Q1: NTA Test 01 (Single Choice)

If the units of mass, length and time are doubled then unit of angular momentum will be

(A) Doubled

(B) Tripled

(C) Quadrupled

(D) Eight times the original value

Q2: NTA Test 02 (Numerical)

Let ε_0 denote the dimensional formula of the permittivity of vacuum. If M = mass, L = length, T = time and A = electric current, then dimensions of permittivity is given as $\left[M^p L^q T^r A^s\right]$. Find the value of $\frac{p-q+r}{s}$

Q3: NTA Test 03 (Numerical)

Coefficient of thermal conductivity is the product of heat, distance and reciprocal of (area $\times$ difference in temperature $\times$ time). The new value of a unit of coefficient of thermal conductivity, if fundamental units are 21.6kg, 1 decimetre, 4 K and 1 minute will be ______ $\times 10^{-6}$ new units.

Q4: NTA Test 04 (Single Choice)

The potential difference across a resistor is measured to be $V = (8 \pm 0.5)$ V and the current through it is measured to be $I = (2 \pm 0.2)$ A, then the value of the resistance R is

(A) $4 \pm 16.25\%$

(B) $4 \pm 6.25\%$

(C) $4 \pm 10\%$

(D) $4 \pm 8\%$

Q5: NTA Test 05 (Single Choice)

A student performs an experiment to determine 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 $\pm$ 0.05 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 mm. The young's modulus obtained from the reading is [Take $g = 9.8$ ms^{-2}]

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

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

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

(D) $(2.0 \pm 0.05) \times 10^{11}$ Nm^{-2}

Q6: NTA Test 09 (Single Choice)

The accuracy in the measurement of time for 20 oscillations of a pendulum for the following measurements, $t_1 = 39.6$ s, $t_2 = 39.9$ s and $t_3 = 39.5$ s, is

(A) ± 0.2 s

(B) ± 0.3 s

(C) ± 0.5 s

(D) ± 0.4 s

Q7: NTA Test 10 (Single Choice)

If C (velocity of light), h (Planck's constant) and G (Universal gravitational constant) are taken as fundamental quantities, then the dimensional formula of mass is

(A) $h^{-\frac{1}{2}} G^{\frac{1}{2}} C^{o}$

(B) $h^{\frac{1}{2}} C^{\frac{1}{2}} G^{-\frac{1}{2}}$

(C) $h^{-\frac{1}{2}} C^{\frac{1}{2}} G^{-\frac{1}{2}}$

(D) $h^{-\frac{1}{2}} C^{-\frac{1}{2}} G^{-\frac{1}{2}}$

Q8: NTA Test 11 (Single Choice)

In a new system of units, the unit of force is 100 N, unit of length is 10 m and unit of time is 100 s. Unit of mass in this system can be expressed as

(A) 10^5 kg

(B) 10^6 kg

(C) 10^2 kg

(D) 10^3 kg

Q9: NTA Test 13 (Single Choice)

In CGS system of units, the density of a material is 4 g cm^{-3}. What will be the value of the density of the material in a system of units in which unit of length is 10 cm and unit of mass is 100 g?

(A) 0.04

(B) 0.4

(C) 40

(D) 400

Q10: NTA Test 14 (Single Choice)

If velocity, force and time are taken as the fundamental quantities, then using dimensional analysis choose the correct dimensional formula for mass among the following. [K is a dimensionless constant]

(A) $Q = K\, v^{-1}\, F\, T$

(B) $Q = K\, v^{3}\, F\, T^{2}$

(C) $Q = 2\, K\, v^{-1}\, F\, T$

(D) $Q = 3\, K\, v^{2}\, F\, T$

Q11: NTA Test 15 (Single Choice)

Suppose a quantity can be dimensionally represented in terms M, L and T, that is $[\text{y}] = [\text{M}^{\text{a}}\ \text{L}^{\text{b}}\ \text{T}^{\text{c}}]$. The quantity mass

