Chapter 02

Unit & Measurement

JEE-FLASHBACK

JEE MAINS QUESTION

Q.1 In an experiment the angles are required to be measured using an instrument. In this instrument 29 divisions of the main scale exactly coincide with the 30 divisions of the vernier scale. If the smallest division of the main scale is half-a-degree (= 0.5°), then the least count of the instrument is **[AIEEE-2009]**

(1) Half minute (2) One degree
(3) Half degree (4) One minute

Q.2 The respective number of significant figures for the numbers 23.023, 0.0003 and 2.1×10^{-3} are **[AIEEE-2010]**

(1) 4, 4, 2 (2) 5, 1, 2
(3) 5, 1, 5 (4) 5, 5, 2

Q.3 A spectrometer gives the following reading when used to measure the angle of a prism.
Main scale reading : 58.5 degree
Vernier scale reading : 09 divisions
Given that 1 division on main scale corresponds to 0.5 degree. Total divisions on the vernier scale is 30 and match with 29 divisions of the main scale. The angle of the prism from the above data **[AIEEE-2012]**

(1) 58.77 degree (2) 58.65 degree
(3) 59 degree (4) 58.59 degree

Q.4 Resistance of a given wire is obtained by measuring the current flowing in it and the voltage difference applied across it. If the percentage errors in the measurement of the current and the voltage difference are 3% each, then error in the value of resistance of the wire is **[AIEEE-2012]**

(1) Zero (2) 1 % (3) 3 % (4) 6 %

Q.5 Let $[\varepsilon_0]$ denote the dimensional formula of the permittivity of vacuum. If M = mass, L = length, T = time and A = electric current, then **[JEE (Main)-2013]**

(1) $[\varepsilon_0] = M^{-1} L^{-3} T^2 A]$ (2) $[\varepsilon_0] = M^{-1} L^{-3} T^4 A^2]$
(3) $[\varepsilon_0] = M^{-1} L^2 T^{-1} A^{-2}$ (4) $[\varepsilon_0] = M^{-1} L^2 T^{-1} A]$

Q.6 The current voltage relation of diode is given by $I = (e^{1000V/T} - 1)$ mA, where the applied V is in volts and the temperature T is in degree kelvin. If a student makes an error measuring ± 0.01 V while measuring the current of 5 mA at 300 K, what will be the error in the value of current in mA? **[JEE (Main)-2014]**

(1) 0.2 mA (2) 0.02 mA
(3) 0.5 mA (4) 0.05 mA

Q.7 A student measured the length of a rod and wrote it as 3.50 cm. Which instrument did he use to measure it? **[JEE (Main)-2014]**

(1) A meter scale
(2) 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.
(3) A screw gauge having 100 divisions in the circular scale and pitch as 1 mm.
(4) A screw gauge having 50 divisions in the circular scale and pitch as 1 mm.

Q.8 The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Measured value of L is 20.0 cm known to 1 mm accuracy and time for 100 oscillations of the pendulum is found to be 90 s

using a wrist watch of 1 s resolution. The accuracy in the determination of g is

[JEE (Main)-2015]

(1) 2 % (2) 3 % (3) 1 % (4) 5 %

Q.9 A student measures the time period of 100 oscillations of a simple pendulum four times. The data set is 90 s, 91 s, 95 s and 92 s. If the minimum division in the measuring clock is 1 s, then the reported mean time should be:

[JEE (Main)-2016]

(1) 92 ± 5.0 s (2) 92 ± 1.8 s

(3) 92 ± 3 s (4) 92 ± 2 s

Q.10 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, its 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? **[JEE (Main)-2016]**

(1) 0.80 mm (2) 0.70 mm

(3) 0.50 mm (4) 0.75 mm

Q.11 The following observations were taken for determining surface tension T of water by capillary method:

Diameter of capillary, D = 1.25×10^{-2} m

Rise of water, h = 1.45×10^{-2} m

Using g = 9.80 m/s^2 and the simplified relation $T = \frac{rhg}{2} \times 10^3 N/m$, the possible error in surface tension is closest to **[JEE (Main)-2017]**

(1) 0.15 % (2) 1.5 % (3) 2.4 % (4) 10 %

Q.12 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 **[JEE (Main)-2018]**

(1) 2.5 % (2) 3.5 % (3) 4.5 % (4) 6 %

Q.13 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 **[JEE (Main)-2019]**

(1) 5.725 mm (2) 5.740 mm

(3) 5.755 mm (4) 5.950 mm

Q.14 Expression for time in terms of G(universal gravitational constant), h (Planck constant) and c (speed of light) is proportional to

[JEE (Main)-2019]

