1. Units and dimensions

$n \propto \frac{1}{U}$ where n = number
U = unit

$n_1 U_1 = n_2 U_2$

$n_1 U = \text{constant}$

Dimensional formulas:

1. Angle = $\frac{\text{length of arc}}{\text{radius}} = \frac{L}{L} = L^0$ = No dimensions

1 Astronomical unit = 10^{11} m
1 Light year (Ly) = 10^{12} m
1 Parsec (Pc) = 10^{13} m

2. Displacement = L
   Area = L^2
   Volume = L^3

3. Density = $\frac{\text{mass}}{\text{volume}} = \frac{kg}{m^3} = ML^{-3}$

4. Velocity = LT^{-1}

5. Acceleration = Acceleration due to gravity (g) = LT^{-2}

6. Momentum $p = mv = MLT^{-1}$

7. Force (F) = $\frac{dp}{dt} = \frac{MLT^{-1}}{T} = MLT^{-2} = ma$

8. Impulse (I) = $Ft = MLT^{-1}$

9. Radius of gyration [k] = L

10. Moment of inertia [I] = Mk^2
    = ML^2

11. Torque τ = F × ⊥ er distance
    = $MLT^{-2} \times L$
    = ML^2T^{-2}

12. Angular momentum (mvr) = ML^2T^{-1}

13. Frequency (ν) = T^{-1}

14. Planck's constant (h) = $\frac{E}{\nu} \Rightarrow ML^2T^{-1}$

15. Work (W) = $FS \Rightarrow ML^2T^{-2}$

16. Energy (E) = $\frac{1}{2}mv^2$ (or) $mgh \Rightarrow ML^2T^{-2}$

17. Power (P) = $\frac{\text{Work}}{\text{time}} = ML^2T^{-3}$

18. Spring constant (K) = $F/x \Rightarrow MT^{-2}$

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

20. Velocity gradient = $\frac{dv}{dx} = \frac{LT^{-1}}{L} = T^{-1}$

21. Surface tension (T) = $\frac{F}{d} = \frac{MLT^{-2}}{L} = MT^{-2}$

22. Radiant Power (P) = $\sigma A e T^4 \Rightarrow \sigma = MT^{-3}\theta^{-4}$

23. Thermal resistance $R = \frac{d}{kA} \Rightarrow M^{-1}L^{-2}T^3\theta$

24. Angular velocity (W) = $\frac{\theta}{t} \Rightarrow T^{-1}$

25. Propagation constant $k = \frac{2\pi}{\lambda} = L^{-1}$

26. Charge (q) = $It = IT$

27. Electric field intensity [E] = $\frac{F}{q} = MLT^{-3}I^{-1}$

28. Electric flux $\phi = EA \Rightarrow ML^3T^{-3}I^{-1}$

29. Linear charge density (λ) = $\frac{\text{charge}}{\text{length}} = L^{-1}IT$

30. Areal charge density (or) Surface charge density $\sigma = \frac{\text{charge}}{\text{area}} = L^{-2}TI$

31. Electric potential $V = W/q \Rightarrow ML^2T^{-3}I^{-1}$

32. Capacity [C] = $q/V = M^{-1}L^{-2}T^4I^2$

33. Current [I] = $q/t = I$ (or) A

34. Resistance (R) = $\frac{V}{I} = ML^2T^{-3}I^{-2}$

35. Conductivity $\sigma = 1/\rho$

35. Resistivity $\rho = \frac{RA}{l} = ML^3T^{-3}I^{-2}$

36. Pole strength [M] = IL

37 Magnetic moment $[M] = IL \times L = IL^2$

38 Magnetic field induction $(B) = \frac{F}{iL} = MT^{-2}I^{-1}$

39. Magnetic field intensity $[H] = \frac{B}{M_0} \Rightarrow M^0 L T^{-4} I^{-3}$

40. Magnetic flux $[\phi] = BA$
$= ML^2T^{-2}I^{-1}$

