7 YEARS (2019 to 2025) JEE Main

All 143 Shifts

CHAPTER-WISE & TOPIC-WISE SOLVED PAPERS

CONCENTRATE ON RELEVANCE: 2019-25 REFLECTING REAL JEE PATTERNS

4000+ PYQs

2019
JEE TRANSFORMATION

- Shifted 100% Online
- Multiple Shifts Started in Jan & April
- Integer Type introduced from 2019-20
- More than enough (4000+) PYQs to practice

PHYSICS

100% Solved by Expert Faculties | 100% Verified from NTA Answer Keys

1 Units and Measurements

Units, System of Units

1. Match List-I with List-II.

	List-I		List-II
A.	Heat capacity of body	I.	$J\ kg^{-1}$
B.	Specific heat capacity of body	II.	JK^{-1}
C.	Latent heat	III.	$J\ kg^{-1}\ K^{-1}$
D.	Thermal conductivity	IV.	$Jm^{-1}\ K^{-1}s^{-1}$

Choose the correct answer from the options given below:

[02 April, 2025 (Shift-II)]

(*a*) (A)-(III), (B)-(I), (C)-(II), (D)-(IV)
(*b*) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)
(*c*) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)
(*d*) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)

2. Match **List-I** with **List-II**. **[29 Jan, 2025 (Shift-II)]**

	List-I		List-II
A.	Magnetic induction	I.	Ampere $meter^2$
B.	Magnetic intensity	II.	Weber
C.	Magnetic flux	III.	Gauss
D.	Magnetic moment	IV.	Ampere meter

Choose the **correct** answer from the options given below:

(*a*) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)
(*b*) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)
(*c*) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)
(*d*) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

3. Electric field in a certain region is given by $\vec{E} = \left(\frac{A}{x^2}\hat{i} + \frac{B}{y^3}\hat{j}\right)$.

The SI unit of A and B are: **[30 Jan, 2023 (Shift-I)]**

(*a*) $Nm^3C^{-1}; Nm^2C^{-1}$ (*b*) $Nm^2C^{-1}; Nm^3C^{-1}$
(*c*) $Nm^3C; Nm^2C$ (*d*) $Nm^2C; Nm^3C$

4. Match List-I with List-II. **[27 Aug, 2021 (Shift-II)]**

	List-I		List-II
A.	R_H (Rydberg constant)	I.	$kg\ m^{-1}\ s^{-1}$
B.	h(Planck's constant)	II.	$kg\ m^2\ s^{-1}$
C.	μ_B (Magnetic field energy density)	III.	m^{-1}
D.	η(coefficient of viscocity)	IV.	$kg\ m^{-1}\ s^{-2}$

(*a*) A-II, B-III, C-IV, D-I (*b*) A-III, B-II, C-I, D-IV
(*c*) A-III, B-II, C-IV, D-I (*d*) A-IV, B-II, C-I, D-III

5. If E and H represents the intensity of electric field and magnetising field respectively, then the unit of E/H will be:

[27 Aug, 2021 (Shift-I)]

(*a*) Joule (*b*) Newton (*c*) Ohm (*d*) Mho

6. 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 50 g, the numerical value of density of the material is

[10 Jan, 2019 (Shift-I)]

(*a*) 40 (*b*) 16 (*c*) 640 (*d*) 410

Dimension, Dimensional Formula

7. The dimension of $\sqrt{\frac{\mu_0}{\epsilon_0}}$ is equal to that of:

(μ_0 = Vacuum permeability and $\in_0$ = Vacuum permittivity)

[07 April, 2025 (Shift-II)]

(*a*) Voltage (*b*) Capacitance
(*c*) Inductance (*d*) Resistance

8. Match List-I with List-II.

	List-I		List-II
(A)	Mass density	(I)	$[ML^2\ T^{-3}]$
(B)	Impulse	(II)	$[MLT^{-1}]$
(C)	Power	(III)	$[ML^2\ T^0]$
(D)	Moment of inertia	(IV)	$[ML^{-3}\ T^0]$

Choose the correct answer from the options given below :

[07 April, 2025 (Shift-II)]

(*a*) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)
(*b*) (A)-(I), (B)-(III), (C)-(IV), (D)-(II)
(*c*) (A)-(IV), (B)-(II), (C)-(I), (D)-(III)
(*d*) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

9. Match the **LIST-I** with **LIST-II**

LIST-I		LIST-II	
A.	Boltzmann constant	I.	$ML^2\ T^{-1}$
B.	Coefficient of viscosity	II.	$MLT^{-3}\ K^{-1}$
C.	Planck's constant	III.	$ML^2\ T^{-2}\ K^{-1}$
D.	Thermal conductivity	IV.	$ML^{-1}\ T^{-1}$

Choose the **correct** answer from the options given below:

[03 April, 2025 (Shift-II)]

(*a*) A-III, B-IV, C-I, D-II (*b*) A-II, B-III, C-IV, D-I

(*c*) A-III, B-II, C-I, D-IV (*d*) A-III, B-IV, C-II, D-I

10. Given a charge q, current I and permeability of vacuum μ_0. Which of the following quantity has the dimension of momentum?

[02 April, 2025 (Shift-II)]

(*a*) qI/μ_0 (*b*) $q\mu_0 I$ (*c*) $q^2\mu_0 I$ (*d*) $q\mu_0/I$

11. If μ_0 and ε_0 are the permeability and permittivity of free space, respectively, then the dimension of $\left(\frac{1}{\mu_0\varepsilon_0}\right)$ is :

[02 April, 2025 (Shift-II)]

(*a*) L/T^2 (*b*) L^2/T^2 (*c*) T^2/L (*d*) T^2/L^2

12. If B is magnetic field and μ_0 is permeability of free space, then the dimensions of (B/μ_0) is: **[22 Jan, 2025 (Shift-I)]**

(*a*) $ML^2T^{-2}A^{-1}$ (*b*) $MT^{-2}A^{-1}$ (*c*) $LT^{-2}A^{-1}$ (*d*) $L^{-1}A$

13. Which one of the following is the correct dimensional formula for the capacitance in F? M, L, T and C stand for unit of mass, length, time and charge: **[22 Jan, 2025 (Shift-II)]**

(*a*) $[F] = [C^2M^{-1}\ L^{-2}\ T^2]$ (*b*) $[F] = [CM^{-2}\ L^{-2}\ T^{-2}]$

(*c*) $[F] = [CM^{-1}\ L^{-2}\ T^2]$ (*d*) $[F] = [C^2M^{-2}\ L^2\ T^2]$

14. The position of a particle moving on x-axis is given by $x(t) = A\sin t + B\cos^2 t + Ct^2 + D$, where t is time. The dimension of $\frac{ABC}{D}$ is

[23 Jan, 2025 (Shift-I)]

(*a*) L^3T^{-2} (*b*) L^2 (*c*) L^2T^{-2} (*d*) L

15. Match List - I with List - II.

List - I		List - II	
(A)	Permeability of free space	(I)	$[ML^2\ T^{-2}]$
(B)	Magnetic field	(II)	$[MT^{-2}A^{-1}]$
(C)	Magnetic moment	(III)	$[MLT^{-2}A^{-2}]$
(D)	Torsional constant	(IV)	$[L^2A]$

Choose the correct answer from the options given below:

[23 Jan, 2025 (Shift-II)]

(*a*) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)

(*b*) (A)-(III), (B)-(II), (C)-(IV), (D)-(I)

(*c*) (A)-(II), (B)-(I), (C)-(III), (D)-(IV)

(*d*) (A)-(I), (B)-(IV), (C)-(II), (D)-(III)

16. The energy E and momentum p of a moving body of mass m are related by some equation. Given that c represents the speed of light, identify the correct equation **[24 Jan, 2025 (Shift-II)]**

(*a*) $E^2 = pc^2 + m^2c^4$ (*b*) $E^2 = pc^2 + m^2c^2$

(*c*) $E^2 = p^2c^2 + m^2c^4$ (*d*) $E^2 = p^2c^2 + m^2c^2$

17. In a measurement, it is asked to find modulus of elasticity per unit torque applied on the system. The measured quantity has dimension of $[M^a\ L^b\ T^c]$. If $b = 3$, the value of c is______.

[28 Jan, 2025 (Shift-I)]

18. Match **List-I** with **List-II**. **[28 Jan, 2025 (Shift-II)]**

List-I		List-II	
A.	Angular Impulse	I.	$[M^0\ L^2\ T^{-2}]$
B.	Latent Heat	II.	$[M\ L^2\ T^{-3}A^{-1}]$
C.	Electrical resistivity	III.	$[M\ L^2\ T^{-1}]$
D.	Electromotive force	IV.	$[M\ L^3\ T^{-3}\ A^{-2}]$

Choose the correct answer from the options given below :

(*a*) (A)-(III), (B)-(I), (C)-(II), (D)-(IV)

(*b*) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(*c*) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

(*d*) (A)-(I), (B)-(III), (C)-(IV), (D)-(II)

19. The pair of physical quantities **not** having same dimensions is:

[29 Jan, 2025 (Shift-I)]

(*a*) Pressure and Young's modulus

(*b*) Surface tension and impulse

(*c*) Angular momentum and Planck's constant

(*d*) Torque and energy

20. The expression given below shows the variation of velocity (υ) with time (t), $\upsilon = At^2 + \frac{Bt}{C+t}$. The dimension of ABC is:

[29 Jan, 2025 (Shift-I)]

(*a*) $[M^0L^2T^{-2}]$ (*b*) $[M^0L^1T^{-3}]$ (*c*) $[M^0L^2T^{-3}]$ (*d*) $[M^0L^1T^{-2}]$

21. Match **List-I** with **List-II**. **[29 Jan, 2025 (Shift-II)]**

List-I		List-II	
A.	Young's Modulus	I.	$M\ L^{-1}\ T^{-1}$
B.	Torque	II.	$M\ L^{-1}\ T^{-2}$
C.	Coefficient of Viscosity	III.	$M^{-1}\ L^3\ T^{-2}$
D.	Gravitational Constant	IV.	$M\ L^2\ T^{-2}$

Choose the **correct** answer from the options given below:

(*a*) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)

(*b*) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(*c*) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

(*d*) (A)-(I), (B)-(III), (C)-(II), (D)-(IV)

22. The dimensional formula of latent heat is:

[09 April, 2024 (Shift-I)]

(*a*) $[M^0LT^{-2}]$ (*b*) $[MLT^{-2}]$ (*c*) $[M^0L^2T^{-2}]$ (*d*) $[ML^2T^{-2}]$

23. If ε_0 is the permittivity of free space and E is the electric field, then $\varepsilon_0 E^2$ has the dimensions: **[08 April, 2024 (Shift-II)]**

(*a*) $[M^o L^{-2}\ TA]$ (*b*) $[ML^{-1}\ T^{-2}]$

(*c*) $[M^{-1}L^{-3}T^4A^2]$ (*d*) $[ML^2\ T^{-2}]$

24. Given below are two statements:

Statement (I): Dimensions of specific heat is $[L^2T^{-2}K^{-1}]$

Statement (II): Dimensions of gas constant is $[ML^2T^{-1}K^{-1}]$

[06 April, 2024 (Shift-II)]

(*a*) Statement (I) is incorrect but statement (II) is correct

(*b*) Both statement (I) and statement (II) are incorrect

(*c*) Statement (I) is correct but statement (II) is incorrect

(*d*) Both statement (I) and statement (II) are correct

25. Match List I with List II

List-I		List-II	
A.	Torque	I.	$[M^1L^1T^{-2}A^{-2}]$
B.	Magnetic field	II.	$[L^2A^1]$
C.	Magnetic moment	III.	$[M^1T^{-2}A^{-1}]$
D.	Permeability of free space	IV.	$[M^1L^2T^{-2}]$

Choose the correct answer from the options given below:

[06 April, 2024 (Shift-I)]

(*a*) A-I, B-III, C-II, D-IV (*b*) A-IV, B-III, C-II, D-I
(*c*) A-III, B-I, C-II, D-IV (*d*) A-IV, B-II, C-III, D-I

26. What is the dimensional formula of ab^{-1} in the equation $\left(P+\frac{a}{V^2}\right)(V-b)=RT$, where letters have their usual meaning.

[05 April, 2024 (Shift-II)]

(*a*) $[M^0L^3T^{-2}]$ (*b*) $[ML^2T^{-2}]$ (*c*) $[M^{-1}L^5T^3]$ (*d*) $[M^6L^7T^4]$

27. If G be the gravitational constant and u be the energy density then which of the following quantity have the dimension as that the $\sqrt{uG}$: **[05 April, 2024 (Shift-I)]**

(*a*) Pressure gradient per unit mass
(*b*) Force per unit mass
(*c*) Gravitational potential
(*d*) Energy per unit mass

28. The dimensional formula of angular impulse is:

[1 Feb, 2024 (Shift-I)]

(*a*) $[M L^{-2} T^{-1}]$ (*b*) $[M L^2 T^{-2}]$ (*c*) $[M L T^{-1}]$ (*d*) $[M L^2 T^{-1}]$

29. Given below are two statements: **[27 Jan, 2024 (Shift-I)]**

Statement-I: Planck's constant and angular momentum have same dimensions.

Statement-II: Linear momentum and moment of force have same dimensions.

In the light of the above statements, choose the correct answer from the options given below:

(*a*) Statement-I is true but Statement-II is false
(*b*) Both Statement-I and Statement-II are false
(*c*) Both Statement-I and Statement-II are true
(*d*) Statement-I is false but Statement-II is true

30. Match List-I with List-II. **[30 Jan, 2024 (Shift-I)]**

List-I		List-II	
A.	Coefficient of viscosity	I.	$[M L^2T^{-2}]$
B.	Surface Tension	II.	$[M L^2T^{-1}]$
C.	Angular momentum	III.	$[M L^{-1}T^{-1}]$
D.	Rotational kinetic energy	IV.	$[M L^0T^{-2}]$

(*a*) A-II, B-I, C-IV, D-III (*b*) A-I, B-II, C-III, D-IV
(*c*) A-III, B-IV, C-II, D-I (*d*) A-IV, B-III, C-II, D-I

31. Match List-I with List-II.

List-I		List-I	
A.	Young's Modulus (Y)	I.	$[ML^{-1} T^{-1}]$
B.	Coefficient of Viscosity (η)	II.	$[ML^2 T^{-1}]$
C.	Planck's Constant (h)	III.	$[ML^{-1} T^{-2}]$
D.	Work Function (ϕ)	IV.	$[ML^2 T^{-2}]$

Choose the correct answer from the options given below:

[25 Jan, 2023 (Shift-II)]

(*a*) A-II, B-III, C-IV, D-I (*b*) A-III, B-I, C-II, D-IV
(*c*) A-I, B-III, C-IV, D-II (*d*) A-I, B-II, C-III, D-IV

32. Match List-I with List-II:

List-I (Physical Quantity)		List-II (Dimensional Formula)	
A.	Pressure gradient	I.	$[M^0 L^2 T^{-2}]$
B.	Energy density	II.	$[M^1 L^{-1} T^{-2}]$
C.	Electric Field	III.	$[M^1 L^{-2} T^{-2}]$
D.	Latent heat	IV.	$[M^1L^1T^{-3}A^{-1}]$

Choose the correct answer from the options given below:

[29 Jan, 2023 (Shift-I)]

(*a*) A-III, B-II, C-I, D-IV (*b*) A-II, B-III, C-IV, D-I
(*c*) A-III, B-II, C-IV, D-I (*d*) A-II, B-III, C-I, D-IV

33. Match List-I with List-II

List - I		List - II	
A.	Surface tension	I.	$Kgm^{-1} s^{-1}$
B.	Pressure	II.	$Kgms^{-1}$
C.	Viscosity	III.	$Kgm^{-1} s^{-2}$
D.	Impulse	IV.	Kgs^{-2}

Choose the correct answer from the options given below:

[25 Jan, 2023 (Shift-I)]

(*a*) A-(IV), B-(III), C-(II), D-(I)
(*b*) A-(IV), B-(III), C-(I), D-(II)
(*c*) A-(III), B-(IV), C-(I), D-(II)
(*d*) A-(II), B-(I), C-(III), D-(IV)

34. Match List-I with List-II

List-I		List-II	
A.	Spring constant	I.	(T^{-1})
B.	Angular speed	II.	(MT^{-2})
C.	Angular momentum	III.	(ML^2)
D.	Moment of Inertia	IV.	(ML^2T^{-1})

Choose the correct answer from the options given below:

[12 April, 2023 (Shift-I)]

(*a*) A-II, B-I, C-IV, D-III (*b*) A-IV, B-I, C-III, D-II
(*c*) A-II, B-III, C-I, D-IV (*d*) A-I, B-III, C-II, D-IV

35. Match List-I with List-II.

List-I		List-II	
A.	Angular momentum	I.	$[ML^2 T^{-2}]$
B.	Torque	II.	$[ML^{-2} T^{-2}]$
C.	Stress	III.	$[ML^2 T^{-1}]$
D.	Pressure gradient	IV.	$[ML^{-1} T^{-2}]$

Choose the correct answer from the options given below:

[31 Jan, 2023 (Shift-II)]

(*a*) A-I, B-IV, C-III, D-II (*b*) A-III, B-I, C-IV, D-II
(*c*) A-II, B-III, C-IV, D-I (*d*) A-IV, B-II, C-I, D-III

36. Match List-I with List-II.

List-I		List-II	
A.	Torque	I.	kg m^{-1} s^{-2}
B.	Energy density	II.	kg ms^{-1}
C.	Pressure gradient	III.	kg m^{-2} s^{-2}
D.	Impulse	IV.	kg m^2 s^{-2}

Choose the correct answer from the options given below:

[30 Jan, 2023 (Shift-II)]

(*a*) A-IV, B-III, C-I, D-II (*b*) A-I, B-IV, C-III, D-II
(*c*) A-IV, B-I, C-II, D-III (*d*) A-IV, B-I, C-III, D-II

37. Dimension of $\frac{1}{\mu_0 \in_0}$ should be equal to **[8 April, 2023 (Shift-I)]**

(*a*) T^2/L^2 (*b*) L/T (*c*) L^2/T^2 (*d*) T/L

38. Match List-I with List-II

List-I		List-II	
A.	Planck's constant (*h*)	I.	$[M^1 L^2 T^{-2}]$
B.	Stopping potential (*Vs*)	II.	$[M^1 L^1 T^{-1}]$
C.	Work function (ϕ)	III.	$[M^1 L^2 T^{-1}]$
D.	Momentum (*p*)	IV.	$[M^1 L^2 T^{-3} A^{-1}]$

[24 Jan, 2023 (Shift-I)]

(*a*) A-III, B-I, C-II, D-IV (*b*) A-III, B-IV, C-I, D-II
(*c*) A-II, B-IV, C-III, D-I (*d*) A-I, B-III, C-IV, D-II

39. Identify the pair of physical quantities that have same dimensions: **[24 June, 2022 (Shift-II)]**

(*a*) Velocity gradient and decay constant
(*b*) Wien's constant and Stefan constant
(*c*) Angular frequency and angular momentum
(*d*) Wave number and Avogadro number

40. The dimension of mutual inductance is: **[26 June, 2022 (Shift-II)]**

(*a*) $[ML^2 T^{-2}A^{-1}]$ (*b*) $[ML^2 T^{-3}A^{-1}]$
(*c*) $[ML^2 T^{-2}A^{-2}]$ (*d*) $[ML^2 T^{-3}A^{-2}]$

41. The SI unit of a physical quantity is pascal-second. The dimensional formula of this quantity will be **[27 June, 2022 (Shift-II)]**

(*a*) $[ML^{-1}T^{-1}]$ (*b*) $[ML^{-1}T^{-2}]$ (*c*) $[ML^2T^{-1}]$ (*d*) $[M^{-1}L^3T^0]$

42. If momentum [P], area [A] and time [T] are taken as fundamental quantities, then the dimensional formula for coefficient of viscosity is: **[25 July, 2022 (Shift-I)]**

(*a*) $[PA^{-1}T^0]$ (*b*) $[PAT^{-1}]$ (*c*) $[PA^{-1}T]$ (*d*) $[PA^{-1}T^{-1}]$

43. The dimensions of $\left(\frac{B^2}{\mu_0}\right)$ will be

(if μ_0 : permeability of free space and *B* : magnetic field)

[28 July, 2022 (Shift-I)]

(*a*) $[ML^2T^{-2}]$ (*b*) $[MLT^{-2}]$ (*c*) $[ML^{-1}T^{-2}]$ (*d*) $[ML^2T^{-2}A^{-1}]$

44. Which of the following physical quantities have the same dimensions? **[25 July, 2022 (Shift-I)]**

(*a*) Electric displacement ($\vec{D}$) and surface charge density
(*b*) Displacement current and electric field
(*c*) Current density and surface charge density
(*d*) Electric potential and energy

45. Match Column-I with Column-II.

Column-I		Column-II	
A.	Torque	p.	Nms^{-1}
B.	Stress	q.	J kg^{-1}
C.	Latent heat	r.	Nm
D.	Power	s.	Nm^{-2}

Choose the correct answer from the options given below

[29 July, 2022 (Shift-II)]

(*a*) A-(r); B-(q); C-(p); D-(s) (*b*) A-(r); B-(s); C-(q); D-(p)
(*c*) A-(s); B-(p); C-(r); D-(q) (*d*) A-(q); B-(r); C-(p); D-(s)

46. Identify the pair of physical quantities which have different dimensions: **[24 June, 2022 (Shift-I)]**

(*a*) Wave number and Rydberg's constant.
(*b*) Stress and Coefficient of elasticity.
(*c*) Coercivity and Magnetisation.
(*d*) Specific heat capacity and Latent heat.