(A) maybe represented in terms of L, T and y if $\text{a} = 0$

(B) maybe represented in terms of L, T and y if $\text{a} \neq 0$

(C) Can always be dimensionally represented in terms of L, T and y

(D) Can never be dimensionally represented in terms of L, T and y

Q12: NTA Test 16 (Single Choice)

In the formula, $a = 3bc^2$, a and c have dimensions of electric capacitance and magnetic field intensity respectively. The dimensions of b in S. I. system are

(A) $[\text{M}^{-3}\text{L}^{-2}\text{T}^{4}\text{Q}^{4}]$

(B) $[\text{M}^{-3}\text{T}^{4}\text{Q}^{4}]$

(C) $[\text{M}^{-3}\text{T}^{3}\text{Q}]$

(D) $[\text{M}^{-3}\text{L}^{2}\text{T}^{4}\text{Q}^{-4}]$

Q13: NTA Test 17 (Single Choice)

If $Z = \frac{A \sin\theta + B \cos\theta}{A+B}$; then

(A) the dimensions of Z and A are the same

(B) the dimensions of Z and B are the same

(C) Z is dimensionless quantity

(D) none of these

Q14: NTA Test 21 (Single Choice)

The length and breadth of a metal sheet are 3.124 m and 3.002 m respectively. The area of this sheet up to the correct number of significant figures is

(A) 9.378 m^2

(B) 9.37 m^2

(C) 9.378248 m^2

(D) 9.3782 m^2

Q15: NTA Test 23 (Single Choice)

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

(A) $\frac{\text{PQ}-\text{Q}^2}{\text{R}}$

(B) $\text{PQ} - \text{R}$

(C) $\frac{\text{PQ}}{\text{R}}$

(D) $\frac{(\text{PR}-\text{Q}^2)}{\text{R}}$

Q16: NTA Test 24 (Single Choice)

Two gold pieces, each of mass 0.035 g, are placed in a box of mass 2.3 g. The total mass of the box with gold pieces is

(A) 2.3 g

(B) 2.4 g

(C) 2.37 g

(D) 2.370 g

Q17: NTA Test 26 (Single Choice)

The correct dimensions of the coefficient of viscosity η are

(A) $\left[ML^{-1}T^{-2}\right]$

(B) $\left[MLT^{-1}\right]$

(C) $\left[ML^{-1}T^{-1}\right]$

(D) $\left[ML^{-2}T^{-2}\right]$

Q18: NTA Test 29 (Single Choice)

If speed V, force F and acceleration a are chosen as the fundamental physical quantities, then the dimension of Young's modulus in terms of V, F and a are

(A) $\left[V^{-3}\ Fa\right]$

(B) $\left[V^{-4}F^2a^2\right]$

(C) $\left[V^{-4}\ Fa^2\right]$

(D) $\left[V^{-4}F^2a\right]$

Q19: NTA Test 30 (Single Choice)

The focal length of a mirror is given by $\frac{2}{f} = \frac{1}{v} - \frac{1}{u}$. If in the measurement of u and v, the errors are equal to p each, then the relative error in f is

(A) $\frac{p}{2}\ \left(\frac{1}{u} + \frac{1}{v}\right)$

(B) $p\ \left(\frac{1}{u} + \frac{1}{v}\right)$

(C) $\frac{p}{2}\left(\frac{1}{u} - \frac{1}{v}\right)$

(D) $p\ \left(\frac{1}{u} - \frac{1}{v}\right)$

Q20: NTA Test 31 (Numerical)

The density of a sphere is measured by measuring the mass and diameter. If it is known that the maximum percentage errors in the measurement of mass and diameter are 2% and 3% respectively then the maximum percentage error in the measurement of density is

Q21: NTA Test 32 (Single Choice)

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 45^{th} 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 25^{th} division coincides with the main scale line?