(1) $\sqrt{\frac{Gh}{c^5}}$ (2) $\sqrt{\frac{c^3}{Gh}}$

(3) $\sqrt{\frac{Gh}{c^3}}$ (4) $\sqrt{\frac{hc^5}{G}}$

Q.15 The density of a material is 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

[JEE (Main)-2019]

(1) 640 (2) 410 (3) 40 (4) 16

Q.16 The diameter and height of a cylinder are measured by a meter scale to be 12.6 ± 0.1 cm and 34.2 ± 0.1 cm, respectively. What will be the value of its volume in appropriate significant figures? **[JEE (Main)-2019]**

(1) 4264 ± 81 cm^3 (2) 4300 ± 80 cm^3

(3) 4260 ± 80 cm^3 (4) 4264.4 ± 81.0 cm^3

Q.17 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 constants. The dimension of β is **[JEE (Main)-2019]**

(1) $M^0L^2T^{-4}$ (2) M^2LT^{-4}

(3) MLT^{-2} (4) $M^2L^2T^{-2}$

Q.18 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 μm diameter of a wire is **[JEE (Main)-2019]**

(1) 200 (2) 50
(3) 100 (4) 500

Q.19 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:- **[JEE (Main)-2019]**

(1) $S^{1/2}I^{3/2}h^{-1}$ (2) $S^{3/2}I^{1/2}h^{0}$
(3) $S^{1/2}I^{1/2}h^{-1}$ (4) $S^{1/2}I^{1/2}h^{0}$

Q.20 In a simple pendulum experiment for determination of acceleration due to gravity (g), time taken for 20 oscillations 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: **[JEE (Main)-2019]**

(1) 6.8 % (2) 0.2 % (3) 3.5 % (4) 0.7 %

Q.21 In the density measurement of a cube, the mass and edge length are measured as (10.00 ± 0.10) kg and (0.10 ± 0.01) m, respectively. The error in the measurement of density is **[JEE (Main)-2019]**

(1) 0.31 kg/m^3 (2) 1000 kg/m^3
(3) 0.10 kg/m^3 (4) 3100 kg/m^3

Q.22 The area of a square is 5.29 cm^2. The area of 7 such squares taking into account the significant figures is **[JEE (Main)-2019]**

(1) 37.03 cm^2 (2) 37.0 cm^2
(3) 37.030 cm^2 (4) 37 cm^2

Q.23 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 ? **[JEE (Main)-2019]**

(1) $[M^{-2}L^{-2}T^{6}A^{3}]$ (2) $[M^{-1}L^{-2}T^{4}A^{2}]$
(3) $[M^{-2}L^{0}T^{-4}A^{-2}]$ (4) $[M^{-3}L^{-2}T^{8}A^{4}]$

Q.24 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 stopwatch with 1 s resolution measures the time taken for 40 oscillation to be 50 s. The accuracy in g is **[JEE (Main)-2019]**

(1) 3.40 % (2) 2.40 %
(3) 5.40 % (4) 4.40 %

Q.25 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 **[JEE (Main)-2020]**

(1) 0.01 cm (2) 0.001 mm
(3) 0.001 cm (4) 0.02 mm

Q.26 A quantity f is given by $f = \sqrt{\frac{hc^2}{G}}$ where c is speed of light, G universal gravitational constant and h is the Planck's constant. Dimension of f is that of **[JEE (Main)-2020]**

(1) Energy (2) Area
(3) Volume (4) Momentum

Q.27 For the four sets of three measured physical quantities as given below. Which of the following options is correct? **[JEE (Main)-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) $A_4 = 25$, $B_4 = 236.191$, $C_4 = 19.5$

(1) $A_1+B_1+C_1 = A_2+B_2+C_2 = A_3+B_3+C_3 = A_4+B_4+C_4$
(2) $A_1+B_1+C_1 < A_3+B_3+C_3 < A_2+B_2+C_2 < A_4+B_4+C_4$
(3) $A_4+B_4+C_4 < A_2+B_2+C_2 > A_1+B_1+C_1 = A_3+B_3+C_3$
(4) $A_4+B_4+C_4 < A_1+B_1+C_1 < A_3+B_3+C_3 < A_2+B_2+C_2$

Q.28 The least count of the main scale of a vernier callipers is 1 mm. 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)

[JEE (Main)-2020]

(1) 3.21 cm (2) 2.99 cm
(3) 3.07 cm (4) 3.2 cm

Q.29 If speed V, area A and force F are chosen as fundamental units, then the dimension of Young's modulus will be **[JEE (Main)-2020]**