47. Match List-I with List-II. **[27 July, 2021 (Shift-II)]**

List-I		List-II	
A.	Capacitance, C	I.	$M^1L^1T^{-3}A^{-1}$
B.	Permittivity of free space, ε_0	II.	$M^{-1}L^{-3}T^4 A^2$
C.	Permeability of free space, μ_0	III.	$M^{-1}L^{-2} T^4A^2$
D.	Electric field, E	IV.	$M^1L^1T^{-2}A^{-2}$

Choose the correct answer from the options given below:

(*a*) A-III, B-II, C-IV, D-I (*b*) A-III, B-IV, C-II, D-I
(*c*) A-IV, B-II, C-III, D-I (*d*) A-IV, B-III, C-II, D-I

48. If *E*, *L*, *M* and *G* denote the quantities as energy, angular momentum, mass and constant of gravitation respectively, then the dimensions of *P* in the formula $P = EL^2M^{-5}G^{-2}$ are :- **[26 Aug, 2021 (Shift-I)]**

(*a*) $[M^0 L^0 T^0]$ (*b*) $[M^1L^1T^{-2}]$ (*c*) $[M^0 L^1 T^0]$ (*d*) $[M^{-1}L^{-1}T^2]$

49. If '*C*' and '*V*' represent capacity and voltage respectively then what are the dimensions of λ where C/V = λ? **[26 Feb, 2021 (Shift-II)]**

(*a*) $[M^{-1}L^{-3}I^{-2}T^{-7}]$ (*b*) $[M^{-2}L^{-3}I^2T^6]$
(*c*) $[M^{-3}L^{-4}I^3T^7]$ (*d*) $[M^{-2}L^{-4}I^3T^7]$

50. Which of the following is not a dimensionless quantity?

[27 Aug, 2021 (Shift-I)]

(*a*) Relative magnetic permeability (μr)
(*b*) Power factor
(*c*) Quality factor
(*d*) Permeability of free space (μ_0)

51. Match List-I with List-II: **[25 Feb, 2021 (Shift-I)]**

List-I		List-I	
A.	*h* (Planck's constant)	I.	$[MLT^{-1}]$
B.	*E* (kinetic energy)	II.	$[ML^2T^{-1}]$
C.	*V* (electric potential)	III.	$[ML^2T^{-2}]$
D.	*P* (liner momentum)	IV.	$[ML^2I^{-1}T^{-3}]$

Choose the correct answer from the options given below:

(*a*) A-I, B-II, C-IV, D-III (*b*) A-III, B-II, C-IV, D-I
(*c*) A-II, B-III, C-IV, D-I (*d*) A-III, B-IV, C-II, D-I

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

[27 Aug, 2021 (Shift-II)]

(*a*) $[FL^{-3}T^2]$ (*b*) $[FL^{-5}T^2]$ (*c*) $[FL^{-4}T^2]$ (*d*) $[FL^{-3}T^3]$

53. Match List-I with List-II. **[31 Aug, 2021 (Shift-I)]**

List-I		List-I	
A.	Torque	I.	MLT^{-1}
B.	Impulse	II.	MT^{-2}
C.	Tension	III.	ML^2T^{-2}
D.	Surface Tension	IV.	MLT^{-2}

Choose the most appropriate answer from the option given below:
(*a*) A-II, B-I, C-IV, D-III (*b*) A-I, B-III, C-IV, D-II
(*c*) A-III, B-I, C-IV, D-II (*d*) A-III, B-IV, C-I, D-II

54. 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 **[8 April, 2019 (Shift-II)]**
(*a*) $S^{3/2}I^{1/2}h^0$ (*b*) $S^{1./2}I^{1/2}h^0$ (*c*) $S^{1/2}I^{1/2}h^{-1}$ (*d*) $S^{1/2}I^{3/2}h^{-1}$

55. Which of the following combinations has the dimension of electrical resistance ($\in_0$ is the permittivity of vacuum and μ_0 is the permeability of vacuum)? **[12 April, 2019 (Shift-I)]**
(*a*) $\sqrt{\frac{\in_0}{\mu_0}}$ (*b*) $\frac{\mu_0}{\in_0}$ (*c*) $\frac{\in_0}{\mu_0}$ (*d*) $\sqrt{\frac{\mu_0}{\in_0}}$

56. In SI units, the dimensions of $\sqrt{\frac{\varepsilon_0}{\mu_0}}$ is: **[8 April, 2019 (Shift-I)]**
(*a*) $[AT^{-3}ML^{3/2}]$ (*b*) $[A^{-1}TML^3]$
(*c*) $[A^2T^3M^{-1}L^{-2}]$ (*d*) $[AT^2M^{-1}L^{-1}]$

Dimensional Analysis, Principle of Homogeneity

57. The equation for real gas is given by $\left(P+\frac{a}{V^2}\right)(V-b)=RT$, where P, V, T and R are the pressure, volume, temperature and gas constant, respectively. The dimension of ab^{-2} is equivalent to that of: **[02 April, 2025 (Shift-I)]**
(*a*) Planck's constant (*b*) Compressibility
(*c*) Strain (*d*) Energy density

58. The electric flux is $\phi = \alpha\sigma + \beta\lambda$ where λ and σ are linear and surface charge density respectively, $\left(\frac{\alpha}{\beta}\right)$ represents. **[23 Jan, 2025 (Shift-I)]**
(*a*) charge (*b*) displacement
(*c*) area (*d*) electric field

59. Applying the principle of homogeneity of dimensions, determine which one is correct.
where T is time period, G is gravitational constant, M is mass, r is radius of orbit. **[04 April, 2024 (Shift-II)]**
(*a*) $T^2 = \frac{4\pi^2 r}{GM^2}$ (*b*) $T^2 = 4\pi^2 r^3$
(*c*) $T^2 = \frac{4\pi^2 r^3}{GM}$ (*d*) $T^2 = \frac{4\pi^2 r^2}{GM}$

60. Consider two physical quantities A and B related to each other as $E = \frac{B - x^2}{At}$ where E, x and t have dimensions of energy, length and time respectively. The dimension of AB is **[31 Jan, 2024 (Shift-II)]**
(*a*) $L^{-2}M^1T^0$ (*b*) $L^2M^{-1}T^1$ (*c*) $L^{-2}M^{-1}T^1$ (*d*) $L^0M^{-1}T^1$

61. A force is represented by $F = ax^2 + bt^{1/2}$ Where x = distance and t = time. The dimensions of b^2/a are: **[31 Jan, 2024 (Shift-I)]**
(*a*) $[ML^3T^{-3}]$ (*b*) $[MLT^{-2}]$ (*c*) $[ML^{-1}T^{-1}]$ (*d*) $[ML^2T^{-3}]$

62. If mass is written as $m = k\, c^P\, G^{-1/2}\, h^{1/2}$ then the value of P will be : (Constants have their usual meaning with k a dimensionless constant) **[30 Jan, 2024 (Shift-II)]**
(*a*) 1/2 (*b*) 1/3 (*c*) 2 (*d*) –1/3

63. 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 $\frac{a}{b^2}$ is similar to that of: **[27 Jan, 2024 (Shift-II)]**
(*a*) PV (*b*) P (*c*) RT (*d*) R

64. If the velocity of light c, universal gravitational constant G and planck's constant h are chosen as fundamental quantities. The dimensions of mass in the new system is: **[1 Feb, 2023 (Shift-II)]**
(*a*) $\left[h^{\frac{1}{2}}c^{-\frac{1}{2}}G^1\right]$ (*b*) $[h^1c^1G^1]$ (*c*) $\left[h^{-\frac{1}{2}}c^{\frac{1}{2}}G^{\frac{1}{2}}\right]$ (*d*) $\left[h^{\frac{1}{2}}c^{\frac{1}{2}}G^{-\frac{1}{2}}\right]$

65. $\left(P+\frac{a}{V^2}\right)(V-b)=RT$ 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: **[1 Feb, 2023 (Shift-I)]**
(*a*) Bulk modulus (*b*) Modulus of rigidity
(*c*) Compressibility (*d*) Energy density

66. 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 $[T^{-1}]$. **[29 Jan, 2023 (Shift-II)]**
(*a*) $A = [L^{-1}T]$, $B = [LT^{-1}]$ (*b*) $A = [LT]$, $B = [L^{-1}T^{-1}]$
(*c*) $A = [L^{-1}T^{-1}]$, $B = [LT^{-1}]$ (*d*) $A = [L^{-1}T^{-1}]$, $B = [LT]$

67. The frequency (ν) of an oscillating liquid drop may depend upon radius (r) of the drop, density (ρ) of liquid and the surface tension (s) of the liquid as: $\nu = r^a \rho^b s^c$. The values of a, b and c respectively are **[24 Jan, 2023 (Shift-II)]**
(*a*) $\left(-\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}\right)$ (*b*) $\left(\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}\right)$
(*c*) $\left(\frac{3}{2}, \frac{1}{2}, -\frac{1}{2}\right)$ (*d*) $\left(-\frac{3}{2}, \frac{1}{2}, \frac{1}{2}\right)$

68. If force (F), velocity (V) and time (T) are considered as fundamental physical quantity, then dimensional formula of density will be: **[11 Apr, 2023 (Shift-II)]**
(*a*) $FV^{-2}T^2$ (*b*) $FV^{-4}T^{-2}$ (*c*) FV^4T^{-6} (*c*) $F^2V^2T^2$

69. In the equation $\left[X+\frac{a}{Y^2}\right][Y-b]=RT, X$ is pressure, Y is volume, R is universal gas constant and T is temperature. The physical quantity equivalent to the ratio $\frac{a}{b}$ is : **[13 Apr, 2023 (Shift-II)]**
(*a*) Energy (*b*) Impulse
(*c*) Pressure gradient (*d*) Coefficient of viscosity

70. Velocity (υ) and acceleration (a) in two systems of units 1 and 2 are related as $\upsilon_2 = \frac{n}{m^2}\upsilon_1$ and $a_2 = \frac{a_1}{mn}$ respectively. Here m and n are constants. The relations for distance and time in two system respectively are: **[28 June, 2022 (Shift-II)]**

(*a*) $\frac{n^3}{m^3}L_1 = L_2$ and $\frac{n^2}{m}T_1 = T_2$ (*b*) $L_1 = \frac{n^4}{m^2}L_2$ and $T_1 = \frac{n^2}{m}T_2$

(*c*) $L_1 = \frac{n^2}{m}L_2$ and $T_1 = \frac{n^4}{m^2}T_2$ (*d*) $\frac{n^2}{m}L_1 = L_2$ and $\frac{n^4}{m^2}T_1 = T_2$

71. An expression of energy density is given by $u = \frac{\alpha}{\beta}\sin\left(\frac{\alpha x}{kt}\right)$, where α, β are constants, x is displacement, k is Boltzmann constant and t is the temperature. The dimensions of β will be: **[27 July, 2022 (Shift-II)]**

(*a*) $[ML^2T^{-2}\theta^{-1}]$ (*b*) $[M^0L^2T^{-2}]$
(*c*) $[M^0L^0T^0]$ (*d*) $[M^0L^2T^0]$

72. 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. **[28 July, 2022 (Shift-II)]**

(*a*) Dimension of β is same as that of force.
(*b*) Dimension of $\alpha^{-1}x$ is same as that of energy.
(*c*) Dimension of $\eta^{-1}\sin\theta$ is same of $\alpha\beta$.
(*d*) Dimension of α is same of β.

73. An expression for a dimensionless quantity P is given by $P = \frac{\alpha}{\beta}\log_e\left(\frac{kt}{\beta x}\right)$; where α and β are constants, x is distance; k is Boltzmann constant and t is the temperature. Then the dimensions of α will be: **[26 June, 2022 (Shift-I)]**

(*a*) $[M^0L^{-1}T^0]$ (*b*) $[ML^0T^{-2}]$ (*c*) $[MLT^{-2}]$ (*d*) $[ML^2T^{-2}]$

74. In Vander Waals equation $\left[P + \frac{a}{V^2}\right][V - b] = RT$; P is pressure. V is volume, R is universal gas constant and T is temperature. The ratio of constants a/b is dimensionally equal to **[29 June, 2022 (Shift-I)]**

(*a*) P/V (*b*) V/P (*c*) PV (*d*) PV^3

75. 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: **[20 July, 2021 (Shift-II)]**

(*a*) $[t^{-2}\,v^{-1}\,\ell^{1}]$ (*b*) $[t^{-1}\,v^{1}\,\ell^{-2}]$ (*c*) $[t^{-1}\,v^{-2}\,\ell^{1}]$ (*d*) $[t^{1}\,v^{2}\,\ell^{-1}]$

76. In a typical combustion engine the work done by a gas molecule is given by $W = \alpha^2\beta e^{-\frac{\beta x^2}{kT}}$, where x is the displacement, k is the Boltzmann constant and T is the temperature. If α and β are constants, dimensions of α will be : **[26 Feb, 2021 (Shift-I)]**

(*a*) $[MLT^{-1}]$ (*b*) $[M^0\,L\,T^0]$ (*c*) $[M^2LT^{-2}]$ (*d*) $[MLT^{-2}]$

77. Which of the following equations is dimensionally incorrect? Where t = time, h = height, s = surface tension, θ = angle, ρ = density, r = radius, g = acceleration due to gravity, v = volume, p = pressure, W = work done, τ = torque, $\in$ = permittivity, E = electric field, J = current density, L = length. **[31 Aug, 2021 (Shift-I)]**

(*a*) $W = \tau\theta$ (*b*) $h = \frac{2s\cos\theta}{\rho rg}$ (*c*) $v = \frac{\pi p a^4}{8\eta L}$ (*d*) $J = \in\frac{\partial E}{\partial t}$

78. 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 dimensions of: **[25 Feb, 2021 (Shift-II)]**

(*a*) $[M\,L\,T^0]$ (*b*) $[M\,L\,T^{-1}]$ (*c*) $[M^0\,L^0\,T^0]$ (*d*) $[L\,C^{-1}]$

79. 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 dimensions of β will be: **[24 Feb, 2021 (Shift-I)]**

(*a*) $[MLT^{-2}]$ (*b*) $[ML^2T^{-2}]$ (*c*) $[M^2LT^2]$ (*d*) $[M^0LT^0]$

80. If velocity $[V]$, time $[T]$ and force $[F]$ are chosen as the base quantities, the dimensions of the mass will be : **[31 Aug, 2021 (Shift-II)]**

(*a*) $[FT^2\,V]$ (*b*) $[FTV^{-1}]$ (*c*) $[FVT^{-1}]$ (*d*) $[FT^{-1}\,V^{-1}]$

81. The force is given in terms of time t and displacement x by the equation $F = A\cos Bx + C\sin Dt$. The dimensional formula of AD/B is **[25 July, 2021 (Shift-II)]**

(*a*) $[M^2L^2T^{-3}]$ (*b*) $[M^1L^1T^{-2}]$ (*c*) $[ML^2T^{-3}]$ (*d*) $[M^0LT^{-1}]$

82. The dimension of stopping potential V_0 in photoelectric effect in units of Planck's constant 'h', speed of light 'c' and Gravitational constant 'G' and ampere A is: **[24 Feb, 2021 (Shift-I)]**

(*a*) $h^{1/3}G^{2/3}c^{1/3}A^{-1}$ (*b*) $h^{-2/3}c^{-1/3}G^{4/3}A^{-1}$
(*c*) $h^{2/3}c^{5/3}G^{1/3}A^{-1}$ (*d*) $h^2G^{3/2}c^{1/3}A^{-1}$

83. Dimensional formula for thermal conductivity is (here K denotes the temperature): **[04 Sep, 2020 (Shift-I)]**

(*a*) $MLT^{-3}\,K^{-1}$ (*b*) $MLT^{-2}\,K^{-2}$ (*c*) $MLT^{-2}\,K$ (*d*) $MLT^{-3}\,K$

84. 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 **[3 Sep, 2020 (Shift-II)]**

(*a*) ML^2T^{-2} (*b*) MLT^{-2} (*c*) $M^2L^0T^{-1}$ (*d*) ML^0T^{-3}

85. 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 **[04 Sep, 2020 (Shift-II)]**

(*a*) Coefficient of viscosity (*b*) Force constant
(*c*) Energy density (*d*) Planck's constant

86. A quantity f is given by $f = \sqrt{\frac{hc^5}{G}}$ where c is speed of light, G universal gravitational constant and h is the Planck's constant. Dimension of f is that of: **[9 Jan, 2020 (Shift-I)]**

(*a*) energy (*b*) momentum (*c*) area (*d*) volume

87. If speed V, area A and force F are chosen as fundamental units, then the dimension of Young's modulus will be **[2 Sep, 2020 (Shift-I)]**

(*a*) $FA^{-1}V^0$ (*b*) FA^2V^{-1} (*c*) FA^2V^{-2} (*d*) FA^2V^{-3}

88. If momentum (P), area (A) and time (T) are taken to be the fundamental quantities then the dimensional formula for energy is **[2 Sep, 2020 (Shift-II)]**

(*a*) $\left[P^{\frac{1}{2}}AT^{-1}\right]$ (*b*) $[P^2AT^{-2}]$ (*c*) $\left[PA^{\frac{1}{2}}T^{-1}\right]$ (*b*) $[PA^{-1}T^{-2}]$

89. The quantities $x = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$, $y = \frac{E}{B}$ 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 permitivity and permeability respectively. Then **[5 Sep, 2020 (Shift-II)]**

(*a*) Only x and y have the same dimension.
(*b*) Only x and z have the same dimension.
(*c*) x, y and z have the same dimension.
(*d*) Only y and z have the same dimension.

