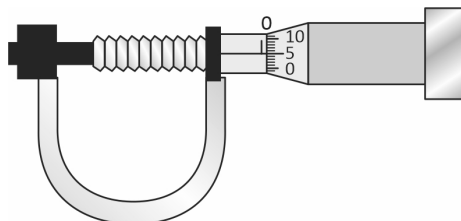
EXPERIMENTS & ERRORS

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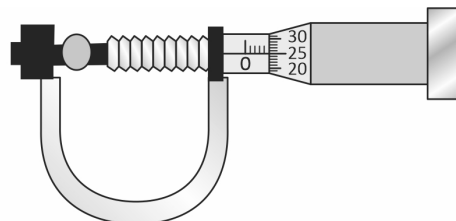
Level -2

SINGLE OPTION CORRECT TYPE

- The dimension of $1/2\epsilon_0 E^2$ (ϵ_0 permittivity of free space; E : electric field) is: [2000]
(A) MLT^{-1} (B) ML^2T^{-2} (C) $ML^{-1}T^{-2}$ (D) ML^2T^{-1}
- A quantity X is given by $\epsilon_0 L \frac{\Delta V}{\Delta t}$ where ϵ_0 is the permittivity 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: [2001]
(A) resistance (B) charge (C) voltage (D) current
- The edge of a cube is measured to be $1.2 \times 10^{-2} m$. Its volume should be recorded as: [2003]
(A) $1.7 \times 10^{-6} m^3$ (B) $1.73 \times 10^{-6} m^3$ (C) $1.70 \times 10^{-6} m^3$ (D) $1.728 \times 10^{-6} m^3$
- A wire of length $l = 6 \pm 0.06$ cm and radius $r = 0.5 \pm 0.005$ cm and mass $m = 0.03 \pm 0.003$ gm. Maximum percentage error in density is: [2004]
(A) 4 (B) 2 (C) 1 (D) 6.8
- Pressure depends on distance as, $P = \frac{\alpha}{\beta} \exp\left(-\frac{\alpha z}{k\theta}\right)$, where α, β are constants, z is distance, k is Boltzmann's constant and θ is temperature. The dimension of β are: [2004]
(A) $M^0 L^0 T^0$ (B) $M^{-1} L^{-1} T^{-1}$ (C) $M^0 L^2 T^0$ (D) $M^{-1} L^1 T^2$
- In a resonance tube with tuning fork of frequency 512 Hz, first resonance occurs at water level equal to 30.3 cm and second resonance occurs at 63.7 cm. The maximum possible error in the speed of sound is: [2005]
(A) 51.2 cm/s (B) 102.4 cm/s (C) 204.8 cm/s (D) 153.6 cm/s
- Which of the following does not have the same dimension? [2005]
(A) Electric flux, Electric field, Electric dipole moment
(B) Pressure, stress, Young's modulus
(C) Electromotive force, Potential difference, Electric voltage
(D) Heat, Potential energy, Work done
- The 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: [2006]



(A) 2.25 mm

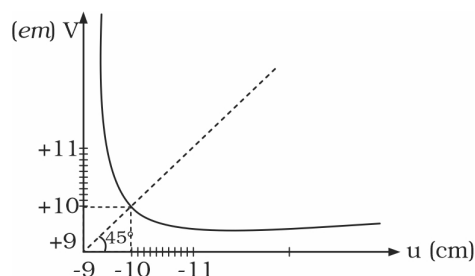


(B) 2.20 mm

(C) 1.20 mm

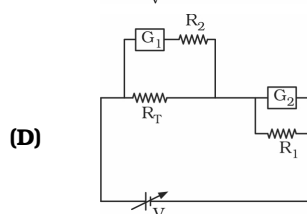
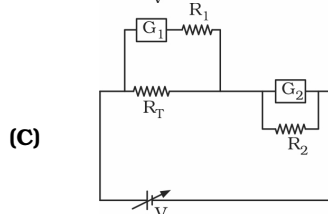
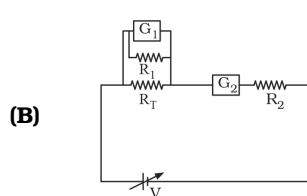
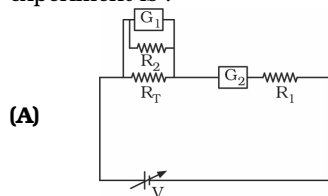
(D) 1.25 mm

