Main Booklet Solution

Units & Dimensions, Errors & Measurement

JEE Main Exercise

Units

1. (C)
Light year is a distance which light travels in one year.

2. (B)
Because magnitude is absolute.

3. (D)
$Watt = Joule/second = Ampere \times volt = Ampere^2 \times Ohm$

4. (C)
Impulse = change in momentum = $F \times t$
So, the unit of momentum will be equal to *Newton-sec.*

5. (C)
Unit of energy will be $kg\text{-}m^2/\sec^2$

6. (C)
$1\ nm = 10^{-9} m = 10^{-7} cm$

7. (D)
$1\ micron = 10^{-6} m = 10^{-4} cm$

8. (C)
$Watt = Joule/sec.$

9. (C)
$$F = \frac{Gm_1m_2}{d^2}; \quad \therefore\ G = \frac{Fd^2}{m_1m_2} = Nm^2/kg^2$$

10. (A)

11. (C)
$$\text{Angular acceleration} = \frac{\text{Angular velocity}}{\text{Time}} = \frac{\text{rad}}{\text{sec}^2}$$

12. (B)
Kg-m/sec is the unit of linear momentum

13. (D)
ct^2 must have dimensions of L
$\Rightarrow c$ must have dimensions of L/T^2 *i.e.* LT^{-2}.

14. (D)
$\tau = \frac{dL}{dt} \Rightarrow dL = \tau \times dt = r \times F \times dt$
i.e. the unit of angular momentum is *joule-second.*

15. (C)

16. (A)
Volume of cube = a^3
Surface area of cube = $6a^2$
According to problem $a^3 = 6a^2 \Rightarrow a = 6$
$\therefore \quad V = a^3 = 216\,units$.

17. (B)
$6 \times 10^{-5} = 60 \times 10^{-6} = 60\,microns$

18. (D)

19. (D)
Because temperature is a fundamental quantity.

20. (A)

21. (A)
1 C.G.S unit of density = 1000 M.K.S. unit of density $\Rightarrow$ $0.5\,gm/cc = 500\,kg/m^3$

22. (B)

23. (D)

24. (D)
$E = -\frac{dV}{dx}$

25. (D)

26. (D)

Surface tension = $\dfrac{\text{Force}}{\text{Length}}$ = *Newtons* / *metre*

27. (B)

$mv = kg\left(\dfrac{m}{\sec}\right)$

28. (A)

Quantities of similar dimensions can be added or subtracted so unit of *a* will be same as that of velocity.

29. (B)

$1\ MeV = 10^6\ eV$

30. (A)

Energy (E) = $F \times d \Rightarrow F = \dfrac{E}{d}$

So, *Erg/metre* can be the unit of force.

31. (B)

Potential energy $= mgh = g\left(\dfrac{cm}{\sec^2}\right)cm = g\left(\dfrac{cm}{\sec}\right)^2$

32. (B)

$\dfrac{watt}{ampere} = volt$

33. (B)

Dimensions

34. (B)

Power $= \dfrac{\text{Work}}{\text{Time}} = \dfrac{ML^2T^{-2}}{T} = ML^2T^{-3}$

35. (A)

Calorie is the unit of heat *i.e.*, energy.

So dimensions of energy $= ML^2T^{-2}$

36. (B)

Angular momentum = $mvr = MLT^{-1} \times L = ML^2T^{-1}$

37. (C)

$\dfrac{L}{R}$ = Time constant

38. (C)

Impulse = change in momentum so dimensions of both quantities will be same and equal to MLT^{-1}

39. (B)

$RC = T$

$\because\ [R] = [ML^2T^{-3}I^{-2}]$ and $[C] = [M^{-1}L^{-2}T^4I^2]$

40. (A, D)

[Torque] = [work] = $[ML^2T^{-2}]$

[Light year] = [Wavelength] = $[L]$

41. (A)

$Q = mL \Rightarrow L = \frac{Q}{m}$ (Heat is a form of energy)

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

42. (D)

