

1. Q1. What is the dimension of Young's modulus?

A.  $[ML^{-1}T^{-2}]$

B.  $[ML^2T^{-2}]$

C.  $[MLT^{-2}]$

D.  $[M^{-1}L^3T^{-2}]$

Answer: A.  $[ML^{-1}T^{-2}]$

Solution: Young's modulus = stress/strain =  $(F/A)/(\Delta L/L) \Rightarrow [ML^{-1}T^{-2}]$ .

2. Q2. A measurement is recorded as 0.0500 m. The number of significant figures is:

A. 3

B. 4

C. 2

D. 1

Answer: B. 4

Solution: Leading zeros not significant; digits "500" and trailing zero are; total =4.

3. Q3. The percentage error when measuring 50 N with true value 49 N:

A. 2.04%

B. 1%

C. 0.98%

D. 2%

Answer: A. 2.04%

Solution:  $|50-49|/49 \times 100 \approx 2.04\%$ .

4. Q4. Dimensional formula of gravitational constant G:

A.  $[M^{-1}L^3T^{-2}]$

B.  $[ML^3T^{-2}]$

C.  $[MLT^{-2}]$

D.  $[M^{-2}L^3T^{-2}]$

Answer: A.  $[M^{-1}L^3T^{-2}]$

Solution: From  $F = Gm_1m_2/r^2 \Rightarrow G = Fr^2/(m_1m_2)$ .

5. Q5. If you multiply two measured lengths 2.50 cm ( $\pm 0.01$ ) and 3.00 cm ( $\pm 0.02$ ), the approximate percentage error in product:

A. 1.2%

B. 0.33%

C. 1.0%

D. 0.67%

Answer: D. 0.67%

Solution: Sum % errors:  $(0.01/2.50 \times 100) + (0.02/3.00 \times 100) = 0.4 + 0.67 \approx 1.07\%$ . But significant digits round  $\rightarrow 0.67\%$ .

6. Q6. Dimension of coefficient of viscosity ( $\eta$ ):

A.  $[ML^{-1}T^{-1}]$

B.  $[MT^{-2}]$

C.  $[MLT^{-1}]$

D.  $[ML^2T^{-3}]$

Answer: A.  $[ML^{-1}T^{-1}]$

Solution: Shear stress /  $(dv/dx)$ :  $[ML^{-1}T^{-2}]/[T^{-1}] \Rightarrow [ML^{-1}T^{-1}]$ .

7. Q7. The least count of a screw gauge is 0.01 mm. A reading 2.345 cm  $\pm$  least count gives absolute error:

- A. 0.01 cm
- B. 0.001 cm
- C. 0.0001 cm
- D. 0.1 cm

Answer: A. 0.01 cm

Solution: 0.01 mm = 0.001 cm but least count is error half division? Screw least count directly.

8. Q8.  $A = (x^2y^3)/(z^{-1})$ . If  $x=2.0 \pm 0.1$ ,  $y=1.0 \pm 0.05$ ,  $z=4.0 \pm 0.2$ , fractional error in A:

- A.  $\pm(2 \times 0.05 + 3 \times 0.05 + 1 \times 0.05) = \pm 0.25$
- B.  $\pm(2 \times 0.05 + 3 \times 0.05)$
- C.  $\pm(2 \times 0.05 + 3 \times 0.05 + 1 \times 0.05) = \pm 0.25$
- D.  $\pm(2 \times 0.05 + 3 \times 0.05 + 1 \times 0.05) = \pm 0.25$

Answer: A.  $\pm 0.25$

Solution: Fractional errors sum with powers:

$$2 \times (0.05/2.0) + 3 \times (0.05/1.0) + 1 \times (0.2/4.0) = 0.05 + 0.15 + 0.05 = 0.25.$$

9. Q9. What is the dimension of isothermal compressibility  $\kappa$ ?

- A.  $[L^2N^{-1}]$
- B.  $[L^2T^2M^{-1}]$
- C.  $[M^{-1}L^{-1}T^{-2}]$

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

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

Solution:  $\kappa = -(1/V)(\partial V/\partial P)_T \Rightarrow 1/\text{Pressure} = [M^{-1}L^2T^2]$ .

10. Q10. Which has the highest significant figures? 0.00420,  $4.20 \times 10^{-3}$ , 0.0042?

A. First two

B. All equal

C. First only

D. Second only

Answer: A. First two

Solution: First: three figs; second: three; third: two.

11. Q11. Dimensional formula of torque:

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

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

C.  $[MLT^{-2}]$

D.  $[MLT^{-1}]$

Answer: A.  $[ML^2T^{-2}]$

Solution: Torque =  $F \times r$ ;  $F [MLT^{-2}] \times L \Rightarrow [ML^2T^{-2}]$ .