9. The graph between object distance u and image distance v for a lens is given below. The focal length of the lens is : ▶ [2006]

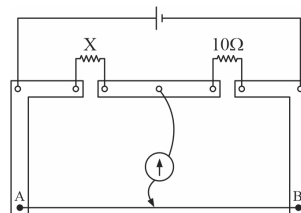


- (A) 5 ± 0.1 (B) 5 ± 0.05 (C) 0.5 ± 0.1 (D) 0.5 ± 0.05
10. A student perform an experiment to determine the Young's modulus of a wire, exactly $2m$ long, by Searle's method. In a particular reading, the student measures the extension in the length of the wire to be 0.8 mm with an uncertainty of $\pm 0.05\text{ mm}$ at a load of exactly 1.0 kg . The student also measures the diameter of the wire to be 0.4 mm with an uncertainty of $\pm 0.01\text{ mm}$. Take $g = 9.8\text{ m/s}^2$ (exact). The Young's modulus obtained from the reading is : ▶ [2007]
- (A) $(2.0 \pm 0.3)10^{11}\text{ N/m}^2$ (B) $(2.0 \pm 0.2)10^{11}\text{ N/m}^2$
(C) $(2.0 \pm 0.1)10^{11}\text{ N/m}^2$ (D) $(2.0 \pm 0.5)10^{11}\text{ N/m}^2$
11. In an experiment to determine the focal length (f) of a concave mirror by the u - v method, a student places the object pin A on the principal axis at a distance x from the pole P . The student looks at the pin and its inverted image from a distance keeping his/her eye in line with PA . When the student shifts his/her eye towards left, the image appears to the right of the object pin. Then, ▶ [2007]
- (A) $x < f$ (B) $f < x < 2f$ (C) $x = 2f$ (D) $x > 2f$
12. Student I, II and III perform an experiment for measuring the acceleration due to gravity (g) using a simple pendulum. They use different lengths of the pendulum and/or record time for different number of oscillations. The observations are shown in the table. ▶ [2008]
- Least count for length = 0.1 cm
Least count for time = 0.1 s
- | Student | Length of the pendulum (cm) | Number of oscillations (n) | Total time for (n) oscillations (s) | Time period (s) |
|---------|-----------------------------|----------------------------|-------------------------------------|-----------------|
| I. | 64.0 | 8 | 128.0 | 16.0 |
| II. | 64.0 | 4 | 64.0 | 16.0 |
| III. | 20.0 | 4 | 36.0 | 9.0 |
- 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,
- (A) $E_I = 0$ (B) E_I is minimum (C) $E_I = E_{II}$ (D) E_{II} is maximum
13. A Vernier caliper has 1 mm marks on the main scale. It has 20 equal divisions on the Vernier scale which match with 16 main scale divisions. For this Vernier caliper the least count is : [2010]
- (A) 0.02 mm (B) 0.05 mm (C) 0.1 mm (D) 0.2 mm

14. To verify Ohm's law, a student is provided with a test resistor R_T , a high resistance R_1 , a small resistance R_2 , two identical galvanometers G_1 and G_2 , and a variable source V . The correct circuit to carry out the experiment is : ▶ [2010]



15. A meter bridge is set-up as shown, to determine an unknown resistance 'X' using a standard 10 ohm resistor. The galvanometer shows null point when tapping-key is at 52 cm mark. The end-corrections are 1 cm and 2 cm respectively for the ends A and B. The determined value of X is : ▶ [2011]