Volume elasticity = $\frac{\text{Force/Area}}{\text{Volume strain}}$

Strain is dimensionless, so $= \frac{\text{Force}}{\text{Area}} = \frac{MLT^{-2}}{L^2} = [ML^{-1}T^{-2}]$

43. (B)

$F = \frac{Gm_1m_2}{d^2} \Rightarrow G = \frac{Fd^2}{m_1m_2}$

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

44. (A)

Angular velocity = $\frac{\theta}{t}$, $[\omega] = \frac{[M^0L^0T^0]}{[T]} = [T^{-1}]$

45. (A)

Power = $\frac{\text{Work done}}{\text{Time}} = \left[\frac{ML^2T^{-2}}{T}\right] = [ML^2T^{-3}]$

46. (A)

Couple = Force $\times$ Arm length $= [MLT^{-2}][L] = [ML^2T^{-2}]$

47. (B)

Angular momentum = mvr

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

48. (B)

Impulse = Force $\times$ Time = $[MLT^{-2}][T]=[MLT^{-1}]$

49. (A)

50. (C)

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

51. (B)

Moment of inertia $=mr^2=[M]\,[L^2]$

Moment of Force = Force $\times$ Perpendicular distance

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

52. (A)

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

Impulse = Force $\times$ Time = $[MLT^{-2}]\times[T]=[MLT^{-1}]$

53. (B)

Pressure = $\frac{\text{Force}}{\text{Area}}=\frac{\text{Energy}}{\text{Volume}}$ = $ML^{-1}T^{-2}$

54. (A)

$\frac{1}{2}Li^2$ = Stored energy in an inductor = $[ML^2T^{-2}]$

55. (D)

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

Force per unit area = $\frac{[MLT^{-2}]}{[L^2]}=[ML^{-1}T^{-2}]$

Product of voltage and charge per unit volume

$=\frac{V\times Q}{\text{Volume}}=\frac{VIt}{\text{Volume}}=\frac{\text{Power}\times\text{Time}}{\text{Volume}}$

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

Angular momentum per unit mass = $\frac{[ML^2T^{-1}]}{[M]}=[L^2T^{-1}]$

So angular momentum per unit mass has different dimension.

56. (D)

Time constant $\tau=[T]$ and Viscosity $\eta=[ML^{-1}T^{-1}]$

For options (a), (b) and (c) dimensions are not matching with time constant.

57. (D)

By putting the dimensions of each quantity both the sides we get $[T^{-1}]=[M]^x[MT^{-2}]^y$

Now comparing the dimensions of quantities in both sides we get $x+y=0$ and $2y=1$

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

58. (C)

m = linear density = mass per unit length = $\left[\frac{M}{L}\right]$

A = force $=[MLT^{-2}]$ $\therefore\ [B]$ = $\frac{[A]}{[m]}=\frac{[MLT^{-2}]}{[ML^{-1}]}=[L^2T^{-2}]$

This is same dimension as that of latent heat.

59. (C)

Let $v^x=kg^y\lambda^z\rho^\delta$.

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

60. (A)

Farad is the unit of capacitance and $C=\frac{Q}{V}=\frac{[Q]}{[ML^2T^{-2}Q^{-1}]}=M^{-1}L^{-2}T^2Q^2$

61. (A)

$\rho=\frac{RA}{l}$ *i.e.* dimension of resistivity is $[ML^3T^{-1}Q^{-2}]$

62. (B)

From the principle of homogenity $\left(\frac{x}{v}\right)$ has dimensions of *T*.

63. (C)

Stress = $\frac{\text{Force}}{\text{Area}}=\frac{[MLT^{-2}]}{[L^2]}=[ML^{-1}T^{-2}]$

64. (C)

65. (B)

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

66. (C)

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

Here % error in $l = \frac{1mm}{100cm}\times 100 = \frac{0.1}{100}\times 100 = 0.1\%$ and % error in $T = \frac{0.1}{2\times 100}\times 100 = 0.05\%$

$\therefore$ % error in g = % error in l + 2(% error in T)

$= 0.1 + 2\times 0.05 = 0.2$ %

67. (B)

$\therefore E = \frac{1}{2}mv^2$

$\therefore$ % Error in K.E.