90. Expression for time in terms of G (universal gravitational constant), h (Planck constant) and c (speed of light) is proportional to: **[9 Jan, 2019 (Shift-II)]**

(a) $\sqrt{\frac{hc^5}{G}}$ (b) $\sqrt{\frac{c^3}{Gh}}$ (c) $\sqrt{\frac{Gh}{c^5}}$ (d) $\sqrt{\frac{Gh}{c^3}}$

91. 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: **[11 Jan, 2019 (Shift-I)]**

(a) $[M^0L^2T^{-4}]$ (b) $[M^2LT^{-4}]$ (c) $[MLT^{-2}]$ (d) $[M^2L^2T^{-2}]$

92. If speed (V), acceleration (A) and force (F) are considered as fundamental units, the dimension of Young's modulus will be: **[11 Jan, 2019 (Shift-II)]**

(a) $V^{-2}A^2F^{-2}$ (b) $V^{-2}A^2F^2$ (c) $V^{-4}A^{-2}F$ (d) $V^{-4}A^2F$

93. Let L, R, C and V represent inductance, resistance, capacitance and voltage, respectively. The dimension of $\frac{L}{RCV}$ in SI units will be: **[12 Jan, 2019 (Shift-II)]**

(a) $[LA^{-2}]$ (b) $[A^{-1}]$ (c) $[LTA]$ (d) $[LT^2]$

Errors in Measurement

94. A physical quantity C is related to four other quantities p, q, r and s as follows

$$C = \frac{pq^2}{r^3\sqrt{s}}$$

The percentage errors in the measurement of p,q,r and s are 1%, 2%, 3% and 2% respectively.

The percentage error in the measurement of C will be ________ %. **[03 April, 2025 (Shift-II)]**

95. The maximum percentage error in the measurement of density of a wire is: **[22 Jan, 2025 (Shift-II)]**

[Given, mass of wire = (0.60± 0.003)g
radius of wire = (0.50 ± 0.01)cm
length of wire = (10.00 ± 0.05)cm]

(a) 5 (b) 8 (c) 4 (d) 7

96. The energy of a system is given as $E(t) = \alpha^3 e^{-\beta t}$, where t is the time and $\beta = 0.3\ s^{-1}$. The errors in the measurement of α and t are 1.2% and 1.6%, respectively. At $t = 5$ s, maximum percentage error in the energy is: **[23 Jan, 2025 (Shift-II)]**

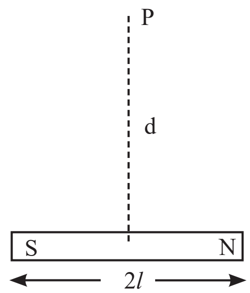
(a) 8.4% (b) 11.6% (c) 6% (d) 4%

97. For an experimental expression $y = \frac{32.3 \times 1125}{27.4}$, where all the digits are significant. Then to report the value of y we should write **[24 Jan, 2025 (Shift-I)]**

(a) $y = 1326.2$ (b) $y = 1330$
(c) $y = 1326.186$ (d) $y = 1326.19$

98. A tiny metallic rectangular sheet has length and breadth of 5 mm and 2.5 mm , respectively. Using a specially designed screw gauge which has pitch of 0.75 mm and 15 divisions in the circular scale, you are asked to find the area of the sheet. In this measurement, the maximum fractional error will be $\frac{x}{100}$ where x is ________. **[28 Jan, 2025 (Shift-I)]**

99.



A bar magnet has total length 2l = 20 units and the field point P is at a distance d =10 units from the centre of the magnet, If the relative uncertainty of length measurement is 1%, then uncertainty of the magnetic field at point P is: **[28 Jan, 2025 (Shift-II)]**

(a) 3% (b) 5 % (c) 4 % (d) 10 %

100. A Physical quantity Q is related to four observables a, b, c, d as follows: $Q = \frac{ab^4}{cd}$, where, $a = (60 \pm 3)$Pa; $b = (20 \pm 0.1)$m; $c = (40 \pm 0.2)$Nsm^{-2} and $d = (50 \pm 0.1)$m, then the percentage error in Q is $\frac{x}{1000}$, where x = ___________. **[29 Jan, 2025 (Shift-II)]**

101. Young's modulus is determined by the equation given by $Y = 49000 \frac{m}{\ell} \frac{\text{dyne}}{\text{cm}^2}$ where m is the mass and ℓ is the extension of wire used in the experiment. Now error in Young modules (Y) is estimated by taking data from m-ℓ plot in graph paper. The smallest scale divisions are 5 g and 0.02 cm along load axis and extension axis respectively. If the value of m and ℓ are 500 g and 2 cm respectively then percentage error of Y is: **[08 April, 2024 (Shift-I)]**

(a) 0.2% (b) 0.02% (c) 2% (d) 0.5%

102. In an expression $a \times 10^b$: **[08 April, 2024 (Shift-I)]**

(a) a is order of magnitude for $b \le 5$
(b) b is order of magnitude for $a \le 5$
(c) b is order of magnitude for $5 < a \le 10$
(d) b is order of magnitude for $a \ge 5$

103. To find the spring constant (k) of a spring experimentally, a student commits 2% positive error in the measurement of time and 1% negative error in measurement of mass. The percentage error in determining value of k is: **[06 April, 2024 (Shift-I)]**

(a) 3% (b) 1% (c) 4% (d) 5%

104. Time periods of oscillation of the same simple pendulum measured using four different measuring clocks were recorded as 4.62 s, 4.632 s, 4.6 s and 4.64 s. The arithmetic mean of these reading in correct significant figure is. **[05 April, 2024 (Shift-I)]**

(a) 4.623 s (b) 4.62 s (c) 4.6 s (d) 5 s

105. In an experiment to measure focal length (f) of convex lens, the least counts of the measuring scales for the position of object (u) and for the position of image (v) are Δu and Δv, respectively. The error in the measurement of the focal length of the convex lens will be: **[04 April, 2024 (Shift-I)]**

(a) $\frac{\Delta u}{u} + \frac{\Delta v}{v}$ (b) $f^2\left[\frac{\Delta u}{u^2} + \frac{\Delta v}{v^2}\right]$

(c) $2f\left[\frac{\Delta u}{u} + \frac{\Delta v}{v}\right]$ (d) $f\left[\frac{\Delta u}{u} + \frac{\Delta v}{n}\right]$

106. Match List-I with List-II.

List-I (Number)		List-II (Significant figure)	
(A)	1001	(I)	3
(B)	010.1	(II)	4
(C)	100.100	(III)	5
(D)	0.0010010	(IV)	6

Choose the correct answer from the options given below:

[1 Feb, 2024 (Shift-II)]

(*a*) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)
(*b*) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)
(*c*) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)
(*d*) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

107. The radius (r), length (l) and resistance (R) of a metal wire was measured in the laboratory as

$r = (0.35 \pm 0.05)$ cm, $R = (100 \pm 10)$ ohm, $l = (15 \pm 0.2)$ cm

The percentage error in resistivity of the material of the wire is:

[1 Feb, 2024 (Shift-I)]

(*a*) 25.6% (*b*) 39.9% (*c*) 37.3% (*d*) 35.6%

108. The measured value of the length of a simple pendulum is 20 cm with 2 mm accuracy. The time for 50 oscillations was measured to be 40 seconds with 1 second resolution. From these measurements, the accuracy in the measurement of acceleration due to gravity is N%. The value of N is: **[31 Jan, 2024 (Shift-II)]**

(*a*) 4 (*b*) 8 (*c*) 6 (*d*) 5

109. If the percentage errors in measuring the length and the diameter of a wire are 0.1% each. The percentage error in measuring its resistance will be: **[31 Jan, 2024 (Shift-I)]**

(*a*) 0.2% (*b*) 0.3% (*c*) 0.1% (*d*) 0.144%

110. The resistance R = $\frac{V}{I}$ where V = (200 ± 5)V and I = (20 ± 0.2)A, the percentage error in the measurement of R is:

[29 Jan, 2024 (Shift-I)]

(*a*) 3.5% (*b*) 7% (*c*) 3% (*d*) 5.5%

111. A physical quantity Q is found to depend on quantities a, b, c by the relation $Q = \frac{a^4 b^3}{c^2}$ The percentage error in a, b and c are 3%, 4% and 5% respectively. Then, the percentage error in Q is:

[29 Jan, 2024 (Shift-II)]

(*a*) 66% (*b*) 43% (*c*) 33% (*d*) 14%

112. A 2 meter long scale with least count of 0.2 cm is used to measure the locations of objects on an optical bench. While measuring the focal length of a convex lens, the object pin and the convex lens are placed at 80 cm mark and 1m mark respectively. The image of the object pin on the other side of lens coincides with image pin that is kept at 180 cm mark. The % error in the estimation of focal length is: **[06 Apr, 2023 (Shift-II)]**

(*a*) 1.02 (*b*) 0.85 (*c*) 1.70 (*d*) 0.51

113. A physical quantity P is given as

$$P = \frac{a^2 b^3}{c\sqrt{d}}$$

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 **[10 Apr, 2023 (Shift-I)]**

(*a*) 13% (*b*) 14% (*c*) 12% (*d*) 16%

114. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R

Assertion A: A spherical body of radius (5 ± 0.1) mm having a particular density is falling through a liquid of constant density. The percentage error in the calculation of its terminal velocity is 4%.

Reason R: The terminal velocity of the spherical body falling through the liquid is inversely proportional to its radius.

In the light of the above statements, choose the correct answer from the options given below **[13 Apr, 2023 (Shift-II)]**

(*a*) Both A and R are true but R is not the correct explanation of A
(*b*) Both A and R are true and R is the correct explanation of A
(*c*) A is false but R is true
(*d*) A is true but R is false

115. Two resistances are given as $R_1 = (10 \pm 0.5)\Omega$ and $R_2 = (15 \pm 0.5\ \Omega$. The percentage error in the measurement of equivalent resistance when they are connected in parallel is **[6 Apr, 2023 (Shift-I)]**

(*a*) 6.33 (*b*) 2.33 (*c*) 4.33 (*d*) 5.33

116. A body of mass (5 ± 0.5) kg is moving with a velocity of (20 ± 0.4) m/s. Its kinetic energy will be **[13 Apr, 2023 (Shift-I)]**

(*a*) (1000 ± 140) J (*b*) (1000 ± 0.14) J
(*c*) (500 ± 0.14) J (*d*) (500 ± 140) J

117. A cylindrical wire of mass (0.4 ± 0.01)g has length (8 ± 0.04) cm and radius (6 ± 0.03) mm. The maximum error in its density will be **[08 Apr, 2023 (Shift-I)]**

(*a*) 1% (*b*) 3.5% (*c*) 4% (*d*) 5%

118. If $Z = \frac{A^2 B^3}{C^4}$, then the relative error in Z will be:

[25 June, 2022 (Shift-I)]

(*a*) $\frac{\Delta A}{A} + \frac{\Delta B}{B} + \frac{\Delta C}{C}$ (*b*) $\frac{2\Delta A}{A} + \frac{3\Delta B}{B} - \frac{4\Delta C}{C}$

(*c*) $\frac{2\Delta A}{A} + \frac{3\Delta B}{B} + \frac{4\Delta C}{C}$ (*b*) $\frac{\Delta A}{A} + \frac{\Delta B}{B} - \frac{\Delta C}{C}$

119. In an experiment to determine the Young's modulus of wire of a length exactly 1 m, the extension in the length of the wire is measured as 0.4 mm with an uncertainty of ±0.02 mm when a load of 1 kg is applied. The diameter of the wire is measured as 0.4 mm with an uncertainty of ±0.01mm.

The error in the measurement of Young's modulus (ΔY) is found to be $x \times 10^{10}$Nm^{-2}. The value of x is ________.

(take g = 10 ms^{-2}) **[26 July, 2022 (Shift-I)]**

120. A torque meter is calibrated to reference standards of mass, length and time each with 5% accuracy. After calibration, the measured torque with this torque meter will have net accuracy of

[27 July, 2022 (Shift-I)]

(*a*) 15% (*b*) 25% (*c*) 75% (*d*) 5%

121. A silver wire has a mass (0.6 ± 0.006)g, radius (0.5 ± 0.005)mm and length(4 ± 0.04) cm. The maximum percentage error in the measurement of its density will be: **[27 June, 2022 (Shift-I)]**

(*a*) 4% (*b*) 3% (*c*) 6% (*d*) 7%

122. For $z = a^2 x^3 y^{\frac{1}{2}}$, where '$a$' is a constant. If percentage error in measurement of 'x' and 'y' are 4% and 12% respectively, then the percentage error for 'z' will be ____________ %.

[25 June, 2022 (Shift-I)]

123. A student in the laboratory measures thickness of a wire using screw gauge. The readings are 1.22 mm, 1.23 mm, 1.19 mm and 1.20 mm. The percentage error is $\frac{x}{121}$%. The value of x is ________.

[28 June, 2022 (Shift-II)]

124. In experiment to find acceleration due to gravity (g) using simple pendulum, time period of 0.5 s is measured from time of 100 oscillation with a watch of 1 s resolution. If measured value of length is 10 cm known to 1 mm accuracy, The accuracy in the determination of g is found to be x %. The value of x is ______.

[28 July, 2022 (Shift-II)]

125. 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, and 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

[6 Sep, 2022 (Shift-II)]

(*a*) (5.5375 ± 0.0739) mm (*b*) (5.54 ± 0.07) mm
(*c*) (5.538 ± 0.074) mm (*d*) (5.5375 ± 0.0740) mm

126. In order to determine the Young's modulus of a wire of radius 0.2 cm (measured using a scale of least count = 0.001 cm) and length 1m (measured using a scale of least count = 1 mm), a weight of mass 1kg (measured 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?

[16 March, 2021 (Shift-II)]

(*a*) 0.14% (*b*) 9% (*c*) 1.4% (*d*) 0.9%

127. 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: **[24 Feb, 2021 (Shift-II)]**

(*a*) 1.33% (*b*) 1.13% (*c*) 1.03% (*d*) 1.30%

128. In the experiment of Ohm's law, a potential difference of 5.0V is applied across the end of a conductor of length 10.0 cm and diameter of 5.00 mm. The measured current in the conductor is 2.00 A. The maximum permissible percentage error in the resistivity of the conductor is: **[18 March, 2021 (Shift-I)]**

(*a*) 3.9 (*b*) 8.4 (*c*) 3.0 (*d*) 7.5

129. A wire of 1Ω has a length of 1m. It is stretched till its length increases by 25%. The percentage change in resistance to the nearest integer is: **[26 Feb, 2021 (Shift-II)]**

(*a*) 56% (*b*) 76% (*c*) 12.5% (*d*) 25%

130. Three students S_1, S_2 and S_3 perform an experiment for determining the acceleration due to gravity (g) using a simple pendulum. They use different lengths of pendulum and record time for different number of oscillations. The observations are as shown in the table.

[22 July, 2021 (Shift-II)]

Student No.	Length of Pendulum (cm)	No. of oscillations (n)	Total for n Time oscillations	Period (s)
1	64.0	8	128.0	16.0
2	64.0	4	64.0	16.0
3	20.0	4	36.0	9.0

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

If E_1, E_2 and E_3 are the percentage errors 'g' for students 1, 2 and 3 respectively, then the minimum percentage error is obtained by student no.__________.

131. If the length of the pendulum in pendulum clock increases by 0.1%, then the error in time per day is **[26 Aug, 2021 (Shift-II)]**

(*a*) 8.64 s (*b*) 43.2 s (*c*) 86.4 s (*d*) 4.32 s

132. The time period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{l}{g}}$. The measured value of the length of pendulum is 10 cm known to a 1 mm accuracy. The time for 200 oscillations of the pendulum is found to be 100 second using a clock of 1 s resolution. The percentage accuracy in the determination of 'g' using this pendulum is 'x'. The value of 'x' to be nearest integer is **[18 March, 2021 (Shift-I)]**

(*a*) 2% (*b*) 3% (*c*) 5% (*d*) 4%

133. A physical quantity 'y' is represented by the formula $y = m^2 r^{-4} g^x \ell^{-\frac{3}{2}}$ if the percentage errors found in y, m, r, ℓ and g are 18, 1, 0.5, 4 and p respectively, then find the value of x and p.

[27 July, 2021 (Shift-II)]

(*a*) 5 and ± 2 (*b*) $\frac{16}{3}$ and $\pm\frac{3}{2}$
(*c*) 8 and ± 2 (*d*) 4 and ± 3

134. 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/s², without any significant error, his observation are as follows:

[1 Sept, 2021 (Shift-II)]

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:
(*a*) 0.083 (*b*) 0.0155 (*c*) 0.0083 (*d*) 0.155

135. The acceleration due to gravity is found upto an accuracy of 4% on a planet. The energy supplied to a simple pendulum of known mass 'm' to undertake oscillations of time period T is being estimated. If time period is measured to an accuracy of 3%, the accuracy to which E is known as _______%. **[26 Aug, 2021 (Shift-II)]**

136. The resistance $R = \frac{V}{I}$, where $V = (50 \pm 2)\ V$ and $I = (20 \pm 0.2)$ A. The percentage error in R is 'x' %. The value of 'x' to the nearest integer is ________. **[16 March, 2021 (Shift-I)]**

137. The radius of a sphere is measured to be (7.50 ± 0.85) cm. Suppose the percentage error in its volume is x. The value of x, to the nearest integer, is ______ **[18 March, 2021 (Shift-II)]**

138. 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: **[8 Jan, 2020 (Shift-II)]**

(*a*) 4.40% (*b*) 3.40% (*c*) 2.40% (*d*) 5.40%

139. A physical quantity z depends on four observables a, b, c and d, as $\frac{a^2 b^{\frac{2}{3}}}{\sqrt{c}\, d^3}$. 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 **[05 Sep, 2020 (Shift-I)]**

(*a*) 13.5% (*b*) 14.5% (*c*) 16.5% (*d*) 12.25%

140. 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 ________ **[6 Sep, 2020 (Shift-I)]**

(*a*) 5010 (*b*) 5100 (*c*) 1050 (*d*) 5101

141. 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: **[9 April, 2019 (Shift-I)]**

(*a*) 0.10 kg/m^3 (*b*) 0.31 kg/m^3 (*c*) 0.07 kg/m^3 (*d*) 0.01 kg/m^3

142. 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 30s. 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: **[8 April, 2019 (Shift-II)]**

(*a*) 0.7% (*b*) 3.5% (*c*) 6.8% (*d*) 0.2%

143. 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? **[10 Jan, 2019 (Shift-II)]**

(*a*) 4264 ± 81 cm^3 (*b*) 4264 ± 81.0 cm^3
(*c*) 4260 ± 80 cm^3 (*d*) 4300 ± 80 cm^3

144. A copper wire is stretched to make it 0.5% longer. The percentage change in its electric resistance if its volume remains unchanged is **[9 Jan, 2019 (Shift-I)]**

(*a*) 2.0% (*b*) 2.5% (*c*) 1.0% (*d*) 0.5%

Measuring Instruments

145. Given below are two statements:

Statement I: In a vernier callipers, one vernier scale division is always smaller than one main scale division.