- (A) 10.2 ohm (B) 10.6 ohm (C) 10.8 ohm (D) 11.1 ohm
16. 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: ▶ [2011]
- (A) 0.9% (B) 2.4% (C) 3.1% (D) 4.2%
17. In the determination of Young's modulus $\left(Y = \frac{4MLg}{\pi d^2} \right)$ by using Searle's method, a wire of length $L = 2\text{ m}$ and diameter $d = 0.5\text{ mm}$ is used. For a load $M = 2.5\text{ kg}$ an extension $l = 0.25\text{ mm}$ in the length of the wire is observed. Quantities d and l are measured using a screw gauge and a micrometer, respectively. They have the same pitch of 0.5 mm . The number of divisions on their circular scale is 100. The contributions to the maximum probable error of the Y measurement. ▶ [2012]
- (A) due to the errors in the measurements of d and l are the same
 (B) due to the error in the measurement of d is twice that due to the error in the measurement of l
 (C) due to the error in the measurement of l is twice that due to the error in the measurement of d
 (D) due to the error in the measurement of d is four times that due to the error in the measurement of l
18. A student is performing the experiment of Resonance Column. The diameter of the column tube is 4 cm. The frequency of the tuning fork is 512 Hz. The air temperature is 38°C in which the speed of sound is 336 m/s. The zero of the meter scale coincides with the top end of the Resonance Column tube. When the first resonance occurs, the reading of the water level in the column is : ▶ [2012]
- (A) 14.0 cm (B) 15.2 cm (C) 16.4 cm (D) 17.6 cm

19. The diameter of a cylinder is measured using a Vernier callipers with no zero errors. It is found that the zero of the Vernier scale lies between 5.10 cm and 5.15 cm of the main scale. The Vernier scale has 50 divisions equivalent to 2.45 cm. The 24th division of the Vernier scale exactly coincides with one of the main scale divisions. The diameter of the cylinder is : [2013]
(A) 5.112 cm (B) 5.124 cm (C) 5.136 cm (D) 5.148 cm
20. Using the expression $2d \sin \theta = \lambda$, one calculates the values of d by measuring the corresponding angles θ in the range 0 to 90° . The wavelength λ is exactly known and the error in θ is constant for all values of θ . As θ increases from 0° , [2013]
(A) the absolute error in d remains constant (B) the absolute error in d increases
(C) the fractional error in d remains constant (D) the fractional error in d decreases
21. During an experiment with a metre bridge, the galvanometer shows a null point when the jockey is pressed at 40.0 cm using a standard resistance of 90Ω , as shown in the figure. The least count of the scale used in the metre bridge is 1 mm. The unknown resistance is: [2014]
(A) $60 \pm 0.15 \Omega$ (B) $135 \pm 0.56 \Omega$ (C) $60 \pm 0.25 \Omega$ (D) $135 \pm 0.23 \Omega$
22. There are two vernier calipers both of which have 1 cm divided into 10 equal divisions on the main scale. The scale of one of the calipers (C_1) has 10 equal divisions that correspond to 9 main scale divisions. The vernier scale of the other caliper (C_2) has 10 equal divisions that correspond to 11 main scale divisions. The readings of the two calipers are shown in the figure. The measured values (in cm) by the calipers C_1 and C_2 , respectively, are : [2016]
(A) 2.87 and 2.86 (B) 2.85 and 2.82 (C) 2.87 and 2.87 (D) 2.87 and 2.83
23. Consider an expanding sphere of instantaneous radius R whose total mass remains constant. The expansion is such that the instantaneous density ρ remains uniform throughout the volume. The rate of fractional change in density $\left(\frac{1}{\rho} \frac{d\rho}{dt}\right)$ is constant. The velocity v of any point on the surface of the expanding sphere is proportional to : [2017]
(A) $R^{2/3}$ (B) R (C) R^3 (D) $1/R$
24. A person measures the depth of a well by measuring the time interval between dropping a stone and receiving the sound of impact with the bottom of the well. The error in his measurement of time is $\delta T = 0.01$ seconds and he measures the depth of the well to be $L = 20$ meters. Take the acceleration due to gravity $g = 10 \text{ ms}^{-2}$ and the velocity of sound is 300 ms^{-1} . Then the fractional error in the measurement, $\delta L / L$, is closest to : [2017]
(A) 0.2% (B) 5% (C) 1% (D) 3%

MULTIPLE OPTIONS CORRECT TYPE

- *25. The dimensions of the quantities in one (or more) of the following pairs are the same. Identify the pair(s) [1986]
(A) Torque and work (B) Angular momentum and work
(C) Energy and Young's modulus (D) Light year and Wavelength