41. Self inductance $[L] = \frac{2U}{I^2} = ML^2T^{-2}I^{-2}$

42. Mutual inductance $[M] = ML^2T^{-2}I^{-2}$

43 Rydberg constant $[R_H] \propto 1/\lambda \Rightarrow L^{-1}$

44. Boltzmann constant $[K] = \frac{PV}{NT} \Rightarrow ML^2T^{-2}\theta^{-1}$

permeability $\mu_0 = MLT^{-2}A^{-2}$

Negative power in mass

1. Universal gravity constant $(G) = \frac{Fd^2}{m_1 m_2} = M^{-1}L^3T^{-2}$

2. Thermal resistance $[R] = \frac{l}{KA} = M^{-1}L^{-2}T^3\theta$

3 Electric permitivity $[\varepsilon] = \frac{q_1 q_2}{4\pi F d^2} = M^{-1}L^{-3}T^4I^2$

4. Capacity $[C] = q/V = M^{-1}L^{-2}T^4I^2$

5. Conductance $[G] = 1/R = M^{-1}L^{-2}T^3I^2$

6. Conductivity $\sigma = 1/\rho \Rightarrow M^{-1}L^{-3}T^3I^2$

Coefficients:

1. Coefficient of friction $M = \frac{\text{frictional force}}{\text{normal force}} = 0$
$=$ No dimensions

2. Coefficient of restitution $e = \frac{V_2 - V_1}{u_1 - u_2} = 0 =$ No dimensions

3 Coefficient of viscosity $\eta = \frac{F}{A \cdot \frac{dv}{dx}} \Rightarrow ML^{-1}T^{-1}$

4. Coefficient of linear expansion $\alpha = \frac{l_2 - l_1}{l_1(t_2 - t_1)} = \theta^{-1}$

5. Coefficient of areal expansion $\beta = \frac{A_2 - A_1}{A_1(t_2 - t_1)} = \theta^{-1}$

6. Coefficient of volume expansion $\gamma = \frac{V_2 - V_1}{V_1(t_2 - t_1)} = \theta^{-1}$

7. Coefficient of apparent expansion $\gamma_a = \frac{V_2 - V_1}{V_1(t_2 - t_1)} = \theta^{-1}$

8. Coefficient of real expansion $\gamma_R = \frac{V_2 - V_1}{V_1(t_2 - t_1)} = \theta^{-1}$

9. Coefficient of thermal constant $[K] \Rightarrow \frac{ML^2T^{-2}}{T} = \frac{[K]L^2\theta}{K}$

$$[K] = MLT^{-3}\theta^{-1}$$

10. Refractive index $[M] = 1 =$ No dimensions

11. Magnification $[m] =$ No dimensions

→ $1gm/cc = 1000 kg/m^3$

Magnetic flux $\phi_B = ML^2T^{-2}A^{-1}$ $\quad [A = I]$

→ Trigonometric eqns. are dimensionless quantities.

Ex: $\sin\theta, \cos\theta$, etc.

$e^x \rightarrow x$ is dimensionless quantity.

$\frac{\Delta q}{q}$ → relative error, $\frac{\Delta q}{q} \times 100 \rightarrow$ % error

$Z = \frac{x^a y^b}{p^c} \Rightarrow \frac{\Delta Z}{Z} = \pm\left(a\frac{\Delta x}{x} + b\frac{\Delta y}{y} + c\frac{\Delta p}{p}\right)$ → always +ve

$$\Delta R = \pm R^2\left[\frac{\Delta R_1}{R_1^2} + \frac{\Delta R_2}{R_2^2}\right]$$

Screw gauge – pitch = $\frac{\text{distance moved}}{\text{no of rotations}}$

L.C = $\frac{\text{pitch}}{\text{total no of C.S}}$

T.R = M.S.R + C.S.R × L.C

Vernier calipers –

10 V.C.D coincides with 9 M.S.D ons

1 V.S.D = $\left(\frac{N-1}{N}\right)$ M.S.D

L.C = M.S.D/N = 1 M.S.D – 1 V.S.D

T.R = M.S.R + V.C × L.C – zero error