Statement II: The vernier constant is given by one main scale division multiplied by the number of vernier scale divisions.

In the light of the above statements, choose the correct answer from the options given below: **[22 Jan, 2025 (Shift-I)]**

(*a*) Statement I is false but statement II is true.
(*b*) Statement I is true but statement II is false.
(*c*) Both statement I and statement II are false.
(*d*) Both statement I and statement II are true.

146. The least count of a screw guage is 0.01 mm. If the pitch is increased by 75% and number of divisions on the circular scale is reduced by 50%, the new least count will be ______$\times 10^{-3}$ mm **[24 Jan, 2025 (Shift-I)]**

147. One main scale division of a vernier caliper is equal to m units. If n^{th} division of main scale coincides with $(n+1)^{th}$ division of vernier scale, the least count of the vernier caliper is: **[09 April, 2024 (Shift-I)]**

(*a*) $\frac{n}{(n+1)}$ (*b*) $\frac{m}{(n+1)}$ (*c*) $\frac{1}{(n+1)}$ (*d*) $\frac{m}{n(n+1)}$

148. There are 100 divisions on the circular scale of a screw gauge of pitch 1 mm. With no measuring quantity in between the jaws, the zero of the circular scale lies 5 divisions below the reference line. The diameter of a wire is then measured using this screw gauge. It is found the 4 linear scale divisions are clearly visible while 60 divisions on circular scale coincide with the reference line. The diameter of the wire is: **[08 April, 2024 (Shift-II)]**

(*a*) 4.65 mm (*b*) 4.55 mm (*c*) 4.60 mm (*d*) 3.35 mm

149. Least count of a vernier caliper is $\frac{1}{20N}$ cm. The value of one division on the main scale is 1 mm. Then the number of divisions of main scale that coincide with N divisions of vernier scale is: **[08 April, 2024 (Shift-II)]**

(*a*) $\left(\frac{2N-1}{20N}\right)$ (*b*) $\left(\frac{2N-1}{2}\right)$ (*c*) $(2N-1)$ (*d*) $\left(\frac{2N-1}{2N}\right)$

150. The diameter of a sphere is measured using a vernier caliper whose 9 divisions of main scale are equal to 10 divisions of vernier scale. The shortest division on the main scale is equal to l mm. The main scale reading is 2 cm and second division of vernier scale coincides with a division on main scale. If mass of the sphere is 8.635 g, the density of the sphere is: [08 April, 2024 (Shift-I)]

(*a*) 2.5 g/cm^3 (*b*) 1.7 g/cm^3 (*c*) 2.2 g/cm^3 (*d*) 2.0 g/cm^3

151. In a vernier calliper, when both jaws touch each other, zero of the vernier scale shifts towards left and its 4th division coincides exactly with a certain division on main scale. If 50 vernier scale divisions equal to 49 main scale divisions and zero error in the instrument is 0.04 mm then how many main scale divisions are there in 1 cm? **[06 April, 2024 (Shift-II)]**

(*a*) 40 (*b*) 5 (*c*) 20 (*d*) 10

152. In finding out refractive index of glass slab the following observations were made through travelling microscope 50 vernier scale division = 49 MSD; 20 divisions on main scale in each cm **[06 April, 2024 (Shift-II)]**

For mark on paper
MSR = 8.45 cm, VC = 26
For mark on paper seen through slab
MSR = 7.12 cm, VC = 41
For powder particle on the top surface of the glass slab
MSR = 4.05 cm, VC = 1
(MSR = Main Scale Reading, VC = Vernier Coincidence)
Refractive index of the glass slab is:

(*a*) 1.42 (*b*) 1.52 (*c*) 1.24 (*d*) 1.35

153. While measuring diameter of wire using screw gauge the following readings were noted. Main scale reading is 1 mm and circular scale reading is equal to 42 divisions. Pitch of screw gauge is 1 mm and it has 100 divisions on circular scale. The diameter of the wire is $\frac{x}{50}$ mm. The value of x is: **[06 April, 2024 (Shift-I)]**

(*a*) 142 (*b*) 71 (*c*) 42 (*d*) 21

154. A vernier callipers has 20 divisions on the vernier scale, which coincides with 19th division on the main scale. The least count of the instrument is 0.1 mm. One main scale division is equal to ____ mm. **[05 April, 2024 (Shift-II)]**

(*a*) 1 (*b*) 0.5 (*c*) 2 (*d*) 5

155. 10 divisions on the main scale of a Vernier calliper coincide with 11 divisions on the Vernier scale. If each division on the main scale is of 5 units, the least count of the instrument is:

[1 Feb, 2024 (Shift-I)]

(*a*) $\frac{1}{2}$ (*b*) $\frac{10}{11}$ (*c*) $\frac{50}{11}$ (*d*) $\frac{5}{11}$

156. If 50 Vernier divisions are equal to 49 main scale divisions of a travelling microscope and one smallest reading of main scale is 0.5 mm, the Vernier constant of travelling microscope is:

[30 Jan, 2024 (Shift-II)]

(*a*) 0.1 mm (*b*) 0.1 cm (*c*) 0.01 cm (*d*) 0.01 mm

157. Identify the physical quantity that cannot be measured using spherometer: **[27 Jan, 2024 (Shift-I)]**

(*a*) Radius of curvature of concave surface
(*b*) Specific rotation of liquids
(*c*) Thickness of thin plates
(*d*) Radius of curvature of convex surface

158. Given below are two statements: one is labelled as Assertion(A) and the other is labelled as Reason (R).

Assertion (A): In Vernier calliper if positive zero error exists, then while taking measurements, the reading taken will be more than the actual reading.

Reason (R): The zero error in Vernier Calliper might have happened due to manufacturing defect or due to rough handling.

In the light of the above statements, choose the correct answer from the options given below: **[27 JAN, 2024 (Shift-II)]**

(*a*) Both (A) and (R) are correct and (R) is the correct explanation of (A)
(*b*) Both (A) and (R) are correct but (R) is not the correct explanation of (A)
(*c*) (A) is true but (R) is false
(*d*) (A) is false but (R) is true

159. 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 :

[10 Apr, 2023 (Shift-II)]

(*a*) 3.18 cm (*b*) 3.25 cm (*c*) 3.26 cm (*d*) 3.22 cm

160. Given below are two statements :

Statements I : Astronomical unit (Au). Parsec (Pc) and Light year (ly) are units for measuring astronomical distances.

Statements II: Au < Parsec (Pc) < ly

In the light of the above statements. Choose the most appropriate answer from the options given below: **[11 Apr, 2023 (Shift-I)]**

(*a*) Both Statements I and Statements II are correct
(*b*) Statements I is correct but Statements II is incorrect
(*c*) Both Statements I and Statements II are incorrect
(*d*) Statements I is incorrect but statements II is correct

161. In a screw gauge, there are 100 divisions on the circular scale and the main scale moves by 0.5 mm on a complete rotation of the circular scale. The zero of circular scale lies 6 divisions below the line of graduation when two studs are brought in contact with each other. When a wire is placed between the studs, 4 linear scale divisions are clearly visible while 46th division the circular scale coincide with the reference line. The diameter of the wire is __________ × 10^{-2} mm. **[30 Jan, 2023 (Shift-I)]**

162. In a Vernier Calliper, 10 divisions of Vernier scale is equal to the 9 divisions of main scale. When both jaws of Vernier calipers touch each other, the zero of the Vernier scale is shifted to the left of zero of the main scale and 4th Vernier scale division exactly coincides with the main scale reading. One main scale division is equal to 1 mm. While measuring diameter of a spherical body, the body is held between two jaws. It is now observed that zero of the Vernier scale lies between 30 and 31 divisions of main scale reading and 6th Vernier scale division exactly coincides with the main scale reading. The diameter of the spherical body will be

[26 July, 2022 (Shift-II)]

(*a*) 3.02 cm (*b*) 3.06 cm (*c*) 3.10 cm (*d*) 3.20 cm

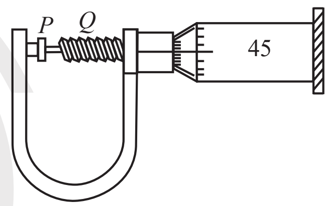
163. The distance of the Sun from earth is 1.5×10^{11} m and its angular diameter is (2000) s when observed from the earth. The diameter of the Sun will be: **[27 June, 2022 (Shift-II)]**

(*a*) 2.45×10^{10} m (*b*) 1.45×10^{10} m
(*c*) 1.45×10^{9} m (*d*) 0.14×10^{9} m

164. 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? **[29 July, 2022 (Shift-I)]**

(*a*) 0.001 cm (*b*) 0.002 mm (*c*) 0.002 cm (*d*) 0.005 cm

165. In an experiment to find out the diameter of wire using screw gauge, the following observations were noted?



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

Then the diameter of wire is **[29 July, 2022 (Shift-I)]**

(*a*) 2.92 mm (*b*) 2.54 mm (*c*) 2.98 mm (*d*) 3.45 mm

166. The Vernier constant of Vernier callipers is 0.1 mm and it has zero error of (–0.05) cm. While measuring diameter of a sphere, the main scale reading is 1.7 cm and coinciding vernier division is 5. The corrected diameter will be _______× 10^{-2} cm.

[29 June, 2022 (Shift-II)]

167. The one division of main scale of Vernier callipers reads 1 mm and 10 divisions of Vernier scale is equal to the 9 divisions on main scale. When the two jaws of the instrument touch each other, the zero of the Vernier lies to the right of zero of the main scale and its fourth division coincides with a main scale division. When a spherical bob is tightly placed between the two jaws, the zero of the Vernier scale lies in between 4.1 cm and 4.2 cm and 6th Vernier division coincides with a main scale division. The diameter of the bob will be _______ × 10^{-2} cm **[27 July, 2022 (Shift-I)]**

168. In a vernier callipers, each cm on the main scale is divided into 20 equal parts. If tenth vernier scale division coincides with ninth main scale division. Then the value of vernier contant will be _____ × 10^{-2} mm. **[26 June, 2022 (Shift-I)]**

169. A screw gauge of pitch 0.5 mm is used to measure the diameter of uniform wire of length 6.8cm, the main scale reading is 1.5 mm and circular scale reading is 7. The calculated curved surface area of wire to appropriate significant figures is: **[26 July, 2022 (Shift-I)]**

[Screw gauge has 50 divisions on its circular scale]

(*a*) 6.8 cm^2 (*b*) 3.4 cm^2 (*c*) 3.9 cm^2 (*d*) 2.4 cm^2

170. In a Screw Gauge, fifth division of the circular scale coincides with the reference line when the ratchet is closed. There are 50 divisions on the circular scale, and the main scale moves by 0.5 mm on a complete rotation. For a particular observation the reading on the main scale is 5mm and the 20th division of the circular scale coincides with reference line. Calculate the true reading. **[26 Aug, 2021 (Shift-I)]**

(*a*) 5.25 mm (*b*) 5.15 mm (*c*) 5.20 mm (*d*) 5.00 mm

171. The vernier scale used for measurement has a positive zero error of 0.2 mm. If while taking a measurement it was noted that zero on the vernier scale lies between 8.5 cm and 8.6 cm. and vernier coincidence is 6, then the correct value of measurement is ______ (least count = 0.01 cm) **[17 March, 2021 (Shift-I)]**

(*a*) 8.58 cm (*b*) 8.54 cm (*c*) 8.56 cm (*d*) 8.36 cm

172. Suppose you have taken a dilute solution of oleic acid in such a way that its concentration becomes 0.01 cm^3 of oleic acid per cm^3 of the solution. Then you make a thin film of this solution (monomolecular thickness) of area 4 cm^2 by considering 100 spherical drops of radius $\left(\frac{3}{40\pi}\right)^{\frac{1}{3}} \times 10^{-3}$ cm . Then the thickness of oleic acid Layer will be $x \times 10^{-14}$ m. Where x is ________. **[17 March, 2021 (Shift-II)]**

173. The pitch of the screw gauge is 1 mm and there are 100 divisions on the circular scale. When nothing is put in between the jaws, the zero of the circular scale lies 8 divisions below the reference line. When a wire is placed between the jaws, the first linear scale division is clearly visible while 72^{nd} division on circular scale coincides with the reference line, The radius of the wire is: **[25 Feb, 2021 (Shift-I)]**

(*a*) 0.82 mm (*b*) 1.64 mm (*c*) 0.90 mm (*d*) 1.80 mm

174. **Assertion A:** If in five complete rotations of the circular scale, the distance travelled on main scale of the screw gauge is 5 mm and there are 50 total divisions on circular scale, then least count is 0.001 cm.

Reason R: Least Count $= \dfrac{\text{Pitch}}{\text{Total divisions on circular scle}}$

In the light of the above statement, choose the most appropriate answer from the options given below: **[27 July, 2021 (Shift-I)]**

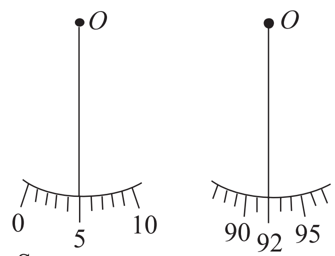
(*a*) **A** is correct but **R** is not correct.
(*b*) **A** is not correct but **R** is correct.
(*c*) Both **A** and **R** are correct and **R** is NOT the correct explanation of **A**.
(*d*) Both **A** and **R** are correct and **R** is the correct explanation of **A**.

175. One main scale division of a vernier calipers is 'a' cm and n^{th} division of the vernier scale coincide with $(n-1)^{th}$ division of the main scale. The least count of the calipers (in mm) is **[16 March, 2021 (Shift-I)]**

(*a*) $\frac{10na}{n-1}$ (*b*) $\frac{10a}{n-1}$ (*c*) $\frac{10a}{n}$ (*d*) $\left(\frac{n-1}{10n}\right)a$

176. The diameter of a spherical bob is measured using a vernier callipers. 9 divisions of the main scale, in the vernier callipers, 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 callipers has positive zero error of 0.04 cm, then the radius of the bob is_____ $\times 10^{-2}$ cm. **[31 Aug, 2021 (Shift-II)]**

177. 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 ___________. **[25 July, 2021 (Shift-I)]**



Screw gauge (A) Screw gauge (B)

[Figure shows position of reference 'O' when jaws of screw gauge are closed] Given pitch = 0.1 cm.

178. 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: **[6 Sep, 2020 (Shift-I)]**

(*a*) Negative, 2μm (*b*) Positive, 10μm
(*c*) Positive, 0.1 mm (*d*) Positive, 0.1 μm

179. For the four sets of three measured physical quantities as given below. Which of the following options is correct? **[9 Jan, 2020 (Shift-II)]**

(*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*) $A_4 = 25$, $B_4 = 236.191$, $C_4 = 19.5$

(*a*) $A_4+B_4+C_4<A_1+B_1+C_1=A_2+B_2+C_2=A_3+B_3+C_3$
(*b*) $A_1+B_1+C_1<A_3+B_3+C_3<A_2+B_2+C_2<A_4+B_4+C_4$
(*c*) $A_1+B_1+C_1=A_2+B_2+C_2=A_3+B_3+C_3=A_4+B_4+C_4$
(*d*) $A_4+B_4+C_4<A_1+B_1+C_1<A_3+B_3+C_3<A_2+B_2+C_2$

180. 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 **[3 Sep, 2020 (Shift-I)]**

(*a*) 2.121 cm (*b*) 2.123 cm (*c*) 2.124 cm (*d*) 2.125 cm

181. 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 **[12 Jan, 2019 (Shift-I)]**

(*a*) 50 (*b*) 200 (*c*) 100 (*d*) 500

ANSWER KEY

1. (d)	2. (*)	3. (b)	4. (c)	5. (c)	6. (a)	7. (d)	8. (c)	9. (a)	10. (b)
11. (b)	12. (d)	13. (a)	14. (c)	15. (b)	16. (c)	17. [0]	18. (c)	19. (b)	20. (c)
21. (a)	22. (c)	23. (b)	24. (c)	25. (b)	26. (b)	27. (b)	28. (d)	29. (a)	30. (c)
31. (b)	32. (c)	33. (b)	34. (a)	35. (b)	36. (d)	37. (c)	38. (b)	39. (a)	40. (c)
41. (a)	42. (a)	43. (c)	44. (a)	45. (b)	46. (d)	47. (a)	48. (a)	49. (d)	50. (d)
51. (c)	52. (c)	53. (c)	54. (b)	55. (d)	56. (c)	57. (d)	58. (b)	59. (c)	60. (b)
61. (a)	62. (a)	63. (b)	64. (d)	65. (c)	66. (b)	67. (a)	68. (b)	69. (a)	70. (a)
71. (d)	72. (d)	73. (c)	74. (c)	75. (c)	76. (b)	77. (c)	78. (c)	79. (a)	80. (b)
81. (c)	82. (*)	83. (a)	84. (d)	85. (c)	86. (a)	87. (a)	88. (c)	89. (c)	90. (c)
91. (b)	92. (c)	93. (b)	94. [15]	95. (a)	96. (c)	97. (b)	98. [3]	99. (c)	100. [7700]
101. (c)	102. (b)	103. (d)	104. (c)	105. (b)	106. (c)	107. (b)	108. (c)	109. (b)	110. (a)
111. (c)	112. (c)	113. (a)	114. (d)	115. (c)	116. (a)	117. (c)	118. (c)	119. [1.99]	120. (b)
121. (a)	122. [18]	123. [150]	124. [5]	125. (b)	126. (c)	127. (b)	128. (a)	129. (a)	130. [1]
131. (b)	132. (b)	133. (b)	134. (b)	135. [14]	136. [5]	137. [34]	138. (a)	139. (b)	140. (c)
141. (*)	142. (c)	143. (c)	144. (c)	145. (b)	146. [35]	147. (b)	148. (b)	149. (b)	150. (d)
151. (c)	152. (a)	153. (b)	154. (c)	155. (d)	156. (d)	157. (b)	158. (b)	159. (a)	160. (b)
161. [220]	162. (c)	163. (c)	164. (c)	165. (c)	166. [180]	167. [412]	168. [5]	169. (b)	170. (b)
171. (b)	172. [25]	173. (a)	174. (b)	175. (c)	176. [52]	177. [13]	178. (b)	179. (*)	180. (c)
181. (b)									

EXPLANATIONS

1. (*d*) Heat capacity $(C') = \dfrac{\Delta Q}{\Delta T}$, unit: J K^{-1}

Specific heat capacity $(s) = \dfrac{\Delta Q}{m\Delta T}$, unit: $Jkg^{-1}K^{-1}$.

Latent heat $(L) = \dfrac{\Delta Q}{m}$, unit: Jkg^{-1}.

Thermal conductivity (K) from $\Delta Q = -KA\dfrac{\Delta T}{\Delta x}$, unit: $Jm^{-1}K^{-1}s^{-1}$

Thus, match: (A)-(II), (B)-(III), (C)-(I), (D)-(IV).

