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Electrostatics Formulas

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List of 26 Electrostatics Formulas

Electrostatics

Capacitance

1) Capacitance

Open Calculator

fx $$C = \varepsilon_r \cdot \frac{Q}{V}$$

ex $$0.01125F = 4.5 \cdot \frac{0.3C}{120V}$$

2) Capacitance for Parallel Plate Capacitors with Dielectric between them

Open Calculator

fx $$C_{\parallel} = \frac{\varepsilon \cdot \varepsilon_r \cdot A}{s}$$

ex $$0.018815F = \frac{0.0001 \cdot 4.5 \cdot 0.012m^2}{0.000287m}$$

3) Capacitance of Cylindrical Capacitor

Open Calculator

fx $$C = \frac{\varepsilon_r \cdot L_{Cylinder}}{2 \cdot [Coulomb] \cdot (r_2 - r_1)}$$

ex $$0.011554F = \frac{4.5 \cdot 60000m}{2 \cdot [Coulomb] \cdot (0.075m - 0.0737m)}$$

4) Capacitance of Parallel Plate Capacitor

Open Calculator

fx $$C_{\parallel} = \frac{\varepsilon_r \cdot [\text{Permitivity-vacuum}] \cdot A_{plate}}{s}$$

ex $$0.018039\text{F} = \frac{4.5 \cdot [\text{Permitivity-vacuum}] \cdot 130000\text{m}^2}{0.000287\text{m}}$$

5) Capacitance of Spherical Capacitor

Open Calculator

fx $$C = \frac{\varepsilon_r \cdot R_s \cdot a_{shell}}{[\text{Coulomb}] \cdot (a_{shell} - R_s)}$$

ex $$0.011273\text{F} = \frac{4.5 \cdot 1.24\text{E}7\text{m} \cdot 2.76\text{E}7\text{m}}{[\text{Coulomb}] \cdot (2.76\text{E}7\text{m} - 1.24\text{E}7\text{m})}$$

6) Capacitor with Dielectric

Open Calculator

fx $$C = \frac{\varepsilon \cdot \varepsilon_r \cdot A}{s}$$

ex $$0.018815\text{F} = \frac{0.0001 \cdot 4.5 \cdot 0.012\text{m}^2}{0.000287\text{m}}$$

7) Energy Stored in Capacitor given Capacitance and Voltage

Open Calculator

fx $$U = \frac{1}{2} \cdot C \cdot V_{capacitor}^2$$

ex $$4.099095\text{J} = \frac{1}{2} \cdot 0.011\text{F} \cdot (27.3\text{V})^2$$

8) Energy Stored in Capacitor given Charge and Capacitance

Open Calculator

fx $$U = \frac{Q^2}{2 \cdot C}$$

ex $$4.090909\text{J} = \frac{(0.3\text{C})^2}{2 \cdot 0.011\text{F}}$$

9) Energy Stored in Capacitor given Charge and Voltage

Open Calculator

fx $$U_e = \frac{1}{2} \cdot Q \cdot V$$

ex $$18\text{J} = \frac{1}{2} \cdot 0.3\text{C} \cdot 120\text{V}$$

10) Equivalent Capacitance for Two Capacitors in Parallel

Open Calculator

fx $$C_{\text{eq, Parallel}} = C_1 + C_2$$

ex $$13\text{F} = 10\text{F} + 3.0\text{F}$$

11) Equivalent Capacitance for Two Capacitors in Series

Open Calculator

fx $$C_{\text{eq, Series}} = \frac{C_1 \cdot C_2}{C_1 + C_2}$$

ex $$2.307692\text{F} = \frac{10\text{F} \cdot 3.0\text{F}}{10\text{F} + 3.0\text{F}}$$

12) Force between Parallel Plate Capacitors

Open Calculator

fx $$F = \frac{Q^2}{2 \cdot C_{||}}$$

ex $$2.5N = \frac{(0.3C)^2}{2 \cdot 0.018F}$$

Electric Charges and Fields

13) Electric Dipole Moment

Open Calculator

fx $$p = |q| \cdot r$$

ex $$0.60013C*m = 2.831E\hat{}\text{-}4C \cdot 2119.85m$$

14) Electric Field

Open Calculator

fx $$E = \frac{\Delta V}{l}$$

ex $$600V/m = \frac{540V}{0.9m}$$

15) Electric Field between Two Oppositely Charged Parallel Plates

Open Calculator

fx $$E = \frac{\sigma}{[\text{Permitivity-vacuum}]}$$

ex $$600V/m = \frac{5.31E\hat{}\text{-}9C/m^2}{[\text{Permitivity-vacuum}]}$$

16) Electric Field due to Infinite Sheet

Open Calculator

fx $$E_{\text{sheet}} = \frac{\sigma}{2 \cdot [\text{Permitivity-vacuum}]}$$

ex $$300\text{V/m} = \frac{5.31\text{E}\hat{}\text{-9C/m}^2}{2 \cdot [\text{Permitivity-vacuum}]}$$