(A) 0.70 mm

(B) 0.50 mm

(C) 0.75 mm

(D) 0.80 mm

Q22: NTA Test 33 (Single Choice)

In a simple pendulum experiment for determination of acceleration due to gravity (g), time taken for 20 oscillations is measures by using a watch of 1 second least count. The mean value of time taken comes out to be 30 s. The length of the 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

(A) 0.2%

(B) 6.8%

(C) 3.5%

(D) 0.7%

Q23: NTA Test 34 (Numerical)

A screw gauge with a pitch of 1 mm has 100 divisions on its circular scale. When it is used to measure the diameter of a thin wire, the main scale reading is 3 mm and the circular scale reading is 45. If D is the diameter of the wire in mm, then find the value of D.

Q24: NTA Test 35 (Numerical)

The lengths of sides of a cuboid are a, 2a and 3a. If the relative percentage error in the measurement of a is 1%, then what is the relative percentage error in the measurement of the volume of the cube.

Q25: NTA Test 36 (Single Choice)

The density of a cube is measured by measuring its mass and length of its sides. If the maximum errors in the measurement of its mass and length are 4% and 3%, respectively, then, the maximum error in density is

(A) 1%

(B) 7%

(C) 5%

(D) 13%

Q26: NTA Test 37 (Single Choice)

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

(A) 3.38 mm

(B) 3.32 mm

(C) 3.73 mm

(D) 3.67 mm

Q27: NTA Test 38 (Single Choice)

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

(A) 1%

(B) 2%

(C) 6%

(D) 8%

Q28: NTA Test 39 (Single Choice)

The dimensions of $\frac{a}{b}$, in the equation $P = \frac{a-t^2}{bx}$, where P is pressure, x is distance and t is time, are

(A) $[M^2LT^{-3}]$

(B) $[MT^{-2}]$

(C) $[ML^3T^{-1}]$

(D) $[LT^{-3}]$

Q29: NTA Test 40 (Single Choice)

If force F is related with distance x and time t as $F = A\sqrt{x} + Bt^2$, the dimensions of $\frac{A}{B}$ is

(A) $M^0L^{-1/2}T$

(B) $ML^{-1/2}T^{-2}$

(C) $M^0L^{-1/2}T^2$

(D) $M^0\ LT^{-2}$

Q30: NTA Test 41 (Single Choice)

If L, C and R denote the inductance, capacitance and resistance respectively, the dimensional formula for C^2LR is

(A) $[ML^{-2}\ T^{-1}I^0]$

(B) $[M^0L^0T^3]$

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

(D) $[M^0L^0T^2I^0]$

Q31: NTA Test 42 (Single Choice)

A spherical body, of mass m and radius r, is allowed to fall in a medium of viscosity η . The time in which the velocity of the body increases from 0 to 0. 63 times the terminal velocity (v) is called time constant (τ) . Dimensionally τ can be represented as

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

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

(C) $\sqrt{\frac{m}{6\pi\eta rv}}$

(D) None of these

Q32: NTA Test 43 (Numerical)

Dimensional analysis of the equation

$(\text{velocity})^x = (\text{pressure difference})^{3/2} \times (\text{density})^{-3/2}$,

gives the value of x as _______.

Q33: NTA Test 44 (Single Choice)

Dimensions of permeability (μ_0) are

(A) $[A^{-2}M^1L^1T^{-2}]$

(B) $[MLT^{-2}]$

(C) $[ML^0T^{-1}]$

(D) $[A^{-1}MLT^2]$

Q34: NTA Test 45 (Single Choice)

A wire has a mass $0.3 \ \pm 0.003$ g, radius $0.5 \ \pm 0.005$ mm and length $6 \ \pm 0.06$ cm. The maximum percentage error in the measurement of its density is

(A) 1

(B) 2

(C) 3

(D) 4

Q35: NTA Test 46 (Single Choice)

The velocity of water waves v may depend upon their wavelength λ , the density of water ρ and the acceleration due to gravity g . The method of dimensions gives the relation between these quantities as