2. (*) DROPPED by NTA

Magnetic intensity

$\left(H = \dfrac{B}{\mu}\right) \to$ Ampere/meter

Magnetic moment $(\vec{M} = i\vec{A})$

Note: None of the option(s) are correct but if we need to choose most appropriate option then the answer is (*d*)

3. (*b*) $\vec{E} = \dfrac{A}{x^2}\hat{i} + \dfrac{B}{y^3}\hat{j}$

$$\left[\frac{A}{x^2}\right] = NC^{-1} \Rightarrow [A] = Nm^2C^{-1}$$

$$\left[\frac{B}{y^3}\right] = NC^{-1} \Rightarrow [B] = Nm^3C^{-1}$$

4. (*c*) Unit of R_H : m^{-1}, h : kgm^2s^{-1}, μ_B : $kgm^{-1}s^{-2}$, η : $kgm^{-1}s^{-1}$,

5. (*c*) $\dfrac{E}{H} = \dfrac{Volt\ /metre}{Ampere\ /metre} = \dfrac{Volt}{Ampere} = ohm$

6. (*a*) $128[M_1L_1^{-3}] = n_2[M_2L_2^{-3}]$

$$\Rightarrow n_2 = 128\left[\frac{M_1}{M_2}\right]\left[\frac{L_1}{L_2}\right]^{-3}$$

$$= 128\left[\frac{1000}{50}\right]\left[\frac{100}{25}\right]^{-3} = \frac{128 \times 20}{64} = 40$$

7. (***d***) Inductance L and capacitance C relate to μ_0 and $\in_0$, with $C = \dfrac{A\in_0}{d}$ and $L = \mu_0 nI$. The ratio $\dfrac{L}{C}$ equals $(R)^2$, where R is resistance. Therefore, $\sqrt{\dfrac{\mu_0}{\in_0}}$ has the dimension of R, the answer is (*d*).

8. (***c***)

(A) Mass density $= \dfrac{M}{V}$, unit = $[ML^{-3}]$.

(B) Impulse = $M.u$, unit = $[MLT^{-1}]$,

(C) Power $= F.V$, unit = $[ML^2T^{-3}]$,

(D) Moment of inertia = Mr^2, unit = $[ML^2]$

9. (*a*)

(A) $[k] = \dfrac{PV}{NT} = \dfrac{ML^2T^{-2}}{K} = ML^2T^{-2}K^{-1}$

(B) $[\eta] = \dfrac{F}{6\pi rv} = \dfrac{MLT^{-2}}{L^2T^{-1}} = ML^{-1}T^{-1}$

(C) $[h] = \dfrac{E}{f} = \dfrac{ML^2T^{-2}}{T^{-1}} = ML^2T^{-1}$

(D) $\dfrac{dQ}{dt} = k\dfrac{AdT}{dx}$

$$k = \frac{(ML^2T^{-2})L}{L^2.K} = MLT^{-3}K^{-1}$$

10. (*b*) $[q] = [AT]$

$[\mu_0] = [M\,LT^{-2}\,A^{-2}]$

Momentum $[P] = [MLT^{-1}]$

$[q\mu_0 I] = [AT][MLT^{-2}A^{-2}][AT] = MLT^{-1}$, matching momentum dimensions.

11. (*b*) The speed of light

$C = \dfrac{1}{\sqrt{\mu_0\varepsilon_0}} \Rightarrow \dfrac{1}{\mu_0\varepsilon_0} = C^2$.

Since C has dimensions $[LT^{-1}]$, $C^2 = [L^2T^{-2}]$.

Thus, the dimension is L^2/T^2.

12. (*d*) $\left[\frac{B}{\mu_0}\right]=[ni]=L^{-1}A^{1}$

13. (*a*) Capacitance is defined as:

$C=\frac{Q}{V}$

- Charge Q has dimensional formula: $[Q]=[C]$
- Voltage V is energy per charge:

$V=\frac{W}{Q}=\frac{ML^2T^{-2}}{C}=ML^2T^{-2}C^{-1}$

Now, substituting in $C=\frac{Q}{V}$:

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

14. (*c*) $x(t)=A\sin(t)+B\cos^2(t)+Ct^2+D$

Here, A, B, C, and D are constants, and t is time.

$[A]=L,\ [B]=L,\ [C]=\frac{L}{T^2},\ [D]=L$

$\left[\frac{ABC}{D}\right]=\left[\frac{L\times L\times LT^{-2}}{L}\right]=\left[L^2T^{-2}\right]$

15. (*b*) (D) Torsional constant $\tau=C\theta$

$C=[ML^2T^{-2}]$

(C) Magnetic moment M = NIA

$M=[L^2A]$

(B) F = qVB

$[MLT^{-2}]=[AT][LT^{-1}]B$

Magnetic field

$B=[MT^{-2}A^{-1}]$

(A) $B=\frac{\mu_o i}{2r}$

Permeability of free space

$\mu_0=\frac{[MT^{-2}A^{-1}][L]}{[A]}$

$\boxed{\mu_o=[MLT^{-2}A^{-2}]}$

16. (*c*) $[E]=M^1L^2T^{-2}$

$[Pc]=M^1L^1T^{-1}.L^1T^{-1}=M^1L^2T^{-2}$

$[mc^2]=M^1L^2T^{-2}\Rightarrow[E]=[pc]=[mc^2]$

From principle of homogenity

$E^2=P^2c^2+m^2c^4$

17. [0] $\left[\frac{\text{Modulus of elasticity}}{\text{TORQUE}}\right]$

$=\left[\frac{\text{STRESS}}{\text{STRAIN}\times\text{TORQUE}}\right]=[L^3]$

hence $C=0$

18. (*c*) Angular impulse has dimension $=[ML^2T^{-1}]$

Latent Heat has dimension $[M^0L^2T^{-2}]$

Electrical resistivity has dimension $[ML^3T^{-3}A^{-2}]$

Electromotive force has dimension $[ML^2T^{-3}A^{-1}]$

19. (*b*) The dimensional formula of surface tension = $[MT^{-2}]$, impulse = $[MLT^{-1}]$ which does not match.

20. (*c*) $[LT^{-1}]=[A][T^2]=\frac{[B][T]}{[C]+[T]}$

$[C]=[T]$

$[A]=[LT^{-3}]$

$[B]=[LT^{-1}]$

$[ABC]=[L^2T^{-3}]$

21. (*a*) (A) $[Y]=\frac{F}{A\left(\frac{\Delta\ell}{\ell}\right)}=ML^{-1}T^{-2}$

$\left(\frac{\Delta\ell}{\ell}=\text{Dimensionless}\right)$

(B) Torque

$(\vec{\tau})=\vec{r}\times\vec{F}=L\times MLT^{-2}=ML^2T^{-2}$

(C) Coefficient of viscosity $\Rightarrow\frac{F}{A\cdot\frac{dv}{dt}}$

$\eta\to Pa$ sec. (Pascal – sec.)

$[\eta]=\frac{MLT^{-2}}{L^2}\times T=ML^{-1}T^{-1}$

(D) Gravitational constant (G)

$[G]=\frac{F\cdot r^2}{m_1m_2}=\frac{MLT^{-2}\times L^2}{M^2}=M^{-1}L^3T^{-2}$

22. (*c*) Heat = m L $\Rightarrow$ L = heat/m

$\Rightarrow[L]=\frac{ML^2T^{-2}}{M}=M^0L^2T^{-2}$

23. (*b*) [Energy Density] $=\frac{1}{2}[\epsilon_0E^2]$

$[\epsilon_0E^2]=\frac{[\text{Energy}]}{[\text{Vol.}]}=\left[\frac{ML^2T^{-2}}{L^3}\right]$

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

24. (*c*) $s=\frac{\Delta Q}{m\Delta T}$

$[s]=\left[\frac{ML^2T^{-2}}{MK}\right]$

$[s]=[L^2T^{-2}K^{-1}]$

Statement-(I) is correct

$PV=nRT\Rightarrow R=\frac{PV}{nT}$

$[R]=\frac{[ML^{-1}T^{-2}][L^3]}{[\text{mol}][K]}$

$[R]=[ML^2T^{-2}\text{mol}^{-1}K^{-1}]$

Statement-II is incorrect

25. (*b*) $[\vec{\tau}]=[\vec{r}\times\vec{F}]=[ML^2T^{-2}]$

$\Rightarrow B=\left(\frac{F}{qV}\right)=\left[\frac{MLT^{-2}}{ATLT^{-1}}\right]=[MA^{-1}T^{-2}]$

$[M]=[I\times A]=[AL^2]$

$B=\frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2}$

$\Rightarrow[\mu]=\left[\frac{Br^2}{Idl}\right]=\left[\frac{MT^{-2}A^{-1}\times L^2}{AL}\right]$

$=[MLT^{-2}A^{-2}]$

26. (*b*) $[b]=[\text{Vol.}]=[L^3]$

$\left[\frac{a}{V^2}\right]=[P]\Leftrightarrow[a]=[V^2P]=[ML^5T^{-2}]$

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

27. (*b*) Here, we have G is gravitational constant and u is the energy density.

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

So, $[\sqrt{uG}]=[L^1T^{-2}]$

28. (*d*) Change in angular momentum = Angular impulse

[Angular momentum] = [Angular impulse]

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

29. (*a*) $[P]=MLT^{-1}$

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

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

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

(Here P is linear momentum and τ is moment of force, h is Planck's constant, L is angular momentum).

30. (*c*) As we know,

$F=\eta A\frac{dv}{dy}$, $L=mvr$, $S.T=\frac{F}{\ell}$,

$K.E=\frac{1}{2}I\omega^2$

Hence, $F=\eta A\frac{dv}{dy}$,

$[MLT^{-2}]=\eta[L^2][T^{-1}]$

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

$S.T=\frac{F}{\ell}=\frac{[MLT^{-2}]}{[L]}=[ML^0T^{-2}]$

$L=mvr=[ML^2T^{-1}]$

$K.E=\frac{1}{2}I\omega^2=[ML^2T^{-2}]$

31. (*b*) $Y=\frac{\text{Stress}}{\text{Strain}}=\frac{[MLT^{-2}]}{[L^2]}=[ML^{-1}T^{-2}]$

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

$\Rightarrow[\eta]=\frac{[MLT^{-2}]}{[L][LT^{-1}]}=[ML^{-1}T^{-1}]$

$\because h=\frac{E}{v}\Rightarrow h=\frac{[ML^2T^{-2}]}{[T^{-1}]}=[ML^2T^{-1}]$

Work function has same dimension as that of energy, so $[\phi]=[ML^2T^{-2}]$

32. (*c*) Pressure gradient

$=\frac{\text{Pressure}}{\text{Length}}=\frac{[ML^{-1}T^{-2}]}{[L]}=[M^1L^{-2}T^{-2}]$

Energy density $= \frac{\text{energy}}{\text{volume}} = [M^1L^{-1}T^{-2}]$

Electric field $= \frac{\text{Force}}{\text{charge}} = \frac{[MLT^{-2}]}{[A.T\ ]}$

$= [M^1L^1T^{-3}A^{-1}]$

Latent heat $= \frac{\text{heat energy}}{\text{mass}} = \frac{[ML^2T^{-2}]}{[M]}$

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

33. (*b*) (A) Surface Tension

$= \frac{F}{\ell} = \frac{MLT^{-2}}{L} = MT^{-2}$

$=$ Kgs $^{-2} \Rightarrow$ option IV

(B) Pressure $= \frac{F}{A} = \frac{MLT^{-2}}{L^2}$

$=$ Kgm^{-1} s$^{-2} \Rightarrow$ option (III)

(C) viscosity $= \frac{F}{A\left(\frac{dV}{dz}\right)} = \frac{MLT^{-2}}{L^2\left(\frac{LT^{-1}}{L}\right)}$

$= ML^{-1}T^{-1}$

$=$ Kgm^{-1} s$^{-1} \Rightarrow$ option (I)

(*D*) impulse $= \int Fdt = MLT^{-2} \times T$

$= MLT^{-1} =$ Kgms$^{-1} \Rightarrow$ option (II)

$\Rightarrow$ (*A*) - (IV), (*B*) - (III), (*C*) - (I), (*D*) - (II)

34. (*a*) Spring Constant

$[K] = \frac{[F]}{[X]} = \frac{MLT^{-2}}{L} = MT^{-2}$

Angular speed $[\omega] = \frac{[\theta]}{[t]} = \frac{1}{T} = T^{-1}$

Angular Momentum,

$[L] = [M]\ [V]\ .\ [R] = [M]\ [LT^{-1}]\ [L] = [ML^2T^{-1}]$

Moment of Inertia,

$[I] = [M]\ [R^2] = [M]\ [L^2] = [ML^2]$

35. (*b*) [Stress]

$= \frac{[F]}{[A]} = \frac{[MLT^{-2}]}{L^2} = [ML^{-1}T^{-2}]$

[Pressure gradient]

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

[Τορθυε] $= [r][F] = [L][MLT^{-2}] = [ML^2T^{-2}]$

[*Angular Momentum*] $= [\tau][t] = [ML^2T^{-2}]$ [T] $= [ML^2T^{-1}]$

36. (*d*)

37. (*c*) $\because c^2 = \frac{1}{\mu_0 \in_0} \Rightarrow \left[\frac{1}{\mu_0 \in_0}\right] = \left[L^2T^{-2}\right]$

38. (*b*) (A) Planck's constant

$h = \frac{E}{v} = \frac{\left[M^1L^2T^{-2}\right]}{\left[T^{-1}\right]} = \left[M^1L^2T^{-1}\right]$

(B) $E = qV$

$V = \frac{E}{q} = \frac{[M^1L^2T^{-2}]}{[A^1T^1]} = [M^1L^2T^{-3}A^{-1}]$

(C) ϕ (work function)

$=$ energy $= [M^1L^2T^{-2}]$

(D) Momentum (p) = F.t $= [M^1L^1T^{-2}T^1]$

$= [M^1L^1T^{-1}]$

39. (*a*) We know that,

Velocity gradient $= \frac{dv}{dx}$

Decay constant (λ) $= \frac{0.693}{T_{1/2}}$

$\therefore$ Dimension of velocity gradient

$\left(\frac{dv}{dx}\right) = \frac{LT^{-1}}{L} = T^{-1}$

40. (*c*) $e = -M\frac{di}{dt} \Rightarrow [M] = \frac{[e.m.f]}{\left[\frac{di}{dt}\right]}$

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

41. (*a*) [Pascal-second] $= \frac{[MLT^{-2}]}{[L^2]}$

$= [ML^{-1}T^{-1}]$

42. (*a*) Unit of Viscosity = Pascal.Second,

Therefore, dimension of viscosity

$= [ML^{-1}T^{-1}]$

According to question,

$[ML^{-1}T^{-1}] = P^x A^y T^z$

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

$[M^xL^{x+2y}T^{-x+z}] = M^1L^{-1}T^{-1}$

$x = 1, x + 2y = -1, -x + z = -1$

$y = -1, z = 0$

Viscosity $= [P^1A^{-1}T^0]$

43. (*c*) $\frac{B^2}{\mu_0}$ is energy density in magnetic field.

$\therefore \left[\frac{B^2}{\mu_0}\right] =$ [Energy density]

$=$ [Energy]/[Volume]

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

44. (*a*) Electric Displacement, $\vec{D} = \in_0\vec{E}$

From Gauss's Law.

$EdA = \frac{q}{\in_0}$ or $[\in_0 E] = \left[\frac{q}{dA}\right] = [AT\,L^{-2}]$

Surface charge density,(σ)

$\sigma\frac{Q}{A} \Rightarrow [\sigma] = \frac{[Q]}{[A]} = \frac{[AT]}{[L^2]} = [L^{-2}AT]$

Electric displacement ($\vec{D}$) and surface charge density (σ) have the same dimension.

45. (*b*) Torque $= \vec{r} \times \vec{F}$ (Nm)

Stress $= \frac{\text{Force}}{\text{Area}}$ (N/m^2)

Latent heat $= \frac{\text{Energy}}{\text{Mass}}$ (J kg^{-1})

Power $= \frac{\text{Work}}{\text{Time}}$ (N ms^{-1})

46. (*d*) $\Delta Q = ms\Delta T \Rightarrow [s] = \frac{[\Delta Q]}{[m][\Delta T]}$

$\Rightarrow [s] = \frac{[ML^2T^{-2}]}{[MK]} = L^2T^{-2}K^{-1}$

$\Delta Q = mL \Rightarrow [L] = \frac{ML^2T^{-2}}{M} = L^2T^{-2}$

47. (*a*) Capacitance

$[C] = \frac{Q}{V} = \frac{Q}{W/Q} = \frac{Q^2}{W} = \frac{A^2T^2}{M^1L^2T^{-2}}$

$= M^{-1}L^{-2}T^4A^2$

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

$c = \frac{1}{\sqrt{\mu_0\varepsilon_0}} \Rightarrow \mu_0 = \frac{1}{\varepsilon_0 c^2}$

$\Rightarrow$ Permeability of freespace $[\mu_0]$

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

Electric field, $E = \frac{F}{q} = \frac{MLT^{-2}}{AT}$

$\Rightarrow [E] = MLT^{-3}A^{-1}$

48. (*a*) $P = EL^2M^{-5}G^{-2}$

$= [ML^2T^{-2}]\ [ML^2T^{-1}]^2\ [M^{-5}][M^{-1}L^3T^{-2}]^2$

$= M^0$ L^0 T^0

49. (*d*) $\lambda = \frac{C}{V} = \frac{Q/V}{V} = \frac{Q}{V^2} = \frac{Q^3}{W^2} = \frac{I^3T^3}{F^2 \cdot d^2}$

$\Rightarrow [\lambda] = \frac{[I^3T^3]}{[M^2L^4T^{-4}]} = [M^{-2}L^{-4}T^7I^3]$

50. (*d*) The dimension of $[\mu_0]$

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

$\left[\because \mu_0 = \frac{B_0}{H} = NA^{-2}\right]$

It is not dimensionless

51. (*c*) $[h] = [ML^2T^{-1}]$

$[E] = [ML^2T^{-2}]$

$[V] = [ML^2T^{-3}I^{-1}]$

$[P] = [MLT^{-1}]$

52. (*c*) We know that, $[F] = MLT^{-2}$

$\Rightarrow M = FL^{-1}T^2$

$[\rho] = ML^{-3} = FL^{-1}T^2L^{-3} = FL^{-4}T^2$

53. (*c*)

(a) Torque $\rightarrow$ ML^{2}T$^{-2} \rightarrow$ (iii)

(b) Impulse $\rightarrow$ MLT$^{-1} \rightarrow$ (i)

(c) Tension $\rightarrow$ MLT$^{-2} \rightarrow$ (iv)

(d) surface Tension

$\rightarrow \frac{MLT^{-2}}{L} = MT^{-2} \rightarrow$ (ii)

54. (*b*) $p = k\, S^a I^b h^c$

where k is dimensionless constant

$MLT^{-1} = (MT^{-2})^a (ML^2)^b (ML^2T^{-1})^c$

$a + b + c = 1 \quad ...(i)$

$2b + 2c = 1 \quad ...(ii)$

$-2a - c = -1 \quad ...(iii)$

On solving the above equations

$a = \frac{1}{2} \quad b = \frac{1}{2} \quad c = 0$

Thus, $p \propto S^{1/2} I^{1/2} h^0$

55. (*d*) Dimension for permittivity $[\varepsilon 0] = M^{-1} L^{-3} T^4 A^2$

Dimension for permeability $[\mu 0] = M\, L\, T^{-2} A^{-2}$

Dimension for electrical resistance $[R] = M\, L^2\, T^{-3}\, A^{-2}$

Using the given options

$$[R] = \sqrt{\frac{\mu_0}{\varepsilon_0}}$$

56. (*c*) *Dimension of*

$$\sqrt{\frac{\varepsilon_0}{\mu_0}} = \left[\frac{M^{-1}L^{-3}T^4A^2}{MLT^{-2}A^{-2}}\right] = [M^{-1}L^{-2}T^3A^2]$$

57. (*d*) The real gas equation is $\left(P + \frac{a}{V^2}\right)(V - b) = RT$, where P, V, T, and R are pressure, volume, temperature, and gas constant.