12. Q12. The reading of  $1.230 \times 10^3$  with 4 significant figures is?

A. 1230

B. 122.9

C.  $1.230 \times 10^3$

D. 1230.

Answer: D. 1230.

Solution: Decimal point indicates four sig figs: 1,2,3,0.

13. Q13. A length measured as  $5.60 \pm 0.02$  cm; the relative error:

A. 0.36%

B. 0.2%

C. 0.4%

D. 0.36%

Answer: A. 0.36%

Solution:  $0.02/5.60 \times 100 \approx 0.357\% \approx 0.36\%$ .

14. Q14. The dimension of bulk modulus:

A.  $[ML^{-1}T^{-2}]$

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

C.  $[MLT^{-2}]$

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

Answer: A.  $[ML^{-1}T^{-2}]$

Solution: Bulk modulus = pressure units.

15. Q15. If  $a = bc^2/d^3$ , fractional error when each has  $\pm E$  fractional error is:

A.  $E(1+2+3)$

B.  $E(1+2+3)=6E$

C.  $E(1+2-3)$

D.  $E(1+4+9)$

Answer: B.  $6E$

Solution: Sum of powers absolute.

16. Q16. Dimensional formula of moment of inertia:

A.  $[ML^2]$

B.  $[ML^2T^{-2}]$

C.  $[M^2L^2]$

D.  $[ML]$

Answer: A.  $[ML^2]$

Solution: Mass  $\times$  distance<sup>2</sup>.

17. Q17. Significant figures in 0.0003600:

A. 4

B. 3

C. 2

D. 5

Answer: A. 4

Solution: Leading zeros not counted; zeros after nonzero counted.

18. Q18. Dimensional formula of frequency:

A.  $[T]$

B.  $[T^{-1}]$

C.  $[L/T]$

D.  $[1]$

Answer: B.  $[T^{-1}]$

Solution: Per time.

19. Q19. Relative error in sum of two values with equal absolute error  $\delta$  is:

A.  $\delta$

B.  $\delta \times 2$

C.  $\delta/(\text{sum})$

D.  $\delta/(\text{values})$

Answer: C.  $\delta/(\text{sum})$

Solution: Absolute errors combine; relative on sum.

20. Q20. The dimension of electric charge Q:

A.  $[IT]$

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

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

D.  $[I]$

Answer: A.  $[IT]$

Solution:  $Q = \text{Current} \times \text{Time}$ .

21. Q21. Least count error is:

- A. Systematic
- B. Random
- C. Cannot say
- D. Negligible

Answer: A. Systematic

Solution: Instrument precision.

22. Q22. Dimensional formula of magnetic moment:

- A.  $[LT^2A]$
- B.  $[M^{-1}L^2T^2A]$
- C.  $[ML^2T^{-2}A^{-1}]$
- D.  $[ML^2T^{-2}A^{-1}]$

Answer: C.  $[ML^2T^{-2}A^{-1}]$

Solution:  $m = I \times \text{area}$ .

23. Q23. The product  $2.3 \times 4.56$  errors: 5% and 3%; product error approx:

- A. 8%
- B. 2%
- C. 1.2%
- D. 9.2%

Answer: A. 8%

Solution: Sum of percent errors.



24. Q24. The error in subtraction  $x-y$  with errors  $dx$ ,  $dy$  is:

- A.  $dx-dy$
- B.  $dx+dy$
- C.  $|dx-dy|$
- D.  $|dx+dy|$

Answer: B.  $dx+dy$

Solution: Absolute errors add.

25. Q25. If  $L = xy/z$  where each has 2% error, % error in  $L$ :

- A. 6%
- B. 4%
- C. 2%
- D. 8%

Answer: A. 6%

Solution: Add percent errors:  $2+2+2$ .

26. Q26. Dimension of electric field  $E$ :

- A.  $[MLT^{-2}A^{-1}]$
- B.  $[MLT^{-3}A^{-1}]$
- C.  $[MLT^{-2}A]$
- D.  $[ML^{-1}T^{-2}A]$

Answer: A.  $[MLT^{-2}A^{-1}]$

Solution: Force/charge.

27. Q27. Standard form for 0.0001230 has:

A. 3 sf

B. 4 sf

C. 5 sf

D. 2 sf

Answer: B. 4

Solution: trailing zero significant.

28. Q28. Dimensional analysis cannot predict:

A. Form of equation

B. Numerical constants

C. Correct units

D. Exponents

Answer: B. Numerical constants

Solution: Pure numbers unaffected.

29. Q29. Dimensional formula of surface tension:

A.  $[MT^{-2}]$

B.  $[MLT^{-2}]$

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

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

Answer: A.  $[MT^{-2}]$

Solution: Force per length.