(A) $v^2 \propto \rho g$

(B) $v^2 \propto g\lambda\rho$

(C) $v^2 \propto g\lambda$

(D) $v^2 \propto g^{-1}\lambda^{-3}$

Q36: NTA Test 47 (Single Choice)

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

(A) $T = k\sqrt{\rho r^3/S}$

(B) $T = k\sqrt{\rho^{1/2} r^3/S}$

(C) $T = k\sqrt{\rho r^3/S^{1/2}}$

(D) None of these

Answer Keys

Q1: (C)	**Q2:** 3	**Q3:** 02.50
Q4: (A)	**Q5:** (B)	**Q6:** (A)
Q7: (B)	**Q8:** (A)	**Q9:** (C)
Q10: (A)	**Q11:** (B)	**Q12:** (A)
Q13: (C)	**Q14:** (A)	**Q15:** (A)
Q16: (B)	**Q17:** (C)	**Q18:** (C)
Q19: (B)	**Q20:** 11	**Q21:** (D)
Q22: (B)	**Q23:** 3.45	**Q24:** 3
Q25: (D)	**Q26:** (A)	**Q27:** (D)
Q28: (B)	**Q29:** (C)	**Q30:** (B)
Q31: (D)	**Q32:** 3	**Q33:** (A)
Q34: (D)	**Q35:** (C)	**Q36:** (A)

Solutions

Q1: (C) Quadrupled

The dimensions of angular momentum are

$$J = \left[\mathrm{ML}^2 T^{-1}\right]$$

When units of mass, length and time are doubled, than

$$J' = \left[2\mathrm{M}(2\mathrm{L})^2(2\mathrm{T})^{-1}\right]$$

$$\Rightarrow \quad J' = 4\left[\mathrm{ML}^2\mathrm{T}^{-1}\right] = 4\ \mathrm{J}$$

Unit of angular momentum is quadrupled.

Q2: 3

From Coulomb's law,
$F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$
$\therefore \varepsilon_0 = \frac{q_1 q_2}{4\pi F r^2} = \frac{(A^1T^1)(A^1T^1)}{[M^1L^1T^{-2}][L^2]} = [M^{-1}L^{-3}T^4A^2]$
$\therefore p = -1, q = -3, r = 4, s = 2$
$\therefore \frac{p-q+r}{s} = \frac{-1-(-3)+4}{2} = \frac{6}{2} = 3$

Q3: 02.50

Coefficient of thermal conductivity, $k = \frac{Q \times l}{A \times \Delta\theta \times t}$

$\Rightarrow K = \frac{\frac{ml^2}{t^2} \times 1}{l^2 \times \Delta\theta \times t}$

$\Rightarrow K = \frac{m \times 1}{\Delta\theta \times t^3} = \frac{21.6 \times 0.1}{4 \times (60)^3}$

$= 2.5 \times 10^{-6}$ new units

Q4: (A) $4 \pm 16.25\%$

$V = (8 + 0.5)$

$I = (2 + 0.2)$

$R = \frac{8}{2} = 4$

$\frac{\Delta R}{R}\% = \left(\frac{\Delta V}{V} + \frac{\Delta I}{I}\right)$

$= \left(\frac{0.5}{8} + \frac{0.2}{2}\right) \times 100 = 16.25\%$

$\therefore \ R = (4 \pm 16.25\%)$

Q5: (B) $(2.0 \pm 0.2) \times 10^{11}\ \text{Nm}^{-2}$
Young's modulus $Y = \frac{FL}{Al} = \frac{4FL}{\pi d^2 l}$

$$= \frac{(4)(1.0 \times 9.8)(2)}{\pi(0.4 \times 10^{-3})^2(0.8 \times 10^{-3})}$$

$$= 2.0 \times 10^{11}\ \text{Nm}^{-2}$$

Further, $\frac{\Delta Y}{Y} = 2\left(\frac{\Delta d}{d}\right) + \left(\frac{\Delta l}{l}\right)$