= % error in mass + 2 × % error in velocity

= 2 + 2 × 3 = 8%

68. (B)

69. (B)

Number of significant figures are 3, because 10^3 is decimal multiplier.

70. (B)

$\because V = \frac{4}{3}\pi r^3$

$\therefore$ % error is volume $= 3\times$% error in radius

$= 3\times 1 = 3\%$

71. (C)

Mean time period $T = 2.00$ *sec*

& Mean absolute error $= \Delta T = 0.05$ *sec.*

To express maximum estimate of error, the time period should be written as $(2.00 \pm 0.05)\, sec$

72. (B)

Here, $S = (13.8 \pm 0.2)\, m$ and $t = (4.0 \pm 0.3)\ sec$

Expressing it in percentage error, we have,

$S = 13.8 \pm \frac{0.2}{13.8}\times 100\% = 13.8 \pm 1.4\%$ and $t = 4.0 \pm \frac{0.3}{4}\times 100\% = 4 \pm 7.5\%$

$\because V = \frac{s}{t} = \frac{13.8 \pm 1.4}{4 \pm 7.5} = (3.45 \pm 0.3)\ m/s.$

73. (C)

% error in velocity = %error in L + %error in t

$= \frac{0.2}{13.8}\times 100 + \frac{0.3}{4}\times 100$

= 1.44 + 7.5 = 8.94 %

74. (C)

75. (A)

$$\frac{1}{20} = 0.05$$

$\therefore$ Decimal equivalent upto 3 significant figures is 0.0500

76. (B)

77. (B)

$\because V = \frac{4}{3}\pi r^3$

$\therefore$ % error in volume

$= 3 \times \%$ error in radius.

$$= \frac{3 \times 0.1}{5.3} \times 100$$

78. (A)

Since percentage increase in length = 2 %

Hence, percentage increase in area of square sheet

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

79. (C)

Since for 50.14 *cm*, significant number = 4 and for 0.00025, significant numbers = 2

80. (D)

$a = b^\alpha c^\beta / d^\gamma e^\delta$

So maximum error in *a* is given by

$$\left(\frac{\Delta a}{a} \times 100\right)_{\max} = \alpha . \frac{\Delta b}{b} \times 100 + \beta . \frac{\Delta c}{c} \times 100 + \gamma . \frac{\Delta d}{d} \times 100 + \delta . \frac{\Delta e}{e} \times 100$$

$$= \left(\alpha b_1 + \beta c_1 + \gamma d_1 + \delta e_1\right)\%$$

81. (A)

Weight in air $= (5.00 \pm 0.05)\, N$

Weight in water $= (4.00 \pm 0.05)\, N$

Loss of weight in water $= (1.00 \pm 0.1)\, N$

Now relative density $= \frac{\text{weight in air}}{\text{weight loss in water}}$

i.e. $R\,.\,D = \frac{5.00 \pm 0.05}{1.00 \pm 0.1}$

Now relative density with max permissible error

$$= \frac{5.00}{1.00} \pm \left(\frac{0.05}{5.00} + \frac{0.1}{1.00}\right) \times 100 = \frac{5.00}{1.00} \pm \left(\frac{0.05}{5.00} + \frac{0.1}{1.00}\right) \times 100 = 5.0 \pm (1 + 10)\% = 5.0 \pm 11\%$$

82. (B)

$$\therefore \left(\frac{\Delta R}{R}\times 100\right)_{\max} = \frac{\Delta V}{V}\times 100 + \frac{\Delta I}{I}\times 100$$

$$= \frac{5}{100}\times 100 + \frac{0.2}{10}\times 100 = (5+2)\% = 7\%$$

83. (B)

