Units and Measurements

Dimensional Formula Derivation

1. Electric Charge (Q)

Electric charge is defined as the product of current and time.
$$Q = I \cdot T$$

- Current (I) has the dimensional formula: $[I]$
- Time (T) has the dimensional formula: $[T]$
  Therefore,
  $$[Q] = [I][T]$$
  Dimensional formula of electric charge: $[Q] = [IT]$

2. Electric Force (F)

Electric force is given by Coulomb's law:
$$F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$$

- Charge (q) has the dimensional formula: $[Q] = [IT]$
- Distance (r) has the dimensional formula: $[L]$
  Therefore,
  $$[F] = [MLT^{-2}]$$
  Dimensional formula of electric force: $[F] = [MLT^{-2}]$

3. Electric Field (E)

Electric field is defined as the electric force per unit charge.
$$E = \frac{F}{Q}$$

- Force (F) has the dimensional formula: $[MLT^{-2}]$
- Charge (Q) has the dimensional formula: $[IT]$
  Therefore,
  $$[E] = \frac{[F]}{[Q]} = \frac{[MLT^{-2}]}{[IT]} = [MLT^{-3}I^{-1}]$$
  Dimensional formula of electric field: $[E] = [MLT^{-3}I^{-1}]$

4. Magnetic Force (F)

Magnetic force on a moving charge is given by:
$$F = qvB \sin\theta$$

- Charge (q) has the dimensional formula: $[Q] = [IT]$
- Velocity (v) has the dimensional formula: $[LT^{-1}]$

- Magnetic field (B) has the dimensional formula: $[B]$
  Therefore,
  $[F] = [Q][v][B] = [IT][LT^{-1}][B] = [ILB]$
  Since $[F] = [MLT^{-2}]$,
  $[MLT^{-2}] = [ILB]$
  $[B] = [MT^{-2}I^{-1}]$
  Dimensional formula of magnetic force: $[F] = [MLT^{-2}]$

5. Magnetic Field (B)

$[B] = [MT^{-2}I^{-1}]$
Dimensional formula of magnetic field: $[B] = [MT^{-2}I^{-1}]$

6. Electric Potential (V)

Electric potential is defined as the electric potential energy per unit charge.
$V = \frac{W}{Q}$

- Work (W) has the dimensional formula: $[ML^2T^{-2}]$
- Charge (Q) has the dimensional formula: $[IT]$
  Therefore,
  $[V] = \frac{[W]}{[Q]} = \frac{[ML^2T^{-2}]}{[IT]} = [ML^2T^{-3}I^{-1}]$
  Dimensional formula of electric potential: $[V] = [ML^2T^{-3}I^{-1}]$

7. Magnetic Flux (Φ)

Magnetic flux is defined as the product of magnetic field and area.
$\Phi = B \cdot A$

- Magnetic field (B) has the dimensional formula: $[MT^{-2}I^{-1}]$
- Area (A) has the dimensional formula: $[L^2]$
  Therefore,
  $[\Phi] = [B][A] = [MT^{-2}I^{-1}][L^2] = [ML^2T^{-2}I^{-1}]$
  Dimensional formula of magnetic flux: $[\Phi] = [ML^2T^{-2}I^{-1}]$

8. Electric Flux (Ψ)

Electric flux is defined as the product of electric field and area.
$\Psi = E \cdot A$

- Electric field (E) has the dimensional formula: $[MLT^{-3}I^{-1}]$
- Area (A) has the dimensional formula: $[L^2]$
  Therefore,
  $[\Psi] = [E][A] = [MLT^{-3}I^{-1}][L^2] = [ML^3T^{-3}I^{-1}]$
  Dimensional formula of electric flux: $[\Psi] = [ML^3T^{-3}I^{-1}]$

9. Inductance (L)

Inductance is defined as the magnetic flux linkage per unit current.
$L = \frac{\Phi}{I}$

- Magnetic flux (Φ) has the dimensional formula: $[ML^2T^{-2}I^{-1}]$
- Current (I) has the dimensional formula: $[I]$

  Therefore,

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

  Dimensional formula of inductance: $[L] = [ML^2T^{-2}I^{-2}]$