$\therefore$ $$\Delta Y = \left\{2\left(\frac{\Delta d}{d}\right) + \left(\frac{\Delta l}{l}\right)\right\} Y$$

$$= \left\{2 \times \frac{0.01}{0.4} + \frac{0.05}{0.8}\right\} \times 2.0 \times 10^{11}$$

$$= 0.2 \times 10^{11}\ \text{Nm}^{-2}$$

Or $(Y + \Delta Y) = (2 + 0.2) \times 10^{11}\ \mathrm{Nm}^{-2}$

Q6: (A) ± 0.2 s

Given, $t_1 = 39.6$ s

$t_2 = 39.9$ s

$t_3 = 39.5$ s

Least count of measuring instrument = 0.1 s

[As measurements have only one decimal place] Precision in the measurement = Least count of the measuring instrument = 0.1 s

Mean value of time for 20 oscillations

$$t = \frac{t_1 - t_2 + t_3}{3} = \frac{39.6 + 39.9 + 39.5}{3} = 39.7\ \mathrm{s}$$

Absolute errors in the measurements

$$\Delta t_1 = t - t_1 = 39.7 - 39.6 = 0.1\mathrm{s}$$
$$\Delta t_2 = t - t_2 = 39.7 - 39.9 = -0.2\mathrm{s}$$
$$\Delta t_3 = t - t_3 = 39.7 - 39.5 = 0.2\mathrm{s}$$

Mean absolute error $= \frac{|\Delta t_1| + |\Delta t_2| + |\Delta t_3|}{3}$

$= \frac{0.1 + 0.2 + 0.2}{3} = \frac{0.5}{3} = 0.17 \approx 0.2$ (rounding-off upto one decimal place).

$\therefore$ Accuracy of measurement $= \pm 0.2$ s

Q7: (B) $h^{\frac{1}{2}}\ C^{\frac{1}{2}}\ G^{-\frac{1}{2}}$

Let, $M = C^a h^b G^c$

$ML^0T^0 = [LT^{-1}]^a\ [ML^2T^{-1}]^b\ [M^{-1}L^3T^{-2}]^c$ ......(i)

Where, $h = \frac{\text{Energy}}{\text{Freqyency}}$

$= \frac{[ML^2T^{-2}]}{[T^{-1}]} = [ML^2T^{-1}]$

$C = \frac{\text{Metre}}{\text{Second}} = [LT^{-1}]$

$G = \frac{\text{Force} \times (\text{distance})^2}{(\text{mass})^2}$

$= \frac{[MLT^{-2}][L^2]}{[M^2]} = [M^{-1}L^3T^{-2}]$

Comparing the coefficients M, L, T, of both sides we get

$b - c = 1$ ......(ii)

$a + 2b + 3c = 0$ ......(iii)

$-(a + b + 2c) = 0$ .....(iv)

Solve the equations (ii), (iii) and (iv), we get

$a = \frac{1}{2},\ b = \frac{1}{2},\ c = \ -\frac{1}{2}$

So, $M = h^{\frac{1}{2}}\ C^{\frac{1}{2}}\ G^{-\frac{1}{2}}$

Q8: (A) 10^5 kg

Here, force (F) = $[MLT^{-2}]$ = 100 N ...(i)

Length (L) = [L] = 10 m ...(ii)

Time (t) = [T] = 100 s ...(iii)