Average value $= \frac{2.63+2.56+2.42+2.71+2.80}{5}$

$= 2.62\,\text{sec}$

Now $|\Delta T_1| = 2.63 - 2.62 = 0.01$

$|\Delta T_2| = 2.62 - 2.56 = 0.06$

$|\Delta T_3| = 2.62 - 2.42 = 0.20$

$|\Delta T_4| = 2.71 - 2.62 = 0.09$

$|\Delta T_5| = 2.80 - 2.62 = 0.18$

Mean absolute error

$$\Delta T = \frac{|\Delta T_1| + |\Delta T_2| + |\Delta T_3| + |\Delta T_4| + |\Delta T_5|}{5}$$

$$= \frac{0.54}{5} = 0.108 = 0.11\,sec$$

84. (C)

Volume of cylinder $V = \pi r^2 l$

Percentage error in volume

$$\frac{\Delta V}{V}\times 100 = \frac{2\Delta r}{r}\times 100 + \frac{\Delta l}{l}\times 100$$

$$= \left(2\times\frac{0.01}{2.0}\times 100 + \frac{0.1}{5.0}\times 100\right) = (1+2)\% = 3\%$$

85. (C)

$Y = \frac{4MgL}{\pi D^2 l}$ so maximum permissible error in $Y = \frac{\Delta Y}{Y}\times 100 = \left(\frac{\Delta M}{M} + \frac{\Delta g}{g} + \frac{\Delta L}{L} + \frac{2\Delta D}{D} + \frac{\Delta l}{l}\right)\times 100$

$$= \left(\frac{1}{300} + \frac{1}{981} + \frac{1}{2820} + 2\times\frac{1}{41} + \frac{1}{87}\right)\times 100 = 0.065\times 100 = 6.5\%$$

86. (B)

$H = I^2 R t$

$$\therefore \frac{\Delta H}{H}\times 100 = \left(\frac{2\Delta I}{I} + \frac{\Delta R}{R} + \frac{\Delta t}{t}\right)\times 100 = (2\times 3 + 4 + 6)\% = 16\%$$

87. (D)

Kinetic energy $E = \frac{1}{2}mv^2$

$\therefore \frac{\Delta E}{E}\times 100 = \frac{v'^2 - v^2}{v^2}\times 100 \;= [(1.5)^2 - 1]\times 100$

$\therefore \frac{\Delta E}{E}\times 100 = 125\%$

88. (C)

Quantity *C* has maximum power. So it brings maximum error in *P*.

89. (C)

Given, $L = 2.331\,cm$

$= 2.33$ (correct upto two decimal places) and $B = 2.1\,cm = 2.10\,cm$

$\therefore L + B = 2.33 + 2.10 = 4.43\,cm. = 4.4\,cm$

Since minimum significant figure is 2.

90. (D)

The number of significant figures in all of the given number is 4.

91. (C)

92. (A)

Percentage error in $X = a\alpha + b\beta + c\gamma$

93. (D)

Percentage error in $A = \left(2\times 1 + 3\times 3 + 1\times 2 + \frac{1}{2}\times 2\right)\% = 14\%$

PYQ : JEE Main

1. (A)

Torque = Force × Perpendicular distance = $[MLT^{-2}]$ $[L]$ = $[ML^2T^{-2}]$

Work = Force × Displacement = $[MLT^{-2}]$ $[L]$ = $[ML^2T^{-2}]$

2. (B)

$\frac{1}{\sqrt{\mu_0 \in_0}} = \sqrt{L^2T^{-2}} = LT^{-1}$

Speed = LR^{-1}

Stress, Young's modulus $= \frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2}$

Momentum = MLT^{-1}

Torque, work = ML^2T^{-2}

Planck's constant $= \frac{ML^2T^{-2}}{\left(LT^{-1}\right)}\times L = ML^2T^{-1}$

3. (C)

Vaccum permittivity:

$$F_c = \frac{1}{4\pi\varepsilon_0} \times \frac{q_1 q_2}{r^2}$$

Where ε_0 is permittivity of vaccum.