To find the dimension of ab^{-2}, note that a/V^2 has dimensions of pressure (since it adds to P),

so $[a] = [P][V^2] = ML^{-1}T^{-2}.L^6 = ML^5T^{-2}$.

Since $[b] = [V] = [L^3]$

$\therefore \quad [ab^{-2}] = [ML^5T^{-2}]\cdot[L^3]^{-2}$

$= [ML^{-1}T^{-2}]$, matching energy density.

58. (*b*) The electric flux ϕ has dimensions of charge per unit area, i.e.,:

$$[\phi] = \left[\frac{Q}{\text{Area}}\right]$$

σ is associated with surface charge density which has the dimensions:

$$[\sigma] = \frac{Q}{\text{Area}}$$

Thus, the dimensions of a will be:

$$[\alpha] = \left[\frac{\phi}{\sigma}\right] = \frac{Q/\text{ Area}}{Q/\text{ Area}} = 1$$

Next, for linear charge density, we have:

$$[\lambda] = \frac{Q}{\text{Length}}$$

$$[\beta] = \left[\frac{\phi}{\lambda}\right] = \frac{Q/\text{ Area}}{Q/\text{ Length}} = \frac{\text{Length}}{\text{Area}}$$

Now, considering the ratio $\frac{\alpha}{\beta}$, we find:

$$\left[\frac{\alpha}{\beta}\right] = \frac{1}{\frac{\text{Length}}{\text{Area}}} = \text{Length}$$

Thus, the ratio $\left[\frac{\alpha}{\beta}\right]$ represents length.

59. (*c*) Since, $T^2 = \frac{4\pi^2 r^3}{GM}$

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

(Dimension of G is $[M^{-1}L^3T^{-2}]$)

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

60. (*b*) Dimension formula for $[B] = L^2$

$$A = \frac{x^2}{tE} = \frac{L^2}{TML^2T^{-2}} = \frac{1}{MT^{-1}}$$

Dimension formula for $[A] = M^{-1}T$

Dimension formula for [AB]

$= L^2M^{-1}T^1$

61. (*a*) Force, $F = ax^2 + bt^{1/2}$

$$[a] = \frac{[F]}{[x^2]} = [M^1L^{-1}T^{-2}]$$

$$[b] = \frac{[F]}{[t^{1/2}]} = [M^1L^1T^{-5/2}]$$

$$\left[\frac{b^2}{a}\right] = \frac{[M^2L^2T^{-5}]}{[M^1L^{-1}T^{-2}]} = [M^1L^3T^{-3}]$$

62. (*a*) $m = k\, c^P\, G^{-1/2}\, h^{1/2}$

$M^1L^0T^0 = [LT^{-1}]^P\,[M^{-1}L^3T^{-2}]^{-1/2}\,[ML^2T^{-1}]^{1/2}$

By comparing P = 1/2

63. (*b*) $[P] = \left[\frac{a}{V^2}\right] \Rightarrow [a] = [PV^2]$

And dimension of V = dimension of b

$$\therefore \quad \frac{[a]}{[b^2]} = \frac{[PV^2]}{[V^2]} = [P]$$

64. (*d*) According to the question, $m \,\alpha\, h^x c^y G^z$

$M^1 = (ML^2T^{-1})^x\,(LT^{-1})\,(M^{-1}L^3T^{-2})^z$

$M^1L^0T^0 = M^{x-z}\,L^{2x+y+3z}\,T^{-x-y-2z}$

on comparing both sides

$x - z = 1 \quad ...(i)$

$2x + y + 3z = 0 \quad ...(ii)$

$-x - y - 2z = 0 \quad ...(iii)$

On solving equations (*i*), (*ii*) and (*iii*) we get

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

65. (*c*) b has the dimensions of volume, $[b] = [V]$

$$\ell \quad \left[\frac{a}{V^2}\right] = [P]$$

$$\Rightarrow \left[\frac{a}{b^2}\right] = [P] \therefore \left[\frac{b^2}{a}\right] = \frac{1}{[P]} = \frac{1}{[B]} = [K]$$

$$\therefore \quad \left[\frac{b^2}{a}\right] = \frac{1}{[P]} = \frac{1}{[B]} = [K]$$

66. (*b*) $(x - At)^2 + \left(y - \frac{t}{B}\right)^2 = a^2$

$[At] = [L]$

$\therefore \quad [A] = [T^1L^1]$ {dimension of $t = [T^{-1}]$}

Similarly, given

$$\left[\frac{t}{B}\right] = [L] \Rightarrow \frac{1}{T[B]} = [L]$$

$\therefore \quad [B] = [T^{-1}\,L^{-1}]$

67. (*a*) $[T^{-1}] = [L^1]^a\,[M^1L^{-3}]^b\left[\frac{MLT^{-2}}{L}\right]^c$

$\Rightarrow \ [T^{-1}] = [M^{b+c}\cdot L^{a-3b}\cdot T^{-2c}]$

Equating the power,

$$c = \frac{1}{2}, b = -\frac{1}{2}, a - 3b = 0 \Rightarrow a = -\frac{3}{2}$$

68. (*b*) $[ML^{-3}] = [MLT^{-2}]a\,[LT^{-1}]b[T]c$

$= [MaLa^+bT^2a{-}b{+}c]$

$a = 1, \quad ...(i)$

$a + b = -3, \quad ...(ii)$

$2a - b + c = 0 \quad ... (iii)$

Solving (i), (ii) and (iii)

$c = -2 \Rightarrow b = -4$

69. (*a*) X and $\frac{a}{Y^2}$ have same dimensions

Y and b have same dimensions

$\therefore\ [a] = [ML^5\,T^{-2}]\ [b] = [L^3]$

$\frac{[a]}{[b]} = [ML^2T^{-2}]$ has dimensions of energy

70. (*a*) Given that,

$$v_2 = \frac{n}{m^2}v_1 \ \Rightarrow \frac{L_2}{T_2} = \frac{n}{m^2}\frac{L_1}{T_1} \quad ...(i)$$

Also, $a_2 = a_1/mn \ \Rightarrow \frac{L_2}{T_2^2} = \frac{L_1}{T_1^2} \times \frac{1}{mn}$

$$\Rightarrow \left(\frac{T_1}{T_2}\right)^2 = \frac{L_1}{L_2} \times \frac{1}{mn}$$

On Putting the volue of $\frac{L_1}{L_2}$ from (*i*)

$$\left(\frac{T_1}{T_2}\right)^2 = \frac{T_1}{T_2} \times \frac{m^2}{n} \times \frac{1}{mn}$$

$$\Rightarrow \frac{n^2}{m}T_1 = T_2 \quad ...(ii)$$

Solving (*i*) and (*ii*), we get

$$L_2 = \frac{n^3}{m^3}L_1$$

71. (*d*) Given, $u = \frac{\alpha}{\beta}\sin\left(\frac{\alpha x}{kt}\right)$

Dimension of Boltzmann Constant,

$[k] \to [M^1L^2T^{-2}K^{-1}]$

Dimension of Energy density

$[u] \to [ML^{-1}T^{-2}]$

Dimension of Temperature $[t] = [K]$

Since, angle has no dimension, therefore its dimensional formula is [M°L°T°]

or $\frac{\alpha x}{kt} = \left[M^\circ L^\circ T^\circ\right]$

$\Rightarrow \frac{\alpha[L]}{\left[ML^2T^{-2}K^{-1}K\right]} = \left[M^\circ L^\circ T^\circ\right]$

$\alpha = [MLT^{-2}]$

Also, dimension of $\frac{\alpha}{\beta}$ = dimension of energy density

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

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

72. (*d*) Trigonometric function and logarithmic function are dimensionless quantities.

$\therefore [\eta] = [M^0L^0T^0]$

Also, dimensions of temperature,

$[T] = [M^0L^0T^0K]$

Dimensions of Boltzmann constant, [k] $= [ML^2T^{-2}K^{-1}]$

Dimension of $[x] = [M^0LT^0]$

A. $[\beta] = \left[\frac{kT}{x}\right] = \left[\frac{E}{x}\right] = [MLT^{-2}] = [F]$

B. $[\alpha\beta] = [M^0L^0T^0] \Rightarrow [\alpha]^{-1} = [\beta] = \left[\frac{kT}{x}\right]$

So $[\alpha]^{-1}[x] = [kT] = [ML^2T^{-2}]$

C. $\eta \sin\theta = \alpha\beta$

So, $[\eta \sin\theta] = [\alpha\beta]$

$[\eta] = [M^0L^0T^0]$ it is dimensionless quantity

D. $[\alpha] \neq [\beta]$

73. (*c*) $\frac{kt}{\beta x} = 1 \Rightarrow [\beta] = \left[\frac{kt}{x}\right] = \left[\frac{ML^2T^{-2}}{L}\right]$

$\left(\because\ E = \frac{1}{2}kt\right)$

As P is dimensionless

$\Rightarrow [\alpha] = [\beta] = [MLT^{-2}]$

74. (*c*) From principle of homogeinity,

$[P] = \left[\frac{a}{V^2}\right]$ and $[b] = [V] \Rightarrow \left[\frac{a}{b}\right] = [PV]$

75. (*c*) Let us suppose,

Mass $\alpha\ [t^a\ \upsilon^b\ \ell^c] \Rightarrow [M^1\ L^0\ T^0] \equiv [T]^a \times [LT^{-1}]^b \times [ML^2T^{-1}]^C$

On equating both sides, we get

$\Rightarrow a - b - c = 0;\ c = 1,$ *and* $b + 2c = 0$

$\Rightarrow b = -2c = -2$

$\Rightarrow a = b + c = 1 - 2 = -1$

Hence, dimension of mass $= [t^a\ \upsilon^b\ \ell^c] = [t^{-1}\ \upsilon^{-2}\ \ell^1]$

76. (*b*) We have, $W = \alpha^2\beta e^{-\frac{\beta x^2}{kT}}$

$\therefore \left[\beta x^2\right] = [kT] = \left[ML^2T^{-2}\right]\left[\therefore E = \frac{3}{2}kT\right]$

$\Rightarrow [\beta] = [MT^{-2}]$

And, $[W] = [\alpha^2\beta] \Rightarrow [ML^2T^2] = [\alpha^2][MT^{-2}]$

$\Rightarrow [\alpha] = [L]$

77. (*c*) Work done,

$[W] = [\tau\theta] = [ML^2T^{-2}] \to$ correct

height, $[h] = [L] = \left[\frac{2s\cos\theta}{\rho rg}\right] \to$ correct

Volume, $[V] = [L^3]$; $\left[\frac{\pi pa^4}{8\eta L}\right] = [L^3T^{-1}] \to$ incorrect

Current density, $J = \varepsilon\frac{\partial E}{\partial t} \to$ correct

78. (*c*) $\frac{1}{4\pi\varepsilon_0}\frac{|e|^2}{hc} = \frac{1}{4\pi\varepsilon_0}\frac{|e|^2}{r^2}\times\frac{r^2}{\frac{hc}{\lambda}\times\lambda} = \frac{Fr\times r}{E\times\lambda}$

Dimension of 'Fr' (work) and 'E' (energy) are same.

Therefore, given quantity is dimensionless

79. (*a*) Since, $\frac{x^2}{\alpha kT}$ should be dimensionless.

$\therefore [\alpha] = \frac{L^2}{ML^2\ T^{-2}} = M^{-1}\ T^2$

[KT] = [Energy]

Dimension of $\alpha\beta^2$ should be dimension of *W*.

So, $[\alpha\beta^2] = ML^2T^{-2}$

$\Rightarrow \left[\beta^2\right] = \frac{ML^2\ T^{-2}}{M^{-1}\ T^2} = M^2\ L^2\ T^{-4}$

$\Rightarrow [\beta] = MLT^{-2}$

80. (*b*) Let $M = K\ (V)^a(F)^b(T)^c$

$\Rightarrow$ Equating dimensions of both the sides

$M^1L^0T^0 = (I)[L^1T^{-1}]^a[M^1L^1T^{-2}]^b[T^1]^c$

$M^1L^0T^0 = M^bL^{a+b}T^{-a-2b+c}$

Comparing dimensions, we get

$a = -1, b = 1, c = 1$

Thus, M = (Some Number) $(V^{-1}F^1T^1)$

$\Rightarrow [M] = [V^{-1}F^1T^1]$

81. (*c*) $[A] = [MLT^{-2}]$

$[B] = [L^{-1}]$,

$[D] = [T^{-1}]$

$\Rightarrow \left[\frac{AD}{B}\right] = \frac{[MLT^{-2}][T^{-1}]}{[L^{-1}]}$ or

$\left[\frac{AD}{B}\right] = [ML^2T^{-3}]$

82. (*) $V = K(h)^x\,(I)^y\,(G)^z\,(C)^w$ (V is voltage)

We know, $[h] = ML^2T^{-1}$

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

$[C] = L\ T^{-1},\ [V] = ML^2\ T^{-3}\ A^{-1}$

$M\ L^2\ T^{-3}\ A^{-1} = (ML^2\ T^{-1})^x\ (A)^y\ (M^{-1}\ L^3T^{-2})^z\ (LT^{-1})^w$

$ML^2T^{-3}\ A^{-1} = M^{x-z}\ L^{2x+3z+w}\ T^{-x-2z-w}\ A^y$

$x - z = 1$ ...(*i*)

$2x + 3z + w = 2$ ...(*ii*)

$-x - 2z - w = -3$ ...(*iii*)

$y = -1$ ...(*iv*)

On solving,

$z = -1, x = 0, w = 5, y = -1$

Hence, $V = K(h)^\circ\,(I)^{-1}(G)^{-1}(C)^5$ (Bonus)

83. (*a*) $K_{th} = \frac{Q\Delta x}{A\Delta Tt}$

Dimensional formula $= \frac{\left(ML^2T^{-2}\right)(L)}{\left(L^2\right)(K)(T)}$

$= M^1\ L^1\ T^{-3}\ K^{-1}$

84. (*d*) Solar constant $= \frac{E}{AT}$

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

85. (*c*) $x = \frac{IFv^2}{WL^4}$

$\therefore [x] = \frac{(ML^2)\times(MLT^{-2})\times(LT^{-1})^2}{(ML^2T^{-2})\times L^4}$

$= ML^{-1}T^{-2}$ = [Energy density]

86. (*a*) Planck's constant, $(h) = [M^1L^2T^{-1}]$

Speed of light, $(c) = [L^1T^{-1}]$

Universal gravitational constant

$(G) = [M^{-1}L^3T^{-2}]$

$[f] = \frac{\sqrt{M^1L^2T^{-1}\times L^5\times T^{-5}}}{\sqrt{M^{-1}L^3T^{-2}}} = M^1L^2T^{-2}$

87. (*a*) [Young's modulus] $= \left[\frac{\text{Force}}{\text{Area}}\right]$

$\Rightarrow$ [Young's modulus] $= FA^{-1}$

$\Rightarrow$ [Young's modulus] $= FA^{-1}V^0$

88. (*c*) Energy = Force × Distance

$\Rightarrow$ [Energy] $= \frac{P}{T}\times\sqrt{A} = \left[PA^{\frac{1}{2}}T^{-1}\right]$

89. (*c*) $c = \frac{1}{\sqrt{\mu_0\varepsilon_0}} = x \Rightarrow c = \frac{E}{B} = y$

$\tau = RC = t \Rightarrow \frac{\ell}{RC} = LT^{-1}$

$\Rightarrow [x] = [y] = [z]$

90. (*c*) $t = G^ah^bc^c$

$\Rightarrow M^\circ L^\circ T^1 = (M^{-1}\ L^3\ T^{-2})^a\ (ML^2T^{-1})^b\ (LT^{-1})^c$

$\Rightarrow -a + b = 0 \Rightarrow a = b,$

$3a + 2b + c = 0 \Rightarrow c = -5a,$

$-2a - b - c = 1$

$\Rightarrow a = \frac{1}{2};\ b = \frac{1}{2};\ c = \frac{-5}{2}$

91. (*b*) Power of exponential should be dimensionless.

$\therefore [x^2] = [\alpha tk] \Rightarrow [L^2] = [\alpha]\,[ML^2T^{-2}]$

$\Rightarrow [\alpha] = [M^{-1}T^2]$

$\therefore [F] = [\alpha]\,[\beta] \Rightarrow [MLT^{-2}] = [M^{-1}T^2]\,[\beta]$

$\therefore [\beta] = [M^2LT^{-4}]$

92. (*c*) $\ell\ [Y] = [F]^a\,[V]^b\,[A]^c$

$[ML^{-1}T^{-2}] = [MLT^{-2}]^a\,[LT^{-1}]^b\,[LT^{-2}]^c$

$[ML^{-1}T^{-2}] = [M^aL^{a+b+c}T^{-2a-b-2c}]$

$\therefore a = 1 \quad \ldots(i)$

$a + b + c = -1 \quad \ldots(ii)$

$-2a - b - 2c = -2 \quad \ldots(iii)$

After solving above equations (*i*), (*ii*) and (*iii*).

$a = 1,\ b = -4,\ c = 2 \Rightarrow \therefore [Y] = [V^{-4}A^2F]$

93. (*b*) Time constant $\tau = RC \Rightarrow [RC] = T$

$\Rightarrow V = L\dfrac{di}{dt} \Rightarrow \left[\dfrac{L}{V}\right] = TA^{-1}$

Thus, $\left[\dfrac{L}{RCV}\right] = \dfrac{TA^{-1}}{T} = A^{-1}$

94. [15] $\left(\dfrac{dC}{C}\right)_{\max} = \dfrac{dP}{P} + \dfrac{2dq}{q} + \dfrac{3dr}{r} + \dfrac{1}{2}\dfrac{ds}{s}$

$= 15\%$

95. (*a*) $\rho = \dfrac{M}{\pi r^2 l}$

The maximum percentage error in the measurement of the density of a wire

$$\frac{\Delta\rho}{\rho} = \frac{\Delta M}{M} + 2\frac{\Delta r}{r} + \frac{\Delta l}{l}$$

$$\Rightarrow \frac{\Delta\rho}{\rho} = \left(\frac{0.003}{0.6} + \frac{2\times 0.01}{0.5} + \frac{0.05}{10}\right)100$$

96. (*c*) $E(t) = \alpha^3 e^{-\beta t}$

$E(t) = 3\alpha^2 e^{-\beta t}d\alpha - \beta\alpha^3 e^{-\beta t}dt$

$$\frac{dE(t)}{E(t)} = \frac{3\alpha^2 e^{-\beta t}d\alpha}{E(t)} + \frac{\beta\alpha^3 e^{-\beta t}dt}{E(t)}$$

or $\dfrac{\Delta E}{E} = \dfrac{3\Delta\alpha}{\alpha} + \beta\Delta t$

$\dfrac{\Delta t}{t}\times 100 = 1.6\ (t = 5.8) \Rightarrow \Delta t = 0.08$

$\dfrac{\Delta E}{E} = 3\times 0.012 + 0.3\times 0.08$

$\Rightarrow \dfrac{\Delta E}{E} = 0.06$

maximum percentage error in the energy is:

$\boxed{\%E = 6\%}$

97. (*b*) $y = \dfrac{32.3\times 1125}{27.4}$

$y = 1326.186$

Significant Figures Rule:

The given numbers have 3 significant digits.