Substituting values of L and T from Equations. (ii) and (iii) in Equation. (i), we get

$$M \times 10 \times (100)^{-2} = 100$$

or $$\frac{M \times 10}{100 \times 100} = 100$$

or $$M = 100 \times 1000 \text{ kg}$$

$$M = 10^5 \text{ kg}$$

Q9: (C) 40

As $n_1 u_1 = n_2 u_2$

$4\ g\ cm^{-3} = n_2 \frac{100\ g}{(10\ cm)^3}$

$\Rightarrow n_2 = 40$

Q10: (A) $Q = K\ v^{-1}\ F\ T$

Let the quantity be Q, then,

$Q = f(v, F, T)$

Assuming that the function is the product of power functions of v, F and T,

$Q \ = \ Kv^x\ F^y\ T^z\ \ldots$ (i)

where K is a dimensionless constant of proportionality. The above equation dimensionally becomes

$$[Q] \ = \ [LT^{-1}]^x [MLT^{-2}]^y [T]^z$$

i.e., $[Q] \ = \ [M^y L^{(x+y)} T^{(-x-2y+z)}]$, Now

Q = mass i.e., $[Q] = [M]$

So Equation (ii) becomes

$[M] \ = \ [M^y L^{(x+y)} T^{(-x-2y+z)}]$

its dimensional correctness requires

$y = 1,\ x + y = 0$ and $-x - 2y + z = 0$

which on solving yields

$x = -1,\ y = 1$ and $z = 1$

Substituting it in Equation (i), we get

$Q = K\, v^{-1}\, F\, T$

Q11: (B) maybe represented in terms of L, T and y if a $\neq 0$

$\mathrm{M} = y^{\frac{1}{a}} . L^{-\frac{b}{a}} . T^{-\frac{c}{a}}$

where a should not be zero.

Q12: (A) $\left[\mathrm{M}^{-3} \mathrm{L}^{-2} \mathrm{T}^{4} \mathrm{Q}^{4}\right]$

Given, $a = 3bc^2$

$\Rightarrow \quad b = \frac{a}{3c^2}$

Writing dimensions for a and c, we have

$[b] = \frac{[Q/V]}{[B]^2} = \frac{[\mathrm{Q}]\left[\mathrm{ML}^2\mathrm{T}^{-2}\mathrm{Q}^{-1}\right]^{-1}}{\left[\mathrm{MT}^{-1}\mathrm{Q}^{-1}\right]^2}$

$= \left[\mathrm{M}^{-3}\mathrm{L}^{-2}\mathrm{T}^4\mathrm{Q}^4\right]$

Q13: (C) Z is dimensionless quantity

$Z = \frac{A \sin\theta + B\cos\theta}{A+B}$; Dimensions of A and B would be same as two quantities can be added only when they have same dimensions. So from given equation, we can say that Z is dimensionless.

Q14: (A) $9.378\ \mathrm{m}^2$

Area of metal sheet $= 3.124 \times 3.002\ \mathrm{m}^2$

$= 9.378248\ \mathrm{m}^2$

Now, the result must have significant figures equal to the least of figures being multiplied, so, area of metal sheet $= 9.378\ \mathrm{m}^2$ (four significant digits)

Q15: (A) $\frac{\mathrm{PQ}-\mathrm{Q}^2}{\mathrm{R}}$

$\frac{(\mathrm{P}-\mathrm{Q})\mathrm{Q}}{\mathrm{R}}$

Since P and Q have different dimensions, therefore, their subtraction is not possible

Q16: (B) $2.4\ \mathrm{g}$

$(2.3 + 0.035 + 0.035)\ g = 2.37\ g$

But we have to retain only one decimal place.

So, the total mass is $2.4\ g$

Q17: (C) $\left[ML^{-1}T^{-1}\right]$

Viscous force is given as, $F = 6\pi\eta rv$.

$\therefore \eta = \frac{F}{6\pi rv}$

$\left[\eta\right] = \frac{[F]}{[r][v]}$

$\left[\eta\right] = \frac{\left[MLT^{-2}\right]}{[L]\left[LT^{-1}\right]}$

Q18: (C) $\left[V^{-4}Fa^{2}\right]$

Let $Y = f(V,\ F,\ a)$

$\therefore Y = KV^{x}F^{y}a^{z}, \qquad K \rightarrow$ Unitless

$\therefore [Y] = [V]^{x}[F]^{y}[a]^{z}$

$\therefore \left[ML^{-1}T^{-2}\right] = \left[LT^{-1}\right]^{x}\left[MLT^{-2}\right]^{y}\left[LT^{-2}\right]^{z}$