- *26. Let $[\epsilon_0]$ denote the dimensional formula of the permittivity of the vacuum, and $[\mu_0]$ that of the permeability of the vacuum. If M = mass, L = length, T = time and I = electric current, [1998]
 (A) $[\mu_0] = M^{-1}L^{-3}T^2I$ (B) $[\epsilon_0] = M^{-1}L^{-3}T^4I$ (C) $[\mu_0] = MLT^{-2}I^{-2}$ (D) $[\mu_0] = ML^2T^{-1}I$
- *27. A student performed the experiment of determination of focal length of a concave mirror by $u-v$ method using an optical bench of length 1.5 meter. The focal length of the mirror used is 24 cm. The maximum error in the location of the image can be 0.2 cm. The 5 sets of (u, v) values recorded by the student (in cm) are : (42, 56), (48, 48), (60, 40), (66, 33), (78, 39). The data set(s) that cannot come from experiment and is (are) incorrectly recorded, is (are):  [2009]
 (A) (42, 56) (B) (48, 48) (C) (66, 33) (D) (78, 39)
- *28. A student performed the experiment to measure the speed of sound in air using resonance air-column method. Two resonances in the air-column were obtained by lowering the water level. The resonance with the shorter air-column is the first resonance and that with the longer air column is the second resonance. Then,  [2009]
 (A) the intensity of the sound heard at the first resonance was more than that at the second resonance
 (B) the prongs of the tuning fork were kept in a horizontal plane above the resonance tube
 (C) the amplitude of vibration of the ends of the prongs is typically around 1 cm
 (D) the length of the air-column at the first resonance was somewhat shorter than $1/4^{\text{th}}$ of the wavelength of the sound in air
- *29. 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 s for this and records 40 s for 20 oscillations. For the observation, which of the following statement(s) is/are correct? [2010]
 (A) Error ΔT in measuring T , the time period is 0.05 s
 (B) Error ΔT in measuring T , the time period is 1 s
 (C) Percentage error in the determination of g is 5%
 (D) Percentage error in the determination of g is 2.5%
- *30. 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)  [2015]
 (A) $\mu_0 I^2 = \epsilon_0 V^2$ (B) $\epsilon_0 I = \mu_0 V$ (C) $I = \epsilon_0 c V$ (D) $\mu_0 c I = \epsilon_0 V$
- *31. Consider a Vernier callipers in which each 1 cm on the main scale is divided into 8 equal divisions and a screw gauge with 100 divisions on its circular scale. In the Vernier callipers, 5 divisions of the Vernier scale coincide with 4 divisions on the main scale and in the screw gauge, one complete rotation of the circular scale moves it by two divisions on the linear scale. Then: [2015]
 (A) If the pitch of the screw gauge is twice the least count of the Vernier callipers, the least count of the screw gauge is 0.01 mm
 (B) If the pitch of the screw gauge is twice the least count of the Vernier callipers, the least count of the screw gauge is 0.005 mm
 (C) If the least count of the linear scale of the screw gauge is twice the least count of the Vernier callipers, the least count of the screw gauge is 0.01 mm
 (D) If the least count of the linear scale of the screw gauge is twice the least count of the Vernier callipers, the least count of the screw gauge is 0.005 mm

- *32. 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):  [2015]
 (A) $M \propto \sqrt{c}$ (B) $M \propto \sqrt{G}$ (C) $L \propto \sqrt{h}$ (D) $L \propto \sqrt{G}$
- *33. A length-scale (l) depends on the permittivity (ϵ) of a dielectric material, Boltzmann constant (k_B), the absolute temperature (T), the number per unit volume (n) of certain charged particles, and the charge (q) carried by each of the particles. Which of the following expression(s) for l is (are) dimensionally correct? [2016]
 (A) $l = \sqrt{\left(\frac{nq^2}{\epsilon k_B T}\right)}$ (B) $l = \sqrt{\left(\frac{\epsilon k_B T}{nq^2}\right)}$ (C) $l = \sqrt{\left(\frac{q^2}{\epsilon n^{2/3} k_B T}\right)}$ (D) $l = \sqrt{\left(\frac{q^2}{\epsilon n^{1/3} k_B T}\right)}$
- *34. In an experiment to determine the acceleration due to gravity g , the formula used for the time period of a periodic motion is $T = 2\pi\sqrt{\frac{7(R-r)}{5g}}$. The values of R and r are measured to be (60 ± 1) mm and (10 ± 1) mm, respectively. In five successive measurements, the time period is found to be 0.52 s, 0.56 s, 0.57 s, 0.54 s and 0.59 s. The least count of the watch used for the measurement of time period is 0.01 s. Which of the following statement(s) is (are) true?  [2016]
 (A) The error in the measurement of r is 10%
 (B) The error in the measurement of T is 3.57%
 (C) The error in the measurement of T is 2%
 (D) The error in the determined value of g is 11%
- *35. Let us consider a system of units in which mass and angular momentum are dimensionless. If length has dimension of L , which of the following statement(s) is/are correct?  [2019]
 (A) The dimension of force is L^{-3}
 (B) The dimension of power is L^{-5}
 (C) The dimension of energy is L^{-2}
 (D) The dimension of linear momentum is L^{-1}