The result must also be rounded to 3 significant digits.

Rounding 1326.186 to 3 significant digits:

1326.186→ 1330 (since 1326 rounds up to 1330)

the correct answer is (*b*) 1330.

98. [3] Least Count $= \dfrac{0.75}{15} = 0.05$

$A = lb$

$$\frac{\Delta A}{A} = \frac{\Delta l}{l} + \frac{\Delta b}{b}$$

$$= \frac{0.05}{5} + \frac{0.05}{2.5} = \frac{1}{100} + \frac{1}{50} \Rightarrow \frac{x}{100} = \frac{3}{100}$$

$x = 3$

99. (*c*) for all medium

(a) can also be correct in Hindi & Gujarati medium (NTA)

$$B = \frac{\mu_0}{4\pi}\frac{m}{r^3}$$

$$\frac{\Delta B}{B} = 3\times\left(\frac{\Delta r}{r}\right)$$

% uncertainity in $B = 3\%$

If we also consider error in ℓ.

$$\frac{\Delta B}{B} = \frac{\Delta\ell}{\ell} + 3\times\left(\frac{\Delta r}{r}\right) = 1 + 3\times 1 = 4\%$$

100. [7700] $Q = \dfrac{ab^4}{cd}$

$$\Rightarrow \frac{\Delta Q}{Q} = \frac{\Delta a}{a} + 4\frac{\Delta b}{b} + \frac{\Delta c}{c} + \frac{\Delta d}{d}$$

Percentage error in Q

$$= \left[\frac{\Delta a}{a} + 4\frac{\Delta b}{b} + \frac{\Delta c}{c} + \frac{\Delta d}{d}\right]\times 100$$

$$= \left[\frac{3}{60} + 4\left(\frac{0.1}{20}\right) + \left(\frac{0.2}{40}\right) + \frac{0.1}{50}\right]\times 100 = \frac{x}{1000}$$

$\Rightarrow x = 7700$

101. (*c*) For finding percentage error in Y,

$$\frac{\Delta Y}{Y} = \frac{\Delta m}{m} + \frac{\Delta\ell}{\ell}$$

$$= \frac{5}{500} + \frac{0.02}{2} = 0.01 + 0.01$$

$$\frac{\Delta Y}{Y} = 0.02 \Rightarrow \%\frac{\Delta Y}{Y} = 2\%$$

102. (*b*) if $a \le 5$ order is b

$a > 5$ order is $b + 1$

103. (*d*) From $T = 2\pi\sqrt{\dfrac{m}{k}}$

Since, $T^2 \propto \dfrac{m}{k}$

Therefore,

$$\frac{2\Delta T}{T}\% = \frac{\Delta m}{m}\% - \frac{\Delta k}{k}\%$$

$$\frac{\Delta k}{k}\% = \frac{\Delta m}{m}\% - \frac{2\Delta T}{T}\%$$

$$\frac{\Delta k}{k}\% = (-1)\% - 2(2)\% = |5\%| \ = 5\%$$

104. (*c*) Sum of number by considering significant digit sum = 4.6 + 4.6 + 4.6 + 4.6 = 18.4

Arithmetic Mean $= \dfrac{\text{sum}}{4} = \dfrac{18.4}{4} = 4.6$

105. (*b*) According to lens Formula,

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow f^{-1} = v^{-1} - u^{-1}$$

differentiating w.r.t f

$$\Rightarrow -f^{-2}df = -v^{-2}dv - u^{-2}du$$

$$\Rightarrow \frac{df}{f^2} = \frac{dv}{v^2} + \frac{du}{u^2}$$

$$\Rightarrow df = f^2\left[\frac{dv}{v^2} + \frac{du}{u^2}\right]$$

106. (*c*) Conceptual

107. (*b*) Resistivity of the given material,

$$\rho = R\frac{\rho}{\ell}$$

$$\frac{\Delta\rho}{\rho} = \frac{\Delta R}{R} + 2\frac{\Delta r}{r} + \frac{\Delta\ell}{\ell}$$

$$= \frac{10}{100} + 2\times\frac{0.05}{0.35} + \frac{0.2}{15}$$

$$= \frac{1}{10} + \frac{2}{7} + \frac{1}{75} = 39.9\%$$

108. (*c*) Time period of pendulum,

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

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

Percentage error, $\dfrac{\Delta g}{g} = \dfrac{\Delta\ell}{\ell} + \dfrac{2\Delta T}{T}$

$$= \frac{0.2}{20} + 2\left(\frac{1}{40}\right) = \frac{0.3}{20}$$

Percentage change $= \dfrac{0.3}{20}\times 100 = 6\%$

109. (*b*) Resistance, $R = \dfrac{\rho L}{\pi\dfrac{d^2}{4}}$

$$\frac{\Delta R}{R} = \frac{\Delta L}{L} + \frac{2\Delta d}{d}$$

$\dfrac{\Delta L}{L} = 0.1\%$ and $\dfrac{\Delta d}{d} = 0.1\%$

Percentage error in resistance is

$$\frac{\Delta R}{R} = 0.3\%$$

110. (*a*) Given V = (200 ± 5) V

I = (20 ± 0.2 A)

$R = \frac{V}{T}$

According to error analysis

$\frac{dR}{R} = \frac{dV}{V} + \frac{dI}{I}$

$\frac{dR}{R} = \frac{5}{200} + \frac{0.2}{20} = \frac{5}{200} + \frac{2}{200}$

$\frac{dR}{R} = \frac{7}{200}$

% error $\frac{dR}{R} \times 100 = \frac{7}{200} \times 100 = 3.5\%$

111. (*c*) $Q = \frac{a^4 b^3}{c^2}$

By using the percentage error formula,

$\frac{\Delta Q}{Q} = 4\frac{\Delta a}{a} + 3\left(\frac{\Delta b}{b}\right) + 2\frac{\Delta c}{c}$

$\left(\frac{\Delta Q}{Q} \times 100\right) = 4\left(\frac{\Delta a}{a} \times 100\right) +$
$3\left(\frac{\Delta b}{b} \times 100\right) + 2\left(\frac{\Delta c}{c} \times 100\right)$

% error in $Q = 4 \times 3\% + 3 \times 4\% + 2 \times 5\%$
= 12% + 12% + 10% = 34%

112. (*c*) Least count is 0.2 cm

$u = (100 \pm 0.2) - (80 \pm 0.2) = (20 \pm 0.4)$ cm

$v = (180 \pm 0.2) - (100 \pm 0.2) = (80 \pm 0.4)\,cm$

From lens formula,

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{f} = \frac{1}{80} - \frac{1}{-20} = \frac{-20-80}{-1600}$

f = 16 cm

Also $\frac{\Delta f}{f^2} = \frac{\Delta v}{v^2} + \frac{\Delta u}{u^2}$

$\therefore \frac{\Delta f}{f} \times 100 = \left(\frac{\Delta v}{v^2} + \frac{\Delta u}{u^2}\right) \times f \times 100$

$\Rightarrow \% f = \left(\frac{0.4}{400} + \frac{0.4}{6400}\right) \times 16 \times 100 = 1.70$

113. (*a*) Percentage error in quantity P,

$\frac{\Delta P}{P} \times 100\%$

$= \left(2\frac{\Delta a}{a} + 3\frac{\Delta b}{b} + \frac{\Delta c}{c} + \frac{1}{2}\frac{\Delta d}{d}\right) \times 100\%$

$= 2(1\%) + 3(2\%) + 3\% + \frac{1}{2} \times 4\%$

= 2% + 6% + 3% + 2% = 13%

114. (*d*) Terminal velocity of a spherical body in liquid

$V_t = \frac{2}{9} r^2 \frac{(\rho - \delta) g}{\eta} \Rightarrow Vt \propto r^2$

$\Rightarrow \frac{\Delta V_t}{V_t} = 2 \cdot \frac{\Delta r}{r}$

$\Rightarrow \frac{\Delta V_t}{V_t} \times 100\% = 2\frac{(0.1)}{5} \times 100 = 4\%$

115. (*c*) When R_1 and R_2 are connected in parallel

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ ... (*i*)

$\left[R = \frac{R_1 R_2}{R_1 + R_2} = \frac{10 \times 15}{10 + 15} = 6\right]$

Differentiating (i) both sides

$\frac{\Delta R}{R^2} = \frac{\Delta R_1}{R_1^2} + \frac{\Delta R_2}{R_2^2}$

$\Rightarrow \frac{\Delta R}{R} = \left(\frac{\Delta R_1}{R_1^2} + \frac{\Delta R_2}{R_2^2}\right) R$

$= \left(\frac{0.5}{100} + \frac{0.5}{225}\right) 6 = \frac{13}{300}$

$\frac{\Delta R}{R} \times 100 = \frac{13}{3} = 4.33\%$

116. (*a*) K.E. = $K \pm \Delta K$

$= K \pm K\left(\frac{\Delta m}{m} + \frac{2\Delta v}{v}\right)\left(\because \frac{\Delta K}{K} = \frac{\Delta m}{m} + \frac{2\Delta v}{v}\right)$

$= 1000 \pm 1000\left(\frac{0.5}{5} + \frac{2 \times 0.4}{20}\right)$

= (1000 ± 140) J

117. (*c*) $\rho = \frac{m}{\pi r^2 l} \Rightarrow \left|\frac{d\rho}{\rho}\right|_{max} = \left|\frac{dm}{m}\right| + 2\left|\frac{dr}{r}\right| + \left|\frac{dl}{l}\right|$

$= \frac{0.01}{0.4} + \frac{2(0.03)}{6} + \frac{0.04}{8} = 0.04$

Percentage error in density

$= \left(\frac{d\rho}{\rho}\right) \times 100\% = 4\%$

118. (*c*) $z = \frac{A^2 B^3}{C^4}$

The relative error in z can be given as

$\frac{\Delta z}{z} = \frac{2\Delta A}{A} + \frac{3\Delta B}{B} + \frac{4\Delta C}{C}$

119. [1.99] L = 1m, $\Delta L = 0.4 \times 10^{-3}$m

m = 1kg, $d = 0.4 \times 10^{-3}$m

Area, $A = \frac{\pi d^2}{4} = \frac{3.14 \times (0.4 \times 10^{-3})^2}{4}$
$= 0.1256 \times 10^{-6}\,\text{m}^2$

Young's modulus

$y = \frac{FL}{A\Delta L} = \frac{(1 \times 10) \times 1}{0.1256 \times 10^{-6} \times 0.4 \times 10^{-3}}$

[$\because F$ = mg]

$y = 0.1999 \times 10^{12}$ N/m^2

Now, $\frac{\Delta Y}{Y} = \frac{\Delta F}{F} + \frac{\Delta L}{L} + \frac{\Delta A}{A} + \Delta\left(\frac{\Delta L}{\Delta L}\right)$

$= \frac{2\Delta d}{d} + \frac{\Delta(\Delta L)}{\Delta L} = 2 \times \frac{0.01}{0.4} + \frac{0.02}{0.4}$

$\Delta Y = 0.1 \times 0.199 \times 10^{12} = 1.99 \times 10^{10} = 1.99$

120. (*b*) For torque

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

So, percentage error in torque = %τ
= %M + 2(%L) + 2(%T) = 25%

121. (*a*) Given, $m = 0.6 \pm 0.006$, $r = 0.5 \pm 0.005$, $l = 4 + 0.04$

Percentage error in m,

$\frac{\Delta m}{m} \times 100 = \frac{0.006}{0.6} \times 100 = 1\%$

Percentage error in r,

$\frac{\Delta r}{r} \times 100 = \frac{0.005}{0.5} \times 100 = 1\%$

Percentage error in l,

$\frac{\Delta l}{l} \times 100 = \frac{0.04}{4} \times 100 = 1\%$

Formula of density $\Rightarrow \rho = \frac{m}{V} = \frac{m}{\pi r^2 l}$

$\therefore \frac{\Delta\rho}{\rho} \times 100 = \frac{\Delta m}{m} \times 100 + 2\frac{\Delta r}{r} \times 100 + \frac{\Delta l}{l} \times 100$

= 1 + 2 × 1 + 1 = 4%.

122. [18] We have, $z = a^2 x^3 y^{1/2}$

$\frac{\Delta z}{z} \times 100 = 3\frac{\Delta x}{x} \times 100 + \frac{1}{2}\frac{\Delta y}{y} \times 100$

$= \left(3 \times 4 + \frac{1}{2} \times 12\right) \times 100 = 18\ \%$

123. [150] It is given that, x_1 = 1.22 mm, x_2 = 1.23 mm,

x_3 = 1.19 mm and x_4 = 1.20 mm

$x_{mean} = \frac{x_1 + x_2 + x_3 + x_4}{4}$

$= \frac{1.22 + 1.23 + 1.19 + 1.20}{4} = 1.21$

$|\Delta x_1| = |x_{mean} - x_1| = |1.21 - 1.22| = 0.01$

$|\Delta x_2| = |x_{mean} - x_2| = |1.21 - 1.23| = 0.02$

$|\Delta x_3| = |x_{mean} - x_3| = |1.21 - 1.19| = 0.02$

$|\Delta x_4| = |x_{mean} - x_4| = |1.21 - 1.20| = 0.01$

$(\Delta x)_{mean} = \frac{0.01 + 0.02 + 0.02 + 0.01}{4} = \frac{0.06}{4}$

% error $= \frac{\Delta x_{mean}}{x_{mean}} = \frac{0.06}{4 \times 1.21} \times 100 = \frac{150}{121}\%$

Comparing above result with $\frac{x}{121}\%$, we get x = 150.

124. [5] T = 0.5 sec, No. of oscillation = 100

Resolution = 1sec, ℓ = 10cm ± 1cm

$T = 2\pi\sqrt{\frac{\ell}{g}} \Rightarrow g = \frac{4\pi^2 \ell}{T^2}$

$\frac{dg}{g} \times 100 = \frac{d\ell}{\ell} \times 100 + \frac{2dT}{T} \times 100$

$= \frac{0.1}{10} \times 100 + \frac{2}{50} \times 100 = 5\%$, So, x = 5

125. (*b*) d_{av} = 5.5375 mm

Δd = 0.07395 mm

ℓ Measured data are up to two digits after decimal

$\therefore d = (5.54 \pm 0.07)$ mm

126. (*c*)

$$\frac{\Delta Y}{Y} = \left(\frac{\Delta m}{m}\right) + \left(\frac{\Delta g}{g}\right) + \left(\frac{\Delta A}{A}\right) + \left(\frac{\Delta l}{l}\right) + \left(\frac{\Delta L}{L}\right)$$

$$= \left(\frac{1\text{g}}{1\text{kg}}\right) + 0 + 2\left(\frac{\Delta r}{r}\right) + \left(\frac{\Delta l}{l}\right) + \left(\frac{\Delta L}{L}\right)$$

$$= \left(\frac{1\text{g}}{1\text{kg}}\right) + 2\left(\frac{0.001\text{cm}}{0.2\text{cm}}\right) + \left(\frac{0.001\text{cm}}{0.5\text{cm}}\right) + \left(\frac{0.001\text{m}}{1\text{m}}\right)$$

$$= \frac{1+10+2+1}{1000} = \frac{14}{1000} \times 100\% = 1.4\%.$$

127. (*b*) Here, time period of oscillation, $T = 2\pi\sqrt{\frac{L}{g}}$

$$\Rightarrow T^2 = 4\pi^2\left(\frac{L}{g}\right) \Rightarrow g = 4\pi^2\left(\frac{L}{T^2}\right)$$

$$\therefore \frac{\Delta g}{g}\% = \left(\frac{\Delta L}{L} + \frac{2\Delta T}{T}\right)\%$$

$$= \left[\frac{1mm}{1m} + \frac{2\times 0.01}{1.95}\right] \times 100\%$$

$= (0.001 + 0.0102) \times 100 = 1.13\%$

128. (*a*) $V = IR = I\dfrac{\rho\ell}{\pi\frac{d^2}{4}} \Rightarrow \rho = \dfrac{\pi d^2 V}{4\ell I}$

So, $\dfrac{\Delta\rho}{\rho} = 2\cdot\dfrac{\Delta d}{d} + \dfrac{\Delta V}{V} + \dfrac{\Delta\ell}{\ell} + \dfrac{\Delta I}{I}$

$$= 2\times\frac{0.01}{5.00} + \frac{0.1}{5.0} + \frac{0.1}{10.0} + \frac{0.01}{2000} = 0.039$$

Percentage error $= \dfrac{\Delta\delta}{\delta} \times 100 = 3.9\%$

129. (*a*) Initial resistance, $R_i = \dfrac{\rho\,\ell}{A}$, $\ell_f = 1.25\,\ell$

As volume of wise will remain same.

$A_f = \dfrac{A}{1.25}$

Final resistance,

$$R_f = \frac{\rho(1.25\ell)}{(A/1.25)} = (1.25)^2 \times \frac{\rho\ell}{A}$$

$R_f = 1.5625\ 5\ Ri$

% change in resistance

$$= \frac{R_f - R_i}{R_i} \times 100 = 56.25\%$$

130. [1] Time period of pendulum

$T = 2\pi\sqrt{\dfrac{\ell}{g}}\quad \therefore g = 4\pi^2\dfrac{\ell}{T^2}$

Percentage error in g,

$$\frac{\Delta g}{g} = \frac{\Delta\,\ell}{\ell} + \frac{2\Delta T}{T} = \frac{\Delta\,\ell}{\ell} + \frac{2\Delta T_0}{nT}$$

(Where ΔT_0 is least count for time and h is number of oscillation) From the given table it is clear that student - 1 will get least error.