Dimension will be $[M^{-1}L^{-3}T^4I^2]$

Vaccum permeability:

$$\mu_0 = 4\pi \times 10^{-7} \quad N/A^2$$

Dimensions will be $[MLT^{-2}I^{-2}]$

Dimension for $\frac{1}{\mu_0\varepsilon_0}$ will be $\frac{1}{[M^{-1}L^{-3}T^4I^2]\times[M^1L^1T^{-2}I^{-2}]} = [L^2T^{-2}]$

4. (C)

For calculating coefficient of viscosity we can use the formula, $F = \frac{\eta vA}{S}$

Dimension of coefficient of viscosity will be $= \frac{\text{Dimension of force} \times \text{Distance}}{\text{Velocity} \times \text{Area}}$

$$= \frac{MLT^{-2} \times L}{LT^{-1}L^2}$$

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

5. (C)

Moment of Inertia, $I = Mr^2$

$[I] = [ML^2]$

Moment of force, $\vec{\tau} = \vec{r} \times \vec{F}$ -

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

6. (C)

Rad is the unit of absorbed dose of ionizing radiation. One rad is equal approximately to the absorbed dose delivered when soft tissue is exposed to one-roentgen of medium-voltage radiation. Thus this is the bilogical effect of radiation.

7. (B)

Weber = $ML^2T^{-2}I^{-1}$

$= ML^2T^{-2}Q^{-1}T = ML^2T^{-1}Q^{-1}$ $(I = QT^{-1})$

Henry H is SI unit of inductance.

H = $ML^2T^{-2}I^{-2}$; also I = QT^{-1}

So, H = $ML^2T^{-2}Q^{-2}T^2 = ML^2Q^{-2}$

8. (A)

Momentum = mv = 3.513 × 5.00 = 17.565 ≈ 17.57

≈ 17.6 kgm/s

(Since 5.00 contains least no. of significant figures i.e. 3)

9. (C)

$$[B] = \frac{F}{il} = \frac{Ft}{ql} = \frac{MLT^{-2}T}{CL} = [MT^{-1}C^{-1}]$$

10. (A)

30 divisions of vernier scale coincide with 29 divisions of main scale.

$$\therefore\ 1\,V.S.D = \frac{29}{30}\,M.S.D$$

Least count = 1 MSD – 1 VSD

$$= 1\,MSD - \frac{29}{30}\,MSD$$

$$= \frac{1}{30}\,MSD = \frac{1}{30}\times 0.5^{o}$$

$$= \frac{1}{30}\times 30\text{ min} = 1\text{ min}$$

11. (A)

Zeroes before a digit is not counted as a significant figure. In first number all digits are significant. In number second only 3 is significant all other zeroes are before digit therefore, not counted as a significant figure and numbers in powers are also not counted as a significant number, hence there are only 2 significant digits in the last number. Therefore, option (A).

12. (D)

Angular momentum $= m\times v\times r = ML^2T^{-1}$

Latent heat $L = \frac{Q}{m} = \frac{ML^2T^{-2}}{M} = L^2T^{-2}$

Capacitance $C = \frac{\text{Charge}}{\text{P.d.}} = M^{-1}L^{-2}T^4A^2$

13. (A)

Given : $E_y \alpha J_x$ and $E_y \alpha B_Z$

$E_y \alpha J_x B_Z$

$\Rightarrow\ E_y - = KJ_xB_Z$ (where K = constant of proportionality)

By Dimensional analysis we have;

$[E_y] = [KJ_xB_Z]$

$$\Rightarrow\ [K] = \frac{[E_y]}{[J_xB_Z]} = \frac{[M^1L^1T^3A^{-1}]}{[L^{-2}A^A][M^1T^{-2}A^{-1}]}$$

$$\Rightarrow\ [K] = \frac{[L^3]}{[A^1T^1]} \rightarrow \text{Dimensional formula of K}$$

So, S.I. unit of K will be : $\frac{m^3}{As}$

14. (C)

$[t]=[r]^b[s]^{c/2}[d]^{a/2}$

$T=L^b[MT^{-2c/2}][ML^{-3}]^{a/4}$

So, $\frac{c}{2}+\frac{a}{4}=0, c=-1$ and $b-\frac{3a}{4}=0$

Solving above, we get $b=\frac{3}{2}$

15. (A)