LINKED COMPREHENSION TYPE

PARAGRAPH FOR QUESTIONS 36 - 37

A dense collection of equal number of electrons and positive ions is called natural plasma. Certain solids containing fixed positive ions surrounded by free electrons can be treated as neutral plasma. Let ' N ' be the number density of free electrons, each of mass ' m '. When the electrons are subjected to an electric field, they are displaced relatively away from the heavy positive ions. If the electric field becomes zero, the electrons begin to oscillate about the positive ions with a natural angular frequency ' ω_p ' which is called the plasma frequency. To sustain the oscillations, a time varying electric field needs to be applied that has an angular frequency ω , where a part of the energy is absorbed and a part of it is reflected. As ω approaches ω_p all the free electrons are set to resonance together and all the energy is reflected. This is the explanation of high reflectivity of metals. [2011]

36. Taking the electronic charge as ' e ' and the permittivity as ' ϵ_0 '. Use dimensional analysis to determine the correct expression for ω_p

(A) $\sqrt{\frac{Ne}{m\epsilon_0}}$ (B) $\sqrt{\frac{m\epsilon_0}{Ne}}$ (C) $\sqrt{\frac{Ne^2}{m\epsilon_0}}$ (D) $\sqrt{\frac{m\epsilon_0}{Ne^2}}$

37. Estimate the wavelength at which plasma reflection will occur for a metal having the density of electrons $N \approx 4 \times 10^{27} \text{ m}^{-3}$. Taking $\epsilon_0 = 10^{-11}$ and mass $m \approx 10^{-30}$, where these quantities are in proper SI units.

(A) 800 nm (B) 600 nm (C) 300 nm (D) 200 nm

PARAGRAPH FOR QUESTIONS 38 - 39

If the measurement errors in all the independent quantities are known, then it is possible to determine the error in any dependent quantity. This is done by the use of series expansion and truncating the expansion at the first power of the error. For example, consider the relation $z = x/y$. If the errors in x , y and z are Δx , Δy and Δz , respectively, then

$$z \pm \Delta z = \frac{x \pm \Delta x}{y \pm \Delta y} = \frac{x}{y} \left(1 \pm \frac{\Delta x}{x} \right) \left(1 \pm \frac{\Delta y}{y} \right)^{-1}$$

The series expansion for $\left(1 \pm \frac{\Delta y}{y} \right)^{-1}$, to first power in $\Delta y/y$, is $1 \mp (\Delta y/y)$. The relative errors in independent variables are always added. So the error in z will be

$$\Delta z = z \left(\frac{\Delta x}{x} + \frac{\Delta y}{y} \right).$$

The above derivation makes the assumption that $\Delta x/x \ll 1$, $\Delta y/y \ll 1$. Therefore, the higher powers of these quantities are neglected.

[2018]

38. Consider the ratio $r = \frac{(1-a)}{(1+a)}$ to be determined by measuring a dimensionless quantity a . If the error in the measurement of a is Δa ($\Delta a/a \ll 1$), then what is the error Δr in determining r ?