(1) $FA^{-1}V^{0}$ (2) $FA^{2}V^{-1}$
(3) $FA^{2}V^{-2}$ (4) $FA^{2}V^{-3}$

Q.30 If momentum (P), area (A) and time (T) are taken to be the fundamental quantities then the dimensional formula for energy is

[JEE (Main)-2020]

(1) $\left[P^{\frac{1}{2}}AT^{-1}\right]$ (2) $[P^{2}AT^{-2}]$

(3) $\left[PA^{\frac{1}{2}}T^{-1}\right]$ (4) $[P^{-1}AT^{-2}]$

Q.31 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 **[JEE (Main)-2020]**

(1) 2.124 cm (2) 2.123 cm
(3) 2.125 cm (4) 2.121 cm

Q.32 Dimensional formula for thermal conductivity is (here K deontes the temperature)

[JEE (Main)-2020]

(1) $MLT^{-2}K^{-2}$ (2) $MLT^{-3}K^{-1}$
(3) $MLT^{-3}K$ (4) $MLT^{-2}K$

Q.33 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 **[JEE (Main)-2020]**

(1) Coefficient of viscosity
(2) Force constant
(3) Energy density
(4) Planck's constant

Q.34 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

[JEE (Main)-2020]

(1) 13.5 % (2) 14.5 %
(3) 16.5 % (4) 12.25 %

Q.35 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.

[JEE (Main)-2020]

(1) Positive, 0.1 mm
(2) Positive, 10 μm
(3) Negative, 2 μm
(4) Positive, 0.1 μm

Q.36 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 **[JEE (Main)-2020]**

(1) (5.5375 ± 0.0739) mm
(2) (5.54 ± 0.07) mm
(3) (5.538 ± 0.074) mm .
(4) (5.5375 ± 0.0740) mm

Q.37 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 _____.

[JEE (Main)-2020]

Q.38 If E and H represent the intensity of electric field and magnetizing field respectively, then the unit of E/H will be **[2021, 27 Aug Shift-I]**

(1) ohm (2) mho

(3) joule (4) newton

Q.39 Two resistor $R_1 = (4 \pm 0.8)\Omega$ and $R_2 = (4 \pm 0.4)\Omega$ are connected in parallel.

The equivalent resistance of their parallel combination will be **[2021, 1 Sep. Shift-II]**

(1) $(4 \pm 0.4)\Omega$

(2) $(2 \pm 0.4)\Omega$

(3) $(2 \pm 0.3)\Omega$

(4) $(4 \pm 0.3)\Omega$

Q.40 A student determined Young's modulus of elasticity using the formula $Y = \frac{MgL^3}{4bd^3\delta}$. The value of g is taken to be 9.8 m/s^2, without any signification error, his observation are as following.

Physical quantity	Least count of the equipment used for measurement	Observed value
Mass (M)	1 g	2 kg
Length of bar (L)	1 mm	1 m
Breadth of bar (b)	0.1 mm	4 cm
Thickness of bar (d)	0.01 mm	0.4 cm
Depression (δ)	0.01 mm	5 mm

Then, the fractional error in the measurement of Y is **[2021, 1 Sep Shift-II]**

(1) 0.003 (2) 0.0155

(3) 0.155 (4) 0.083

Q.41 The diameter of a spherical bob is measured using a Vernier callipers. 9 division of the main scale, in the vernier calipers, are equal to 10 divisions of vernier scale. One main scale division is 1 mm. The main scale reading is 10 mm and 8th division of vernier scale was found to coincide exactly with one of the main scale division. If the given vernier calipers has positive zero error of 0.04 cm, then the radius of the bob is .....$\times 10^{-2}$ cm.

[2021, 27 Aug Shift-I]

Q.42 If the length of the pendulum in pendulum clock increases by 0.1%, then the error in time per day is **[2021, 26 Aug Shift-I]**

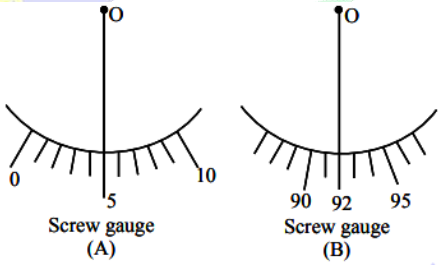
(1) 86.4 s (2) 4.32 s

(3) 43.2 s (4) 8.64 s

Q.43 Student A and student B used two screw gauges of equal pitch and 100 equal circular divisions to measure the radius of a given wire. The actual value of the radius of the wire is 0.322 cm. The absolute value of the difference between the final circular scale readings observed by the students A and B is.....