As we know, $F=\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{R^2} \Rightarrow \varepsilon_0=\frac{q_1 q_2}{4\pi FR^2}$

Hence, $\varepsilon_0=\frac{C^2}{\text{N.m}^2}=\frac{[AT]^2}{[MLT^{-2}][L^2]}=[M^{-1}L^{-3}T^4A^2]$

16. (B)

Here, $T=2\pi\sqrt{\frac{L}{g}}$ or $T^2=4\pi^2\left(\frac{L}{g}\right)$

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

Thus, $\frac{\Delta g}{g}=\frac{\Delta L}{L}+2\frac{\Delta T}{T}$

% error in $g=\frac{\Delta g}{g}\times 100$

$$=\left(\frac{\Delta L}{L}+2\frac{\Delta T}{T}\right)\times 100$$

$$=\left(\frac{(1/10)}{20}+2\times\frac{1}{90}\right)\times 100=2.72\%$$

17. (B)

The dimensional formulae of

$e=\left[M^0L^0T^1A^1\right]$

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

$G=\left[M^{-1}L^3T^{-2}\right]$ and $m_e=\left[M^1L^0T^0\right]$

Now, $\frac{e^2}{2\pi\varepsilon_0 Gm_e^2}=\frac{\left[M^0L^0T^1A^1\right]^2}{2\pi\left[M^{-1}L^{-3}T^4A^2\right]\left[M^{-1}L^3T^{-2}\right]\left[M^1L^0T^0\right]^2}=\frac{1}{2\pi}$

$\because \frac{1}{2\pi}$ is dimensionless thus the combination $\frac{e^2}{2\pi\varepsilon_0 Gm_e^2}$ would have the same value in different systems of units.

18. (D)

The current voltage relation of diode is

$I=\left(e^{1000\,V/T}-1\right)mA$ (given)

When, $I=5mA, e^{1000\,V/T}=6\,mA$

Also, $dI = \left(e^{1000V/T}\right)\times\frac{1000}{T}.dV$

Error = ± 0.01 (By exponential function)

$= (6\,mA)\times\frac{1000}{300}\times(0.01) = 0.2$ mA

19. (A)

Measured length of rod = 3.50 cm
For Vernier Scale with 1 Main Scale Division = 1 mm
9 Main Scale Division = 10 Vernier Scale Division,
Least count = 1 MSD – 1 VSD = 0.1 mm

20. (B)

As, $g = 4\pi^2\frac{L}{T^2}$

So, $\frac{\Delta g}{g}\times 100 = \frac{\Delta L}{L}\times 100 + 2\frac{\Delta T}{T}\times 1000$

$= \frac{0.1}{20}\times 100 + 2\times\frac{1}{90}\times 100 = 2.72 \simeq 3\%$

21. (C)

Dimension of $A \neq$ dimension of (C)
Hence A – C is not possible.

22. (C)

Sum of all observations $= \frac{90+91+95+92}{4} = 368$

Average $= \frac{368}{4} = 92\,\text{sec}$

$\Delta T_1 = 90-90 = 0,\ \Delta T_2 = 91-90 = 1,\ \Delta T_3 = 95-90 = 5, \Delta T_4 = 92-90 = 2$

23. (A)

L.C. $= \frac{0.5}{50} = 0.01\,\text{mm}$

Zero error = (50 – 45) = 5 × 0.01 = 0.05 mm (Negative)
Reading = (0.5 + 25 × 0.01) + 0.05 = 0.80 mm

24. (C)

$\sigma = \frac{ne^2\tau}{m}$

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

25. (A)

$M = \frac{L}{V/r}$

$[M] = \frac{L}{C.Ct} = \frac{[L]}{[C^2]t} = hT^{-1}C^{-2}$

26. (C)