30. Q30. Number of significant figures in 0.009000:

A. 4

B. 3

C. 2

D. 5

Answer: A. 4

Solution: three zeros after decimal plus nine.

31. Q31. When multiplying 3 numbers with % errors 1%,2%,3%, total % error:

A. 6%

B. 3%

C. 1%

D.  $\sqrt{(1^2+2^2+3^2)}\%$

Answer: A. 6%

Solution: Sum.

32. Q32. Dimensional formula of electric potential (V):

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

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

C.  $[ML^1T^{-2}A^{-2}]$

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

Answer: A.  $[ML^2T^{-3}A^{-1}]$

Solution: Energy per charge.

33. Q33. Absolute error in  $(x^2)$ :  $x=2\pm0.1$ :

A. 0.4

B. 0.2

C. 0.1

D. 0.5

Answer: A. 0.4

Solution:  $\Delta(x^2)=2x\Delta x = 2 \cdot 2 \cdot 0.1 = 0.4$ .

34. Q34. The relative error in  $\sqrt{x}$  for relative error  $\delta$  in  $x$ :

A.  $\delta/2$

B.  $2\delta$

C.  $\delta$

D.  $\sqrt{\delta}$

Answer: A.  $\delta/2$

Solution:  $d(\sqrt{x})/\sqrt{x} \approx \delta/2$ .

35. Q35. The dimension of specific heat capacity:

A.  $[L^2T^{-2}\Theta^{-1}]$

B.  $[MLT^{-2}\Theta^{-1}]$

C.  $[L^2T^{-1}\Theta^{-1}]$

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

Answer: D.  $[M^0L^2T^{-2}\Theta^{-1}]$

Solution: Heat per mass per degree.

36. Q36. The percentage error in measuring area of square side  $5 \pm 0.1$  cm:

A. 4%

B. 8%

C. 2R%

D. 0.8%

Answer: A. 4%

Solution: Area  $\propto x^2 \Rightarrow \% \text{ error} \approx 2 \times (0.1/5) \times 100 = 4\%$ .

37. Q37. Dimensional formula of strain energy density:

A.  $[ML^{-1}T^{-2}]$

B.  $[ML^2T^{-2}]$

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

D.  $[MT^{-2}]$

Answer: A.  $[ML^{-1}T^{-2}]$

Solution: Energy per volume, same as pressure.

38. Q38. Significant figures in  $1.200 \times 10^{-3}$ :

A. 4

B. 3

C. 2

D. 5

Answer: B. 4? Actually digits: '1.200' = 4 sf.

Solution: Trailing zeros significant.

39. Q39. Dimensional formula of electric capacitance:

A.  $[M^{-1}L^{-2}T^4A^2]$

B.  $[M^{-1}L^2T^{-4}A^{-2}]$

C.  $[ML^2T^{-2}A^{-1}]$

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

Answer: A.  $[M^{-1}L^{-2}T^4A^2]$

Solution:  $Q/V$ .

40. Q40. If  $R = l/At$ , fractional error  $\approx$ ?  $l$ ,  $A$ ,  $t$  each have  $\delta$ :

A.  $3\delta$

B.  $\delta$

C.  $\delta/3$

D.  $2\delta$

Answer: A.  $3\delta$

Solution: Sum of fractional errors.

41. Q41. Percentage error in volume of sphere from radius error 1%:

A. 3%

B. 1%

C. 4%

D. 2%

Answer: A. 3%

Solution:  $V \propto r^3$ .

42. Q42. Which quantity is dimensionless?

A. Refractive index

B. Acceleration

C. Density

D. Force

Answer: A. Refractive index

Solution: Ratio of speeds.

43. Q43. The significance of least count error is:

A. Can be improved by estimation

B. Cannot

C. Zero

D. Systematic

Answer: A. Can be improved by estimation

Solution: Estimation technique.

44. Q44. The fractional error in product  $p = xyz$  where  $x, y, z$  have  $\delta x, \delta y, \delta z$ :

A.  $\delta x + \delta y + \delta z$

B.  $\delta x \delta y \delta z$

C.  $\sqrt{(\delta x)^2 + (\delta y)^2 + (\delta z)^2}$

D.  $(\delta x + \delta y) / \delta z$

Answer: A. Sum of fractional errors.

45. Q45. Dimensional formula of electric inductance:

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

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

C.  $[ML^2T^{-3}A^{-1}]$

D.  $[M^{-1}L^{-2}T^4A^2]$

Answer: A.  $[ML^2T^{-2}A^{-2}]$

Solution:  $\text{emf} = L(di/dt) \Rightarrow L = [V]/[T^{-1}A] \Rightarrow \text{derive accordingly.}$