[Figure shows position of reference O when jaws of screw gauge are closed]

Given, pitch = 0.1 cm. **[2021, 25 July Shift-I]**



Q.44 Three students S_1, S_2 and S_3 perform an experiment for determining the acceleration due to gravity (g) using different length of pendulum and record time for different number of oscillations. The observations are shown in the table.

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

(Least count of length = 0.1 m, least count for time = 0.1 s)

If E_1, E_2 and E_3 are the percentage error in g for students 1,2 and 3 respectively, then the minimum percentage error is obtained by student number ..... . **[2021, 27 Aug Shift-I]**

Q.45 The vernier scale used for measurement has a positive zero error of 0.2 mm. If while taking a measurement, it was noted that '0' on the vernier sacle lies between 8.5 cm and 8.6 cm, vernier coincidence is 6, then the correct value of measurement it ..... cm.

[2021, 17 March Shift-I]

(1) 8.36 (2) 8.54 (3) 8.58 (4) 8.56

Q.46 In order to determine the Young's modulus of a wire of radius 0.2 cm (measured using a scale of least count = 0.001cm) and length 1m (measured using a scale of least count = 1 mm), a weight of mass 1 kg (measure using a scale of least count = 1g) was hanged to get the elongation of 0. 5 cm (measured using a scale of least count 0.001 cm). What will be the fractional error in the value of Young's modulus determined by this experiment?

[2021, 16 March Shift-I]

(1) 0.14 % (2) 0.9 % (3) 9% (4) 1.4 %

Q.47 One main scale division of a vernier calipers is a cm and nth division of the vernier scale coincide with (n – 1)th division of the main scale. The least count of the calipers (in mm) is

[2021, 16 March Shift-I]

(1) $\frac{10na}{(n-1)}$ (2) $\frac{10a}{(n-1)}$

(3) $\left(\frac{n-1}{10n}\right)a$ (4) $\frac{10a}{n}$

Q.48 The resistance $R=\frac{V}{I}$, where V = (50 ±2) V and I = (20 ± 0.2)A. The percentage error in R is 'x' %. The value of x to the nearest integer is ..... .

[2021, 16 March Shift-I]

Q.49 A large number of water drops, each of radius r, combine to have a drop of radius R. If the surface tension is T and mechanical equivalent of heat is J, the rise in heat energy per unit volume will be **[2021, 26 Feb. Shift-I]**

(1) $\frac{2T}{J}\left(\frac{1}{r}-\frac{1}{R}\right)$ (2) $\frac{2T}{rJ}$

(3) $\frac{3T}{rJ}$ (4) $\frac{3T}{J}\left(\frac{1}{r}-\frac{1}{R}\right)$

Q.50 The period of oscillation of a simple pendulum is $T=2\pi\sqrt{\frac{L}{g}}$. Measured value of L is 1.0 m from meter scale having a minimum division of 1 mm and time of one complete oscillation is 1.95 s measured from stopwatch of 0.01 s resolution. The percentage error in the determination of g will be **[2021, 24 Feb. Shift-I]**

(1) 1.13 % (2) 1.03 %

(3) 1.33 % (4) 1.30 %

Q.51 Which of the following equations is dimensionally incorrect?

Where, t = time, h = height, s = surface tension, θ = angle, ρ = density, a, r = radius, g = acceleration due to gravity, V = volume, p = pressure, W = work done τ = torque, ε = permittivity, E = electric field, J = current density, L = length. **[2021, 31 Aug Shift-I]**

(1) $V=\frac{\pi pa^4}{8\eta L}$ (2) $h=\frac{2s\cos\theta}{\rho rg}$

(3) $J=\varepsilon\frac{\partial E}{\partial t}$ (4) $W=\tau\theta$

Q.52 If velocity [v], time [T] and force [F] are choosen as the base quantities, the dimensions of the mass will be **[2021, 31 Aug Shift-II]**

(1) $[FT^{-1}v^{-1}]$ (2) $[FTv^{-1}]$

(3) $[FT^2v]$ (4) $[FvT^{-1}]$

Q.53 If force (F), length (L) and time (T) are taken as the fundamental quantities. Then what will be the dimension of density ?