$P = a^{1/2}.b^2.c^3.d^{-4}$

Taking long on both sides

$\log P = \frac{1}{2}\log a + 2\log b + 3\log c - 4\log d$

Now differentiating on both sides

$\frac{dP}{P} = \frac{da}{2a} + 2\frac{bd}{b} + 3\frac{dc}{c} - 4\frac{d(d)}{d}$

or $\frac{\Delta P}{P} = \frac{\Delta a}{2a} \pm 2\frac{\Delta b}{b} \pm 3\frac{\Delta c}{c} \pm 4\frac{\Delta d}{d}$

Now, given $\frac{\Delta a}{a}\times 100 = 2$

$\Rightarrow \frac{\Delta b}{b}\times 100 = 1$, $\Rightarrow \frac{\Delta c}{c}\times 100 = 3$, $\Rightarrow \frac{\Delta d}{d}\times 100 = 5$,

$\Rightarrow \frac{\Delta P}{P}\times 100 = \frac{2}{2} \pm 2\times 1 \pm 3\times 3 \pm 4\times 5$

$\Rightarrow \frac{\Delta P}{P}\times 100 = 32\%$

27. (A)

$T = \frac{rhg}{2}\times 10^3 \text{ N/m} = \frac{Dhg}{4}\times 10^3 \text{ N/m}$ (Since $D = 2r$)

$\Rightarrow \log T = \log D + \log h + \log g - 4 + 3$

$\Rightarrow \frac{\Delta T}{T} = \frac{\Delta D}{D} + \frac{\Delta h}{h}$

$= \frac{0.01}{1.25} + \frac{0.01}{1.45} = 0.015 = 1.5\%$

28. (A)

Pascal second = $\frac{NS}{m^2} = \frac{[MLT^{-2}][T]}{[L^2]} = ML^{-1}T^{-1}$

29. (C)

As $\left[\frac{kt}{\beta x}\right] = 1$ $\quad [\beta] = \left[\frac{kt}{x}\right] = \frac{ML^2T^{-2}}{L} = MLT^{-2}$ $\quad [\because [E] = [k_BT]]$

Now, $[P] = \frac{[\alpha]}{[\beta]}$ $\quad \therefore [\alpha] = [P][\beta] = MLT^{-2}$

30. (C)

Mutual inductance, $M = -\frac{e_2}{\frac{di_1}{dt}}$

$$[M] = \frac{[e_2]}{\left[\frac{di_1}{dt}\right]} = \left[\frac{\frac{W}{q}}{\frac{q}{t^2}}\right] = \frac{ML^2T^{-2}}{\frac{A^2T^2}{T^2}} = ML^2A^{-2}T^{-2}$$

31. (D)
Wave number and Rydberg constant have same unit m^{-1}.
Corecivity and magnetisation have same unit A/m.
Whereas, specific heat capacity, $S = \frac{\Delta Q}{m\Delta T}$ has unit $\frac{\text{J}}{\text{Kg K}}$ and latent heat, $L = \frac{\Delta Q}{m}$ has unit $\frac{\text{J}}{\text{Kg}}$.

32. (A)
Velocity gradient = $\frac{dv}{dx}$
So, its unit will be $\frac{m/s}{m} = s^{-1}$
As $N = N_0 e^{-\lambda t}, \lambda =$ decay constant
As power of *e* is dimensionless
So, $[\lambda t] = 1$ or , $[\lambda] = \left(\frac{1}{t}\right)$
So, unit of λ is s^{-1}

33. (A)
Torque $\tau \to ML^2T^{-2}$ (III)
Impulse $I \to MLT^{-1}$ (I)
Tension force $\to MLT^{-2}$ (IV)
Surface tension $\to MT^{-2}$ (II)

34. (A)
(i) $\frac{\pi p a^4}{5\eta L} = \frac{dv}{dt} =$ Volumetric flow rate (Poiseuille's law)
(ii) $\because\ h\rho g = \frac{2s}{r}\cos\theta \qquad \therefore\ h = \frac{2s\cos\theta}{\rho r g}$
(iii) $RHS \Rightarrow\ \varepsilon \times \frac{1}{4\pi\varepsilon_0}\frac{a}{r^2} \times \frac{1}{\varepsilon} = \frac{q}{t} \times \frac{1}{r^2} = \frac{1}{L^2} = IL^{-2}$
LHS $J = \frac{I}{A} = IL^{-2}$
(iv) $W = \tau\theta$