$\therefore [M]\left[L^{-1}\right] = \left[T^{-2}\right] = [M]^{y}\left[L^{x+y+z}\right]\left[T^{-x-2y-2z}\right]$

$\therefore y = 1; \quad x + y + z = -1; \quad -x - 2y - 2z = 2$

$\therefore x + z = -2 \qquad \therefore x + 2y + 2z = 2$

$\therefore x + 2z = 0 \qquad \therefore z = 2,\ x = -4$

$\therefore [Y] = \left[V^{-4}Fa^{2}\right]$

Q19: (B) $p\ \left(\frac{1}{u} + \frac{1}{v}\right)$

Given, equation is $\frac{2}{f} = \frac{1}{v} - \frac{1}{u}$ ....(i)

Differentiating the given equation, we have

$-\frac{2}{f^{2}}\,df = -\frac{1}{v^{2}}dv - \left(-\frac{1}{u^{2}}\right)\ du$

$= -p\ \left(\frac{1}{v} - \frac{1}{u}\right)\ \left(\frac{1}{v} + \frac{1}{u}\right)\ \ (\because\ \ dv = du = p)$

$= \frac{-2p}{f}\left(\frac{1}{v} + \frac{1}{u}\right)$ [using Eq. (i)]

$\therefore\ \ \frac{df}{f} = p\ \left(\frac{1}{v} + \frac{1}{v}\right)$

Q20: 11

The density can be computed by

$\rho = \frac{m}{v} = \frac{m}{\frac{\pi d^3}{6}}$

or $\rho \propto \frac{m}{d^3}$

$\therefore \frac{\Delta\rho}{\rho} \times 100\% = \frac{\Delta m}{m} \times 100\% + 3\frac{\Delta d}{d} \times 100\%$

or $\frac{\Delta\rho}{\rho} \times 100 = 2 + 3 \times 3 = 11$

Hence, the percentage error in measurement of density is 11%

Q21: (D) 0.80 mm

$LC = \frac{0.5}{50} = 0.01$ mm

Zero error $= 0.50 - 0.45 = -0.05$

Thickness $= (0.5 + 25 \times 0.01) + 0.05$

$= 0.50 + 0.25 + 0.05$

$= 0.80$ mm

Q22: (B) 6.8%

$g = \frac{4\pi^2 l}{T^2}$

$\frac{\Delta g}{g} = \frac{\Delta l}{l} + \frac{2\Delta T}{T}$

$= \frac{0.1}{55} + 2 \times \left(\frac{1}{30}\right)$

$= 0.06848$

Percentage error $\approx 6.8\%$

Q23: 3.45

Least count $= \frac{\text{Pitch}}{\text{No. of division}} = \frac{1\text{mm}}{100} = 0.01$ mm

Diameter of wire = main scale + circular scale reading

$= 3$ mm $+ (L.C) \times$ No. of division

$= 3$ mm $+ 0.01 \times 45$

$D = 3.45$ mm

Q24: 3

$V = a \times 2a \times 3a$

$\Rightarrow V = 6a^3$

$\Rightarrow \frac{\Delta V}{V} = 3\frac{\Delta a}{a} = 3\%$

Q25: (D) 13%

$\rho = \frac{Mass}{L^3}$

% error in ρ = % error in mass + 3[% error in length]

$= 4\% + 3[3\%] = 13\%$

Q26: (A) 3.38 mm

Least count of the screw gauge,

$$= \frac{0.5 \text{ mm}}{50} = 0.01 \text{ mm}$$

Main scale reading $= 3 \text{ mm}$

Vernier scale reading$= 35$

$\therefore$ Observed reading $= 3 + 0.35 = 3.35$ mm
Zero error$=$ -0.03 mm

$\therefore$ Actual diameter of the wire$= 3.35 - (-0.03) = 3.38 \text{ mm}$

Q27: (D) 8%

$\therefore p = \frac{F}{A} = \frac{F}{l^2}$, so maximum error in pressure (p) is

$$\left(\frac{\Delta p}{p} \times 100\right)_{\max} = \frac{\Delta F}{F} \times 100 + 2\frac{\Delta l}{l} \times 100$$