131. (*b*) $T = 2\pi\sqrt{\dfrac{l}{g}}$

$$\Rightarrow \frac{\Delta T}{T}\times 100 = \frac{1}{2}\frac{\Delta l}{l}\times 100 + \frac{1}{2}\frac{\Delta g}{g}\times 100$$

[As $\Delta g = 0$]

$$\frac{\Delta T}{T}\times 100 = \frac{1}{2}\times 0.1 = 0.05\%$$

For 1 day $\Delta T = \dfrac{0.05}{100}\times 24\times 3600$

$\Delta T = 43.2$ sec

132. (*b*) $T = 2\pi\sqrt{\dfrac{l}{g}} \Rightarrow T^2 = 2\pi\left(\dfrac{l}{g}\right) \Rightarrow g = 2\pi\dfrac{l}{T^2}$

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

$$\Rightarrow \frac{\Delta g}{g} = \frac{1\times 10^{-3}}{1\times 10^{-2}} + \frac{2\times 1}{100}$$

$$\Rightarrow \frac{\Delta g}{g} = 0.02 + 0.01 = 0.03$$

$$\Rightarrow 100\times\frac{\Delta g}{g} = 0.03\times 100 = 3\%$$

133. (*b*)

$$\left(\frac{\Delta y\times 100}{y}\right)$$

$$= \left[2\times\frac{\Delta m}{m} + \frac{4\times\Delta r}{r} + \frac{x\times\Delta g}{g} + \frac{3}{2}\times\frac{\Delta\ell}{\ell}\right]\times 100$$

$\Rightarrow 18 = (2 \times 1) + (4 \times 0.5) + (xp) + \left(\dfrac{3}{2}\times 4\right) \Rightarrow 8 = xp$

Using given options

$$\Rightarrow x = \frac{16}{3};\ p = \pm\frac{3}{2}$$

134. (*b*) $Y = \dfrac{MgL^3}{4bd^3\delta}$

$$\frac{\Delta Y}{Y} = \frac{\Delta M}{M} + \frac{3\Delta L}{L} + \frac{\Delta b}{b} + 3\frac{\Delta d}{d} + \frac{\Delta\delta}{\delta}$$

$$= \frac{1\times 10^{-3}}{2} + \frac{3\times 10^{-3}}{1} + \frac{10^{-2}}{4} + 3\times\frac{0.01\times 10^{-1}}{0.4} + \frac{10^{-2}}{5}$$

$$= 10^{-3}\left[\frac{1}{2} + 3 + \frac{1}{0.4} + \frac{3}{0.4} + \frac{1}{0.5}\right] = 0.0155$$

135. [14] $T = 2\pi\sqrt{\dfrac{l}{g}} \Rightarrow l = \dfrac{T^2 g}{4\pi^2}$

$$E = mgl\frac{\theta^2}{2} = mg^2\frac{T^2\theta^2}{8\pi^2}$$

$$\Rightarrow \frac{\Delta E}{E} = 2\left(\frac{\Delta g}{g} + \frac{\Delta T}{T}\right) = 2(4+3) = 14\%$$

136. [5] $\varepsilon_V = \dfrac{2}{50}\times 100 = 4\%$, $\varepsilon_I = \dfrac{0.2}{20}\times 100 = 1\%$

$\therefore \varepsilon_R = \pm(\varepsilon_V + \varepsilon_I) = \pm(4\% + 1\%) = \pm 5\%$

137. [34] We know that, volume of sphere,

$$V = \frac{4\pi}{3}r^3 \Rightarrow \frac{\Delta V}{V} = 3\frac{\Delta r}{r}$$

$$\%\text{error in volume} = \frac{\Delta V}{V}\times 100 = 3\frac{\Delta r}{r}\times 100$$

$$= 3\times\frac{0.85}{7.50}\times 100 \approx 34$$

138. (*a*) $\dfrac{\Delta T}{T} = \dfrac{1}{2}\left(\dfrac{\Delta g}{g} + \dfrac{\Delta L}{L}\right)$

$$\frac{\Delta g}{g} = \frac{2\Delta T}{T} + \frac{\Delta L}{L};\ = 2\left(\frac{1}{50}\right) + \frac{0.1}{25.0} = 4.4\%$$

139. (*b*) $\dfrac{\Delta z}{z} = 2\dfrac{\Delta a}{a} + \dfrac{2}{3}\dfrac{\Delta b}{b} + \dfrac{1}{2}\dfrac{\Delta c}{c} + 3\dfrac{\Delta d}{d}$

$= 2 \times 2 + \dfrac{2}{3} \times 1.5 + \dfrac{1}{2} \times 4 + 3 \times 2.5 = 14.5\%$

140. (*c*) $\rho = \dfrac{m}{\frac{4}{3}\pi\left(\frac{d}{2}\right)^3}$

$$\therefore \%\ \frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + 3.\left(\frac{\Delta d}{d}\right)$$

$= 6 + 3 \times 1.5 = 10.5\%$

141. (*) As the error is larger in length measurement. So to find the error in density measurement.

$$\rho_{\min} = \frac{m_{\min}}{V_{\max}} = \frac{9.9}{(0.11)^2} = 7438\ \text{kg/m}^3$$

$$\rho_{\max} = \frac{m_{\max}}{V_{\min}} = \frac{10.1}{(0.09)^3} = 13854.6\ \text{kg/m}^3$$

$\therefore \Delta\rho = 13854.6 - 7438 = 6416.6\ \text{kg/m}^3$

(Bonus)

142. (*c*) In case of simple pendulum,

$T = 2\pi\sqrt{\dfrac{L}{g}}\quad \therefore g = \dfrac{4\pi^2 L}{T^2}$

% error in g

$$= \frac{\Delta g}{g}\times 100 = \left(\frac{\Delta L}{L} + \frac{2\Delta T}{T}\right)100\%$$

$$= \left(\frac{0.1}{55} + \frac{2\left(\frac{1}{20}\right)}{\frac{30}{20}}\right)100\% \simeq 6.8\%\cdot$$

143. (*c*) $V = \pi R^2 h = \dfrac{\pi}{4}D^2 h = 4260\ \text{cm}^2$

$$\because \frac{\Delta V}{V} = 2\frac{\Delta D}{D} + \frac{\Delta h}{h}$$

$$\Delta V = \left(2\times\frac{0.1}{12.6} + \frac{0.1}{34.2}\right)V$$

$$= \frac{2\times 426}{12.6} + \frac{426}{34.2}$$

$= 67.61 + 12.459 = 80.075$

$\therefore V = 4260 \pm 80$ cm^3

144. (*c*) $R_2 = (1.005)^2 R_1$

$\% \varepsilon_R = \frac{R_2 - R_1}{R_1} \times 100 = 1\%$

145. (*b*) A vernier scale is designed such that its divisions are slightly smaller than the main scale divisions. This difference allows precise measurements by aligning a particular vernier division with the main scale.

The vernier constant (least count) is actually given by:

Least Count = Value of One Main Scale Division-Value of One Vernier Scale Division

Thus, the correct option is:

A is true but *B* is false.

146. [35] The least count is given by the formula:

$$LC = \frac{\text{Pitch}}{\text{Number of circular divisions}} = \frac{P}{N}$$

= 0.01 mm

Increase in Pitch: The pitch is increased by 75%. So, the new pitch becomes:

New pitch = P × (1 + 0.75) = P × 1.75

Reduction in Number Divisions: The number of divisions is reduced by 50%. So, the new number of divisions is:

New number of divisions = N × (1 – 0.5) = N × 0.5

$$\text{New LC} = \frac{\text{New pitch}}{\text{New number of divisions}}$$

$$= \frac{P \times 1.75}{N \times 0.5}$$

Substituting the values from the original least count:

$$\text{New LC} = \frac{P}{N} \times \frac{1.75}{0.5}$$

= 0.01 mm × 3.5 = 0.035 mm

New LC = 35×10^{-3} mm

147. (*b*) $(n + 1)$ VSD = n MSD

$$\Rightarrow 1VSD = \frac{n}{n+1} MSD$$

$$\Rightarrow L.C = 1\ MSD - 1\ VSD$$

$$L \cdot C = m - m\left(\frac{n}{n+1}\right) = m\left(\frac{n+1-n}{n+1}\right)$$

$$\Rightarrow L \cdot C = \left(\frac{m}{n+1}\right)$$

148. (*b*) **Least count of the screw gauge**

$$= \frac{1}{100} mm = 0.01 mm$$

zero error = +0.05 mm

Reading = 4 × 1 mm + 60 × 0.01 mm – 0.05 = 4.55 mm

149. (*b*) **Least count of vernier calipers**

$$= \frac{1}{20N} cm$$

Least count = 1 MSD – 1VSD

let x no. of divisions of main scale coincides with N division of vernier scale, then

$$1\text{ VSD} = \frac{x \times 1mm}{N}$$

$$\therefore \frac{1}{20N} cm = 1mm - \frac{x \times 1mm}{N}$$

$$\frac{1}{2N} mm = 1mm - \frac{x}{N} mm \Rightarrow x = \frac{2N - 1}{2}$$

150. (*d*) Here, 9MSD = 10VSD and mass = 8.635 g

For least count we have,

$LC = 1\ MSD - 1\ VSD$

$$LC = 1MSD - \frac{9}{10} MSD = \frac{1}{10} MSD$$

$LC = 0.01$ cm

Reading of diameter = MSR + LC × VSR

= 2 cm + (0.01) × (2) = 2.02 cm

Volume of sphere

$$= \frac{4}{3}\pi\left(\frac{d}{2}\right)^3 = \frac{4}{3}\pi\left(\frac{2.02}{2}\right)^3 = 4.32 \text{ cm}^3$$

Density

$$= \frac{\text{mass}}{\text{volume}} = \frac{8.635}{4.32} = 1.998 \sim 2.00 \text{ g}$$

151. (*c*) $1\text{VSD} = \frac{49}{50}$ MSD

$$\text{LC} = \left(1 - \frac{49}{50}\right)\text{MSD} = \frac{1}{50}\text{MSD}$$

zero error ⇒ +4 × (LC) = 0.04 mm

$$\Rightarrow 4 \times \frac{1}{50} \text{ MSD} = 0.04 \text{ mm}$$

So, 1 MSD = 0.05 mm

$$\Leftrightarrow 1 \text{ cm} = \frac{1}{0.05} \text{ MSD}$$

1 cm ≡ 20 MSD

152. (*a*) $1 \text{ VSD} = \frac{49}{50}$ MSD

$$= \frac{1}{50} \times \frac{1}{20} = 0.001 \text{ cm}$$

LC = 1MSD- 1VSD = 0.001 cm

For mark on paper, L_1 = 8.45 cm + 26 × 0.001 cm = 84.76 mm

For mark on paper through slab, L_2 = 7.12 cm + 41× 0.001 cm= 71.61 mm

For powder particle on top surface. L_3 = 4.05 cm +1 × 0.001 cm = 40.51 mm

∴ actual $L_1 = L_1 - L_3$ = 84.76 – 40.51 = 44.25 mm

actual $L_2 = L_2 - L_3$ = 71.61 – 40.51 = 31.10 mm

$$\text{refractive index} = \frac{44.25}{31.10} = 1.42$$

153. (*b*) $$LC = \frac{\text{pitch}}{\text{No. of CSD}} = \left(\frac{1}{100}\right)$$

= 0.01 mm

Diameter = *MSR* + *LC* × *CSD*

Diameter = 1 + (0.01) × 42 mm

Therefore, $\frac{x}{50} = 1.42$

$\therefore x = 71$

154. (*c*) 20VSD = 19 MSD

$$\Rightarrow 1\text{VSD} = \frac{19}{20} \text{ MSD}$$

given LC = 0.01 mm = 1 MSD – 1 VSD

⇔ 1 MSD = 2 mm

155. (*d*) Given: 10 MSD = 11 VSD

$$\Rightarrow 1\text{VSD} = \frac{10}{11}\text{MSD}$$

As, LC = 1MSD – 1VSD

$$= 1\text{MSD} - \frac{10}{11}\text{MSD} = \frac{1\text{MSD}}{11}$$

$$= \frac{5}{11} \text{ units}$$

156. (*d*) 50 V + S = 49S + S

S = 50 (S – V)

0.5 = 50 (S – V)

The Vernier constant of travelling microscope is

$$S - V = \frac{0.5}{50} = \frac{1}{100} = 0.01\text{mm}$$

157. (*b*) Spherometer is an instrument that can be used to measure curvature of surface.

158. (*b*)

159. (*a*) ℓ Zero Error = 6 × Least Count

= 0.6 mm

∴ Reading = MSR + VSR × LC – Zero Error

= [32 *mm* + (0.1)4*mm*] – 0.6 *mm*

= 31.8 *mm* = 31.8 × 10^{-1} cm = 3.18 cm

= 3.18 *cm*

160. (*b*) 1 light year = 9.46×10^{15}m

1 parsec = 3.08×10^{16} m

1Au = $1.496 \times 10^{11\text{m}}$

Therefore, Au < ly < Parsec

161. [220] Least count

$$= \frac{\text{Pitch}}{\text{No. of circular divisions}} = \frac{0.5 \text{ mm}}{100}$$

= 5×10^{-3} mm

Positive Error = MSR + CSR(LC)

= 0 mm + 6(5×10^{-3} mm)

Reading of Diameter = $MSR + CSR\,(LC)$– Positive zero error

$= 4 \times 0.5$ mm + $(46(5 \times 10^{-3}))- 6(5 \times 10^{-3})$mm

= 2 mm+ 40×5×10−3 mm = 2.2 mm

162. (*c*) 1 M.S.D. = 1 mm

Now, 9 M.S.D. = 10 V.S.D.

1 V.S.D. = 0.9 M.S.D. = 0.9 mm = 0.01 cm

Now, L.C. of vernier caliper = 1 – 0.9 = 0.1 mm = 0.01 cm

zero error = –(10 – 4) × 0.1 mm –0.6 mm

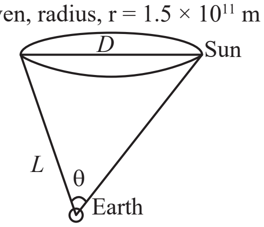
Reading = M.S.R + V.S.R – Zero error

= 3 cm + 6 × 0.01 – [–0.06]

= 3 + 0.06 + 0.06

= 3.12 cm ~ nearest to 3.10

163. (*c*) Given, radius, r = 1.5×10^{11} m



θ = 2000 seconds [ℓ 1° = 60°, 1' = 60"]

$$= \frac{2000}{60\times 60}\text{degree} = \frac{2000}{60\times 60}\times\frac{\pi}{180}\text{radian}$$

$$= \frac{\pi}{36\times 9}\text{radian}$$

Formula, Angle (θ) = $\dfrac{\text{Arc}}{\text{radius}}$

$$\theta = \frac{D}{r} \Rightarrow D = \theta\cdot r \qquad [\text{arc} \approx D]$$

$$= \frac{\pi}{36\times 9}\times 1.5\times 10^{11} = 1.45 \times 10^9 \text{ m}$$

164. (*c*) MSD = 20 divisions per cm ⇒ 1 MSD $= \dfrac{1}{20}cm$

$$1VSD = \frac{24}{25}MSD,\ L.C. = 1\ MSD - 1VSD$$

$$= 1MSD - \frac{24}{25}MSD = \frac{1}{25}\times\frac{1}{20}cm = 0.002\,cm$$

165. (*c*) $\text{L.C.} = \dfrac{0.5}{50}\text{mm} = 0.01 \text{ mm}$

d = (2.5 + 45 × 0.01) mm = 2.95 mm

correct diameter = d – zero error

= 2.95 – (–0.03) = 2.98 mm.

166. [180] We have given, main scale reading = 1.7 cm

Zero correction = 0.05 cm

Vernier scale reading = 5 × 0.1 = 0.5 mm

Diameter of sphere = Main scale reading + Vernier scale reading + Zero correction

= 1.7 + 0.05 + 0.05 = 1.8 cm = 180 × 10^{-2} cm.

167. [412] 1MSD = 1mm

10VSD = 9MSD

Therefore, 1VSD = 0.9 MSD

L.C = 1MSD – 1VSD = 1 – 0.9 = 0. 1mm

Positive zero error = 4LC = 0.4 mm

Reading = MSR + VSR + correction

= 4.1 cm + 6 × .01cm + (–0.04cm)

= 4.12cm = 412 × 10^{-2}cm

168. [5] Let x be the value of one division of main scale

$$\therefore\ x = \frac{1}{20}\text{ cm} = 0.05 \text{ cm}$$

Let y be value of one division on vernier scale $10y = 9x \Rightarrow y = \dfrac{9x}{10}$

$$\text{Least count} = x - \frac{9x}{10} = \frac{x}{10} = \frac{0.05}{10}$$

= 0.005 cm = 5 × 10^{-2} mm

169. (*b*) $\text{L.C} = \dfrac{\text{Pitch}}{\text{No.of division on circular scale}}$

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

Diameter, d = 1.5 + 7 × 0.01

= 1.57 mm = 0.157 cm

∴ Curved Surface Area = $(2\pi r)\ell = \pi d\ell$ $(\ell\ d = 2r)$

= 3.142 × 0.157 × 6.8 = 3.354 cm^2 = 3.4 cm^2

170. (*b*) Number of divisions = 50, Pitch = 0.5mm

$$\text{L.C} = \frac{0.5 \text{ mm}}{50} = 0.01 \text{ mm}$$

True Reading = 5mm + 20 × 0.01 – 5 × 0.01 = 5.15 mm

171. (*b*) Reading = $MSR + VSD \times LC$ – zero error

$$\text{Reading} = 8.5 + \frac{(0.1)\times 6}{10} - \frac{0.2}{10} = 8.54\text{cm}$$

172. [25] $4t = 100 \times \dfrac{4}{3}\pi\times\dfrac{3}{40\pi}\times 10^{-9}\times 0.01$

⇒ $t = 2.5 \times 10^{-11}$ cm = 25 × 10^{-14} m.

173. (*a*) $LC = \dfrac{\text{Pitch}}{\text{No. of division}} = \dfrac{1}{100}\text{mm}$

= 0.01 mm

Zero error = +0.08 mm.

Diameter = 1 + 72 × 0.01 – 0.08 = 1.64 mm

Radius = 0.82 mm

174. (*b*) Least count

$$= \frac{\text{Pitch}}{\text{Total divisions on circular scale}}$$

In 5 revolution, distance travelled = 5 mm

∴ In 1 revolution, distance travelled = 1 mm

$$\text{L. C.} = \frac{1}{50} = 0.02 \text{ mm} = 0.002 \text{ cm}$$

Therefore, Assertion is not correct but reason is correct

175. (*c*) $(n-1)MSD = nVSD$

$$\Rightarrow VSD = \frac{n-1}{n}(MSD)$$

Now, L.C = [1 MSD – 1VSD] cm

$$= a - \frac{n-1}{n}a = \frac{a}{n}\text{cm} = \left(\frac{10a}{n}\right)\text{mm}$$

176. [52] Given: 9 MSD = 10 VSD

Least count of vernier = 1 MSD – 1 VSD

$$= 1\text{MSD} - \frac{9}{10}\text{MSD}$$

MSD = 0.1MSD = 0.1 × 1 mm = 0.1 mm

Reading = 10 mm + 8 × 0.1 mm = 10.8 mm

Final reading = 10.8 mm – 0.04 mm = 10.4 mm

So, radius of bob = 5.2 mm = 52 × 10^{-2} cm

177. [13] Difference in Reading

= Positive Zero Error – Negative Zero Error

= (+5) – [–(100 – 92)] = 13

178. (*b*) Least count $= \dfrac{0.5\,\text{mm}}{50}$

= 1 × 10^{-5} m = 10μm

179. (*) $A_1 + B_1 + C_1$ = 24.36 + 0.0724 + 256.2

= 280.6324

$A_2 + B_2 + C_2$ = 24.44 + 16.082 + 240.2

= 280.722

$A_3 + B_3 + C_3$ = 25.2 + 19.2812 + 236.183

= 280.6642

$A_4 + B_4 + C_4$ = 25 + 236.191 + 19.5

= 280.691

So, no option is correct. (Bonus)

180. (*c*) Least count = $\dfrac{p}{N} = \dfrac{0.1\text{ cm}}{50}$ = 0.02 mm = 0.002 cm

Hence, measurement should integral multiple of LC.

181. (*b*) Least count

$$= \frac{\text{Pitch}}{\text{No. of divisions on circular scale}}$$

$$\Rightarrow\ 5\times 10^{-6} = \frac{10^{-3}}{N} \Rightarrow \text{N} = 200$$