[2021, 27 Aug Shift-II]

(1) $[FL^{-4}T^2]$ (2) $[FL^{-3}T^2]$
(3) $[FL^{-5}T^2]$ (4) $[FL^{-3}T^3]$

Q.54 Which of the following is not a dimensionless quantity? **[2021, 27 Aug Shift-I]**

(1) Relative magnetic permeability (μ_r)
(2) Power Factor
(3) Permeability of free space (μ_0)
(4) Quality factor

Q.55 If E,L,M and G denote the quantities as energy, angular momentum, mass and constant of gravitation respectively. then the dimension of P in the formula $P = EL^2M^{-5}G^{-2}$ is

[2021, 26 Aug Shift-I]

(1) $[M^0L^1T^0]$ (2) $[M^{-1}L^{-1}T^{-2}]$
(3) $[M^1L^1T^{-2}]$ (4) $[M^0L^0T^0]$

Q.56 If time (t), velocity (v) and angular momentum (ℓ) are taken as the fundamental units, then the dimension of mass (m) in terms of t,v and l is

[2021, 20 July Shift-I]

(1) $[t^{-1}v^1l^{-2}]$ (2) $[t^1v^2l^{-1}]$
(3) $[t^{-2}v^{-1}l^1]$ (4) $[t^{-1}v^{-2}l^1]$

Q.57 The force is given in terms of times t and displacement x by the equation
$F = A\cos Bx + C\sin Dt$
The dimensional formula of $\frac{AD}{B}$ is

[2021, 25 Aug Shift-I]

(1) $[M^0LT^{-1}]$ (2) $[ML^2T^{-3}]$
(3) $[M^1L^1T^{-2}]$ (4) $[M^2L^2T^{-3}]$

Q.58 The entropy of any system is given by

$$S = \alpha^2\beta\ln\left[\frac{\mu kR}{J\beta^2} + 3\right]$$

Where, α and β are the constants; μ, J, k and R are number of moles, mechanical equivalent of heat, Boltzmann constant and gas constant, respectively. Take $S = \frac{dQ}{T}$

[2021, 20 July Shift-I]

Choose the incorrect option.
(1) a and J have the same dimensions.
(2) S, β, k and μR have the same dimensions.
(3) S and a have different dimension.
(4) α and k have the same dimension.

Q.59 If C and V represent capacity and voltage respectively, then what are the dimensions of λ, where $\frac{C}{V} = \lambda$? **[2021, 26 Feb.Shift-I]**

(1) $[M^{-2}L^{-3}I^2T^6]$ (2) $[M^{-3}L^{-4}I^3T^6]$
(3) $[M^{-1}L^{-3}I^{-2}T^{-7}]$ (4) $[M^{-2}L^{-4}I^3T^7]$

Q.60 If e is the electronic charge, c is the speed of light in free space and h is Planck's constant, the quantity $\frac{1}{4\pi\varepsilon_0}\frac{e^2}{hc}$ has dimension of :

[2021, 25 Feb.Shift-I]

(1) $[MLT^0]$ (2) $[MLT^{-1}]$
(3) $[M^0L^0T^0]$ (4) $[LC^{-1}]$

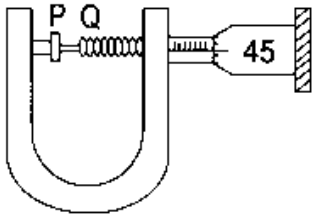
Q.61 The work done by a gas molecule in an isolated system is given by, $W = \alpha\beta^2 e^{-\frac{x^2}{\alpha KT}}$, where x is the displacement, k is the Boltzmann constant and T is the temperature, α and β are constants. Then the dimension of β will be:

[2021, 24 Feb Shift-I]

(1) $[M^2LT^2]$ (2) $[M^0LT^0]$
(3) $[MLT^{-2}]$ (4) $[ML^2T^{-2}]$

Q.62 In an experiment to find out the diameter of wire using screw gauge, the following observations were noted :

[2022, 29 July, shift-I]



(A) Screw moves 0.5mm on main scale in one complete rotation
(B) Total divisions on circular scale = 50
(C) Main scale reading 2.5mm
(D) 45^{th} division of circular scale is in the pitch line
(E) Instrument has 0.03 mm negative error

Then the diameter of wire is :-

(1) 2.92 mm (2) 2.54 mm

(3) 2.98 mm (4) 3.45 mm

Q.63 A travelling microscope has 20 divisions per cm on the main scale while its vernier scale has total 50 divisions and 25 vernier scale divisions are equal to 24 main scale divisions, what is the least count of the travelling microscope?

[2022, 29 July, shift-I]

(1) 0.001 cm (2) 0.002 mm
(3) 0.002 cm (4) 0.005 cm

Q.64 Consider the efficiency of carnot's engine is given by $\eta = \frac{\alpha\beta}{\sin\theta}\log_e\frac{\beta x}{kT}$ where α and β are constants. If T is temperature, k is Boltzmann constant θ is angular displacement and x has the dimensions of length. Then, choose the incorrect option: **[2022, 28 July, shift-II]**

(1) Dimensions of β io same as that of force.
(2) Dimensions of α^{-1} x is same as that of energy (3) Dimension of $\eta^{-1}\sin\theta$ is same as that of $\alpha\beta$.
(4) Dimensions of α is same as that of β.