(A) $\frac{\Delta a}{(1+a)^2}$ (B) $\frac{2\Delta a}{(1+a)^2}$ (C) $\frac{2\Delta a}{(1-a^2)}$ (D) $\frac{2a\Delta a}{(1-a^2)}$

39. In an experiment the initial number of radioactive nuclei is 3000. It is found that 1000 ± 40 nuclei decayed in the first 1.0s. For $|x| \ll 1$, $\ln(1+x) = x$ up to first power in x . The error $\Delta\lambda$, in the determination of the decay constant λ , in s^{-1} , is:

(A) 0.04 (B) 0.03 (C) 0.02 (D) 0.01

PARAGRAPH FOR QUESTIONS 40 - 41

In electromagnetic theory, the electric and magnetic phenomena are related to each other. Therefore, the dimensions of electric and magnetic quantities must also be related to each other. In the questions below, (E) and (B) stand for dimensions of electric and magnetic fields respectively, while $[\epsilon_0]$ and $[\mu_0]$ stand for dimensions of the permittivity and permeability of free space respectively. $[L]$ and $[T]$ are dimensions of length and time respectively. All the quantities are given in SI units.

[2018]

40. The relation between $[E]$ and $[B]$ is:

(A) $[E] = [B] [L] [T]$

(B) $[E] = [B] [L]^{-1} [T]$

(C) $[E] = [B] [L] [T]^{-1}$

(D) $[E] = [B] [L]^{-1} [T]^{-1}$

41. The relation between $[\epsilon_0]$ and $[\mu_0]$ is:

(A) $[\mu_0] = [\epsilon_0] [L]^2 [T]^{-2}$

(B) $[\mu_0] = [\epsilon_0] [L]^{-2} [T]^2$

(C) $[\mu_0] = [\epsilon_0]^{-1} [L]^2 [T]^{-2}$

(D) $[\mu_0] = [\epsilon_0]^{-1} [L]^{-2} [T]^2$

MATRIX MATCH TYPE

42. Match the following:

[1983]

Column I

Column II

(A) Angular momentum

(P) ML^2T^{-2}

(B) Torque

(Q) ML^2T^{-1}

(C) Inductance

(R) $M^{-1}L^{-2}T^2Q^2$

(D) Latent heat

(S) ML^2Q^{-2}

(E) Capacitance

(T) $ML^3T^{-1}Q^{-2}$

(F) Resistivity

(U) L^2T^{-2}

43. Column I. Gives three physical quantities. Select the appropriate units for these from choices given in column II. some the physical quantities may have more than one choice.

[1990]

Column I

Column II

(A) Capacitance

(P) ohm-sec

(B) Inductance

(Q) coulomb² Joule⁻¹

(C) Magnetic induction

(R) coulomb Volt⁻¹

(S) newton (Ampere meter)⁻¹;

(T) volt second (Ampere)⁻¹;

44. Some physical quantities are given in Column I and some possible SI units in which these quantities may be expressed are given in Column II. Match the physical quantities in Column I with the units in Column II and indicate your answer by darkening appropriate bubbles in the 4×4 matrix given in the ORS. [2007]

Column I

Column II

(A) $GM_e M_s$

(P) (volt) (coulomb) (metre)

$G \rightarrow$ universal gravitational constant,

$M_e \rightarrow$ mass of the earth,

$M_s \rightarrow$ mass of the Sun

(B) $\frac{3RT}{M}$

(Q) (kilogram) (metre)³ (second)⁻²

$R \rightarrow$ universal gas constant,

$T \rightarrow$ absolute temperature,

$M \rightarrow$ molar mass

(C) $\frac{F^2}{q^2 B^2}$

$F \rightarrow$ force,
 $q \rightarrow$ charge,
 $B \rightarrow$ magnetic field

(D) $\frac{GM_e}{R_e}$

$G \rightarrow$ universal gravitational constant,
 $M_e \rightarrow$ mass of the earth,
 $R_e \rightarrow$ radius of the earth

(R) (meter)² (second)⁻²

(S) (farad) (volt)² (kg)⁻¹

45. Match List I with List II and select the correct answer using the codes given below the lists: [2013]

List I

- P.** Boltzmann Constant
Q. Coefficient of viscosity
R. Plank Constant
S. Thermal conductivity

List II

- 1.** $[ML^2T^{-1}]$
2. $[ML^{-1}T^{-1}]$
3. $[MLT^3K^{-1}]$
4. $[ML^2T^2K^{-1}]$

Codes :