$= 4\% + 2 \times 2\%$

$= 8\%$

Q28: (B) $[MT^{-2}]$
$P = \frac{a-t^2}{bx}$

$\Rightarrow \quad Pbx = a - t^2$

$\Rightarrow \quad [Pbx] = [a] = [t^2]$

Or $[b] = \frac{[t^2]}{[P][x]} = \frac{[T^2]}{[ML^{-1}T^{-2}][L]} = [M^{-1}T^4]$

$\therefore \quad \left[\frac{a}{b}\right] = \frac{[T^2]}{[M^{-1}T^4]} = [MT^{-2}]$

Q29: (C) $M^0L^{-1/2}T^2$

All terms of an equation must have same dimensions

$[MLT^{-2}] = [AL^{\frac{1}{2}}] = [BT^2]$

$[A] = \frac{MLT^{-2}}{\sqrt{L}}$

$[B] = \frac{MLT^{-2}}{T^2}$

Q30: (B) $\left[M^0L^0T^3\right]$
$\left[C^2LR\right] = \left[C^2L^2\right] \times \left[\frac{R}{L}\right]$

As $\frac{L}{R}$ and $\sqrt{LC}$ both have the dimensions of time, we get

$\left[C^2LR\right] = \left[M^0L^0T^4\right] \times \left[M^0L^0T^{-1}\right] = \left[M^0L^0T^3\right]$

Q31: (D) None of these

Time constant is the time of free fall of a body under gravity in the viscous medium, during which the velocity of the body increases to 63% of the terminal velocity. Dimensionally, none of the alternatives have dimensions of time.

Q32: 3

$(\text{velocity})^x = P^{3/2} \times \rho^{-3/2} = \left(\frac{P}{\rho}\right)^2$

$= \frac{\left[ML^{-1}T^{-2}\right]^{\frac{3}{2}}}{\left[ML^{-3}\right]}$
$= \left[L^2T^{-2}\right]^{3/2}$
$= \left[L^3T^{-3}\right]$
$= \left[L^1T^{-1}\right]^3$
But $\left[L^1T^{-1}\right]$ is the dimension of velocity.
$\Rightarrow x = 3$

Q33: (A) $\left[A^{-2}M^1L^1T^{-2}\right]$

$F = \frac{\mu_0}{4\pi}\frac{2I_1I_2l}{r} \Rightarrow \mu_0 = [F][A]^{-2} = \left[MLT^{-2}A^{-2}\right]$

Q34: (D) 4

Density

$\rho = \frac{m}{\pi r^2 L}$

$\therefore \frac{\Delta\rho}{\rho} \times 100 = \left(\frac{\Delta m}{m} + 2\frac{\Delta r}{r} + \frac{\Delta L}{L}\right) \times 100$

After substituting the values we get the maximum percentage error in density = 4%

Q35: (C) $v^2 \propto g\lambda$

Let $v^x = kg^y\lambda^z\rho^\delta$. Now by substituting the dimensions of each quantities and equating the powers of M, L and T we get $\delta = 0$ and
$x = 2, y = 1, z = 1$.

Q36: (A) $T = k\sqrt{\rho r^3/S}$

Let $T \propto S^x r^y \rho^z$ by substituting the dimension of $[T] = [T]$ $[S] = [MT^{-2}]$, $[r] = [L]$, $[\rho] = [ML^{-3}]$ and by comparing the power of both the sides $x = -1/2, y = 3/2, z = 1/2$ so $T \propto \sqrt{\rho r^3/S} \Rightarrow T = k\sqrt{\frac{\rho r^3}{S}}$