Q.65 In an experiment with vernier callipers of least count 0.1 mm, when two jaws are joined together the zero of vernier scale lies right to the zero of the main scale and 6th division of vernier scale coincides with the main scale division, While measuring the diameter of a spherical bob, the zero of vernier scale lies in between 3.2 cm and 3.3 cm marks and 4th division of vernier scale coincides with the main scale division. The diameter of bob is measured as **[JEE (Main)-2023]**

(1) 3.22 cm (2) 3.18 cm
(3) 3.26 cm (4) 3.25 cm

Q.66 A physical quantity P is given as $P = \frac{a^2b^3}{c\sqrt{d}}$ The percentage error in the measurement of *a*, *b*, *c* and *d* are 1%, 2%, 3% and 4% respectively. The percentage error in the measurement of quantity P will be **[JEE (Main)-2023]**

(1) 13% (2) 16% (3) 12% (4) 14%

Q.67 If force (F), velocity (V) and time (T) are considered as fundamental physical quantity, then dimensional formula of density will be :

[JEE (Main)-2023]

(1) FV^4T^{-6} (2) $FV^{-4}T^{-2}$
(3) $F2V^{-2}T^6$ (4) $FV^{-2}T^2$

Q.68 The equation of a circle is given by $x^2 + y^2 = a^2$, where a is the radius. If the equation is modified to change the origin other than (0,0), then find out the correct dimensions of A and B in a new equation: $(x - At)^2 + \left(y - \frac{t}{B}\right)^2 = a^2$

The dimensions of t is given as $[T^{-1}]$

[JEE (Main)-2023(29 Jan. shift-2)]

(1) A = $[L^{-1}T]$, B = $[L\,T^{-1}]$
(2) A = [LT], B = $[L^{-1}\,T^{-1}]$
(3) A = $[L^{-1}T^{-1}]$, B = $[L\,T^{-1}]$
(4) A = $[L^{-1}T^{-1}]$, B = [L T]

Q.69 $\left(P + \frac{a}{v^2}\right)(v - b) = RT$ represents the equation of state of some gases. Where P is the pressure, V is the volume, T is the temperature and a, b, R are the constants. The physical quantity, which has dimensional formula as that of $\frac{b^2}{a}$, will be:

[JEE (Main)-2023(01 Feb. shift-1)]

(1) Bulk modulus (2) Modulus of rigidity
(3) Compressibility (4) Energy density

Q.70 If the velocity of light c, universal gravitational constant G and plank's constant h are chosen as fundamental quantities. The dimensions of mass in the new system is:

[JEE (Main)-2023(01 Feb. shift-2)]

(1) $\left[h^{\frac{1}{2}}c^{-\frac{1}{2}}G^1\right]$ (2) $[h^1c^1G^{-1}]$

(3) $\left[h^{-\frac{1}{2}}c^{\frac{1}{2}}G^{\frac{1}{2}}\right]$ (4) $\left[h^{\frac{1}{2}}c^{\frac{1}{2}}G^{-\frac{1}{2}}\right]$

JEE ADVANCED QUESTION

Q.1 A student performs an experiment to determine the Young's modulus of a wire, exactly 2 m 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 ± 0.05 mm at load of exactly 1.0 kg. The student also measures the diameter of the wire to be 0.4 mm with an uncertainty of ± 0.01 mm. Take g =

9.8 m/s^2 (exact). The Young's modulus obtained from the reading is **[IIT-JEE-2007 (Paper-2)]**

(1) $(2.0 \pm 0.3) \times 10^{11}$ N/m^2

(2) $(2.0 \pm 0.2) \times 10^{11}$ N/m^2

(3) $(2.0 \pm 0.1) \times 10^{11}$ N/m^2

(4) $(2.0 \pm 0.05) \times 10^{11}$ N/m^2

Q.2 Students 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.