	P	Q	R	S
(A)	3	1	2	4
(C)	4	2	1	3

	P	Q	R	S
(B)	3	2	1	4
(D)	4	1	2	3

NUMERICAL VALUE TYPE

46. 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 the explosion. Find the values of a , b and c [1981]
47. 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 1 mm). The main scale reads 10 mm and first division of vernier scale coincides with the main scale. Mass of the cube is 2.736 g. Find the density of the cube in appropriate significant figures (in g/cm^3) [2005]
48. To find the distance d over which a signal can be seen clearly in foggy conditions, a railway engineer uses dimensional analysis 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 [2014]
49. During Searle's experiment, zero of the Vernier scale lies between $3.20 \times 10^{-2}m$ and $3.25 \times 10^{-2}m$ of the main scale. The 20th division of the Vernier scale exactly coincides with one of the main scale divisions. When an additional load is applied to the wire, the zero of the Vernier scale still lies between $3.20 \times 10^{-2}m$ and $3.25 \times 10^{-2}m$ of the main scale but now the 45th division of Vernier scale coincides with one of the main scale divisions. The length of the thin metallic wire is 2m and its cross-sectional area is $8 \times 10^{-7}m^2$. The least count of the Vernier scale is $8 \times 10^{-7}m^2$. The maximum percentage error in the Young's modules of the wire is [2014]

50. The energy of a system as a function of time t is given as $E(t) = A^2 \exp(-\alpha t)$, $\alpha = 0.2^{-1}$. 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 . [2016]
51. A steel wire of diameter 0.5 mm and Young's modulus $2 \times 10^{11} \text{ Nm}^{-2}$ carries a load of mass M . The length of the wire with the load is 1.0 m. A vernier scale with 10 divisions is attached to the end of this wire. Next to the steel wire is a reference wire to which a main scale, of least count 1.0 mm, is attached. The 10 divisions of the vernier scale correspond to 9 divisions of the main scale. Initially, the zero of vernier scale coincides with the zero of main scale. If the load on the steel wire is increased by 1.2 kg, the vernier scale division which coincides with a main scale division is . Take $g = 10 \text{ ms}^{-2}$ and is $\pi = 3.2$.  [2018]
52. An optical bench has 1.5 m long scale having four equal divisions in each cm. While measuring the focal length of a convex lens, the lens is kept at 75 cm mark of the scale and the object pin is kept at 45 cm mark. The image of the object pin on the other side of the lens overlaps with image pin that is kept at 135 cm mark. In this experiment, the percentage error in the measurement of the focal length of the lens is . [2019]

FILL IN THE BLANKS TYPE

53. Give the MKS units for each of the following quantities: [1980]
 (i) Young's modulus: _____
 (ii) Magnetic Induction: _____
 (iii) Power of lens: _____
53. Write the dimension of the following in terms of mass, time, length and charge [1982]
 (i) magnetic flux (ii) rigidity modulus
55. Planck's constant has the dimensions _____. [1985]
56. In the formula $X = 3YZ^2$, X and Z have dimensions of capacitance and magnetic induction respectively. The dimensions of Y in MKSQ system is _____. [1988]
57. The equation of state of a real gas is given by $\left(P + \frac{a}{V^2}\right)(V - b) = RT$, where P , V and T are pressure, volume and temperature respectively and R is the universal gas constant. The dimensions of the constant a in the above equation is _____.  [1997]

JEE ADVANCED 2020 QUESTIONS

58. Sometimes it is convenient to construct a system of units so that all quantities can be expressed in terms of only one physical quantity. In one such system, dimensions of different quantities are given in terms of a quantity X as follows: [position] = $[X^\alpha]$; [speed] = $[X^\beta]$; [acceleration] = $[X^P]$; [linear momentum] = $[X^q]$; [force] = $[X^r]$. Then  [2020]
 (A) $\alpha + p = 2\beta$ (B) $p + q - r = \beta$ (C) $p - q + r = \alpha$ (D) $p + q + r = \beta$
59. Two capacitors with capacitance values $C_1 = 2000 \pm 10 \text{ pF}$ and $C_2 = 3000 \pm 15 \text{ pF}$ are connected in series. The voltage applied across this combination is $V = 5.00 \pm 0.02 \text{ V}$. The percentage error in the calculation of the energy stored in this combination of capacitors is .  [2020]