35. (C)
As $B = \frac{\mu_0 i}{2\pi r}$
$[\mu_0] = \left[\frac{B \times 2\pi r}{I}\right] = \left[\frac{N}{Am} \times \frac{m}{A}\right] = \left[\frac{N}{A^2}\right] = MLT^{-2}A^{-2}$
Clearly, μ_0 is not a dimensionless quantity.

36. (A)
As, density = $[F]^a\,[L]^b\,[T^c]$
$[ML^{-3}] = [MLT^{-2}]^a\,[L]^b\left[T^c\right]$
$[ML^{-3}] = [M^a L^a T^{-2a} L^b T^c]$

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

On comparing

$a = 1, a+b = -3, 1+b = -3, b = -4$

$-2a + c = 0 \;\; k \;\; c = 2a$

$c = 2 \quad \therefore$ Density $= \left[F^1 L^{-4} T^2\right]$

37. (D)

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

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

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

$$P = \frac{EL^2}{M^5G^2} \Rightarrow [P] = \frac{\left(ML^2T^{-2}\right)\left(M^2L^4T^{-2}\right)}{M^5\left(M^{-2}L^6T^{-4}\right)} = M^0L^0T^0$$

38. (B)

Dimension of $A = MLT^{-2}, B = T^{-1}, D = L^{-1}$

Dimension $= \frac{AB}{D} = \frac{MLT^{-2}T^{-1}}{L^{-1}} = ML^2Th - 3$

39. (D)

$[E] = \frac{hc}{\lambda}$ also $[E] = \frac{e^2}{4\pi\varepsilon_0 r}$

or, $\frac{[E]}{[E]} = \frac{e^2\lambda}{4\pi\varepsilon_0 r \cdot hc}$

or, $\left[M^0L^0T^0\right] = \frac{e^2}{4\pi\varepsilon_0 r}\frac{\lambda}{hc} = \frac{1}{4}\frac{|e|^2}{\pi\varepsilon_0 \hbar c}$ dimensionally.

40. (B)

$W = \alpha^2\beta e^{-\frac{\beta x^2}{kT}}$

As exponents are dimensionless, so, $\frac{\beta x^2}{kT}$ should be dimensionless.

$$[\beta] = \left[\frac{kT}{x^2}\right] = \frac{ML^2T^{-2}}{L^2} = MT^{-2}$$

From the dimensional homogeneity, $\alpha^2\beta$ should have dimension of work.

$\therefore \quad \left[\alpha^2\beta\right] = ML^2T^{-2} \Rightarrow \left[\alpha^2\right] = \frac{ML^2T^{-2}}{MT^{-2}} \Rightarrow [\alpha] = M^0LT^0$

41. (A)

We know that

Speed of light, $c = \frac{1}{\sqrt{\mu_0\varepsilon_0}} = x$

Also, $c = \frac{E}{B} = y$

Time constant, $\tau = Rc = t$ $\quad\therefore\ z = \frac{l}{RC} = \frac{l}{t} = \text{Speed}$

Thus, x, y, z will have the same dimension of speed.

42. (D)

From formula, $\frac{dQ}{dt} = kA\frac{dT}{dx}$

$$\Rightarrow\ k = \frac{\left(\frac{dQ}{dt}\right)}{A\frac{dT}{dx}} \Rightarrow [k] = \frac{[ML^2T^{-3}]}{[L^2][KL^{-1}]} = [MLT^{-3}K^{-1}]$$

43. (B)

Solar constant = $\frac{\text{Energy}}{\text{Time Area}}$

Dimension of Energy, $E = ML^2T^{-2}$

Dimension of Time = T

Dimension of Area = L^2

$\therefore$ Dimension of Solar constant $= \frac{M^1L^2T^{-2}}{TL^2} = M^1L^0T^{-3}$