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 percentage errors in g, i.e. $\left(\frac{\Delta g}{g}\times 100\right)$ for students I, II and III respectively, **[IIT-JEE-2008 (Paper-1)]**

(1) $E_I = 0$ (2) E_I is minimum

(3) $E_I = E_{II}$ (4) E_{II} is maximum

Q.3 A student performed the experiment of determination of focal length of a concave mirror by UV-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) **[IIT-JEE-2009 (Paper-1)]**

(1) (42, 56) (2) (48, 48)

(3) (66, 33) (4) (78, 39)

Q.4 A Vernier calipers 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 calipers, the least count is **[IIT-JEE-2010 (Paper-2)]**

(1) 0.02 mm (2) 0.05 mm

(3) 0.1 mm (4) 0.2 mm

Q.5 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 **[IIT-JEE-2011 (Paper-2)]**

(1) 0.9 % (2) 2.4 % (3) 3.1 % (4) 4.2 %

Paragraph for Q. Nos. 6 and 7

A dense collection of equal number of electrons and positive ions is called neutral 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. **[IIT-JEE-2011 (Paper-1)]**

Choose the correct answer:

Q.6 Taking the electronic charge as 'e' and the permittivity as 'ε_0', use dimensional analysis to determine the correct expression for ω_p

(1) $\sqrt{\frac{Ne}{m\varepsilon_0}}$ (2) $\sqrt{\frac{m\varepsilon_0}{Ne}}$

(3) $\sqrt{\frac{Ne^2}{m\varepsilon_0}}$ (4) $\sqrt{\frac{m\varepsilon_0}{Ne^2}}$

Q.7 Estimate the wavelength at which plasma reflection will occur for a metal having the density of electrons $N \approx 4 \times 10^{27}$ m^{-3}. Take $\varepsilon_0 \approx 10^{-11}$ and $m \approx 10^{-30}$, where these quantities are in proper SI units

(1) 800nm (2) 600nm (3) 300nm (4) 200nm

Q.8 In the determination of Young's modulus $\left(Y = \frac{4MLg}{\pi l d^2}\right)$ by using Searle's method, a wire of length L = 2 m and diameter d = 0.5 mm is used. For a load M = 2.5 kg, an extension l = 0.25 mm in the length of the wire is observed. Quantities

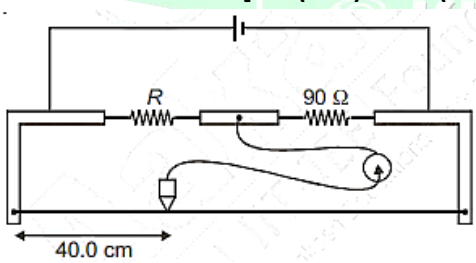
d and l are measured using a screw gauge and a micro meter, respectively. They have the same pitch of 0.5 mm. The number of divisions on their circular scale is 100. The contributions to the maximum probable error of the Y measurement **[IIT-JEE-2012 (Paper-1)]**

(1) Due to the errors in the measurements of d and l are the same.
(2) Due to the errors in the measurements of d is twice that due to the error in the measurement of l.
(3) Due to the error in the measurement of l is twice that due to the error in the measurement of d.
(4) Due to the error in the measurement of d is four times that due to the error in the measurement of l.

Q.9 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 5.10 cm and 5.15 cm of the main scale. The Vernier scale has 50 divisions equivalent to 2.45 cm. The 24^{th} division of the Vernier scale exactly coincides with one of the main scale divisions. The diameter of the cylinder is **[JEE (Adv)-2013 (Paper-1)]**

(1) 5.112 cm (2) 5.124 cm
(3) 5.136 cm (4) 5.148 cm

Q.10 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 90 Ω, as shown in the figure. The least count of the scale used in the metre bridge is 1 mm. The unknown resistance is **[JEE (Adv)-2014 (Paper-2)]**



(1) 60 ± 0.15 Ω (2) 135 ± 0.56 Ω
(3) 60 ± 0.25 Ω (4) 135 ± 0.23 Ω

Q.11 To find the distance d over which a signal can be seen clearly in foggy conditions, a railways-engineer uses dimensional 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 **[JEE (Adv)-2014 (Paper-1)]**

Q.12 The energy of a system as a function of time t is given as $E(t) = A^2 \exp(-\alpha t)$, where $\alpha = 0.2\ s^{-1}$. 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 **[JEE (Adv)-2015 (Paper-2)]**

Q.13 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) **[JEE (Adv)-2015 (Paper-1)]**

(1) $M \propto \sqrt{c}$ (2) $M \propto \sqrt{G}$
(3) $L \propto \sqrt{h}$ (4) $L \propto \sqrt{G}$

Q.14 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) **[JEE (Adv)-2015 (Paper-2)]**

(1) $\mu_0 I^2 = \varepsilon_0 V^2$ (2) $\varepsilon_0 I = \mu_0 V$
(3) $I = \varepsilon_0 cV$ (4) $\mu_0 cI = \varepsilon_0 V$

Q.15 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? **[JEE (Adv)-2016 (Paper-1)]**

(1) $l = \sqrt{\left(\frac{nq^2}{\varepsilon k_B T}\right)}$ (2) $l = \sqrt{\left(\frac{\varepsilon k_B T}{nq^2}\right)}$
(3) $l = \sqrt{\left(\frac{q^2}{\varepsilon n^{2/3} k_B T}\right)}$ (4) $l = \sqrt{\left(\frac{q^2}{\varepsilon n^{1/3} k_B T}\right)}$

Q.16 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?

[JEE (Adv)-2016 (Paper-2)]

(1) The error in the measurement of r is 10%.
(2) The error in the measurement of T is 3.57%.
(3) The error in the measurement of T is 2%.
(4) The error in the determined value of g is 11.14%

Q.17 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 ms^{-2} and the velocity of sound is 300 ms^{-1}. Then the fractional error in the measurement, $\delta L/L$, is closest to

[JEE (Adv)-2017 (Paper-2)]

(1) 1% (2) 5% (3) 3% (4) 0.2%

Paragraph for Q. No. 18 and 19

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 question below, [E] and [B] stand for dimensions of electric and magnetic fields respectively, while e $[\in_0]$ 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. **[JEE (Adv)-2018 (Paper-1)]**

Choose the correct answer :

Q.18 The relation between [E] and [B] is

(1) $[E] = [B][L][T]$ (2) $[E] = [B][L]^{-1}[T]$
(3) $[E] = [B][L][T]^{-1}$ (4) $[E] = [B][L]^{-1}[T]$

Q.19 The relation between $[\in_0]$ and $[\mu_0]$ is

(1) $[\mu_0] = [\in_0][L]^2[T]^{-2}$
(2) $[\mu_0] = [\in_0][L]^{-2}[T]^2$
(3) $[\mu_0] = [\in_0]^{-1}[L]^2[T]^{-2}$
(4) $[\mu_0] = [\in_0]^{-1}[L]^{-2}[T]^2$

Q.20 A steel wire of diameter 0.5 mm and Young's modulus 2×10^{11} 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 ms^{-2} and $\pi = 3.2$.

[JEE (Adv)-2018 (Paper-2)]

Q.21 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?

[JEE (Adv)-2019 (Paper-1)]

(1) The dimension of force is L^{-3}
(2) The dimension of power is L^{-5}
(3) The dimension of linear momentum is L^{-1}
(4) The dimension of energy is L^{-2}

Q.22 Area of the cross-section of a wire is measured using a screw gauge. The pitch of the main scale is 0.5mm. The circular scale has 100 divisions and for one full rotation of the circular scale, the main scale shifts by two divisions. The measured readings are listed below. **[JEE Advanced 2022]**

Measurement condition	Main scale reading	Circular Scale reading
Two arms of gauge touching each other without wire	0 division	4 divisions
Attempt-1 With wire	4 divisions	20 divisions
Attempt-2 with wire	4 divisions	16 divisions

What are the diameter and cross- sectional area of the wire measured using the screw gauge?

(1) 2.22 ± 0.02 mm, $\pi\,(1.23 \pm 0.02)$ mm^2
(2) 2.22 ± 0.01 mm, $\pi\,(1.23 \pm 0.01)$ mm^2
(3) 2.14 ± 0.02 mm, $\pi\,(1.14 \pm 0.02)$ mm^2
(4) 2.14 ± 0.01 mm, $\pi\,(1.14 \pm 0.01)$ mm^2

Q.23 Young's modulus of elasticity Y is expressed in terms of three derived quantities, namely, the gravitational constant G, Planck's constant h and the speed of light c, as $Y = c^{\alpha}h^{\beta}G^{\gamma}$. Which of the following is the correct option?

[JEE Advanced 2023 (Paper-2)]

(1) $\alpha = 7, \beta = -1, \gamma = -2$
(2) $\alpha = -7, \beta = -1, \gamma = -2$
(3) $\alpha = 7, \beta = -1, \gamma = 2$
(4) $\alpha = -7, \beta = 1, \gamma = -2$

ANSWER KEY

JEE-FLASHBACK

JEE-Mains

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	2	2	4	2	1	2	2	4	1	2	3	1	1	3
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	3	2	1	4	1	4	1	4	4	3	1	3	3	1	3
Que.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
Ans.	1	2	3	2	2	2	1050	1	3	2	52	3	13	1	2
Que.	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	4	4	5	4	1	1	2	1	3	4	4	2	4	4	3
Que.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**					
Ans.	3	3	3	4	2	1	2	2	3	4					

JEE-Advanced

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	2,4	3,4	4	3	3	2	1	2	3	3	4	1,3,4	1,3	2,4
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**							
Ans.	1,2,4,	1	3	4	0.3	1,3,4	3	1							