17) Electric Field due to Line Charge

Open Calculator

fx $$E = \frac{2 \cdot [\text{Coulomb}] \cdot \lambda}{r_{\text{ring}}}$$

ex $$600.04\text{V/m} = \frac{2 \cdot [\text{Coulomb}] \cdot 1.1014\text{E}\hat{}\text{-5C/m}}{329.941\text{m}}$$

18) Electric Field due to Point Charge

Open Calculator

fx $$E = \frac{[\text{Coulomb}] \cdot Q}{r^2}$$

ex $$600.0016\text{V/m} = \frac{[\text{Coulomb}] \cdot 0.3\text{C}}{(2119.85\text{m})^2}$$

19) Electric Field for Uniformly Charged Ring

Open Calculator

$$E = \frac{[Coulomb] \cdot Q \cdot x}{\left(r_{ring}^2 + x^2\right)^{\frac{3}{2}}}$$

$$600.0134V/m = \frac{[Coulomb] \cdot 0.3C \cdot 8m}{\left((329.941m)^2 + (8m)^2\right)^{\frac{3}{2}}}$$

20) Electric Field given Electric Force

Open Calculator

$$E = \frac{F_{electric}}{q}$$

$$600V/m = \frac{2.4N}{0.004C}$$

21) Electric Force by Coulomb's Law

Open Calculator

$$F_{electric} = ([Coulomb]) \cdot \left(\frac{q_1 \cdot q_2}{r^2}\right)$$

$$2.400006N = ([Coulomb]) \cdot \left(\frac{0.04C \cdot 0.03C}{(2119.85m)^2}\right)$$

Electric Potential and Energy Density

22) Electric Potential of Dipole

Open Calculator

fx $$\phi = \frac{[\text{Coulomb}] \cdot \text{p} \cdot \cos(\theta)}{|\text{r}|^2}$$

ex $$50.06948\text{V} = \frac{[\text{Coulomb}] \cdot 0.6\text{C*m} \cdot \cos(89^\circ)}{(1371\text{m})^2}$$

23) Electrostatic Potential due to Point Charge

Open Calculator

fx $$\phi = \frac{[\text{Coulomb}] \cdot \text{Q}_{\text{pt}}}{\text{r}}$$

ex $$50.02859\text{V} = \frac{[\text{Coulomb}] \cdot 1.18\text{E}\hat{}\text{-5C}}{2119.85\text{m}}$$

24) Electrostatic Potential Energy of Point Charge or System of Charges

Open Calculator

fx $$\text{U}_{\text{free}} = \frac{[\text{Coulomb}] \cdot \text{q}_1 \cdot \text{q}_2}{\text{r}}$$

ex $$5087.653\text{J} = \frac{[\text{Coulomb}] \cdot 0.04\text{C} \cdot 0.03\text{C}}{2119.85\text{m}}$$

25) Energy Density in Electric Field

Open Calculator

fx $$u = \frac{1}{2} \cdot [\text{Permitivity-vacuum}] \cdot E^2$$

ex $$1.6\text{E}\hat{}\text{-}6\text{J} = \frac{1}{2} \cdot [\text{Permitivity-vacuum}] \cdot (600\text{V/m})^2$$

26) Energy Density in Electric Field given Free Space Permittivity

Open Calculator

fx $$u = \frac{\varepsilon_{\text{free}} \cdot E^2}{2}$$

ex $$1.6\text{E}\hat{}\text{-}6\text{J} = \frac{8.89\text{E}\hat{}\text{-}12 \cdot (600\text{V/m})^2}{2}$$

Variables Used

- **|r|** Magnitude of Position Vector *(Meter)*
- **|q|** Magnitude of Electric Charge *(Coulomb)*
- **A** Area *(Square Meter)*
- A_{plate} Area of Plates *(Square Meter)*
- a_{shell} Radius of Shell *(Meter)*
- **C** Capacitance *(Farad)*
- $C_{\parallel}$ Parallel Plate Capacitance *(Farad)*
- C_1 Capacitance of Capacitor 1 *(Farad)*
- C_2 Capacitance of Capacitor 2 *(Farad)*
- $C_{eq,\ Parallel}$ Equivalent Capacitance for Parallel *(Farad)*
- $C_{eq,\ Series}$ Equivalent Capacitance for Series *(Farad)*
- **E** Electric Field *(Volt per Meter)*
- E_{sheet} Electric Field in Sheet *(Volt per Meter)*
- **F** Force *(Newton)*
- $F_{electric}$ Electric Force *(Newton)*
- **l** Length of Conductor *(Meter)*
- $L_{Cylinder}$ Length of Cylinder *(Meter)*
- **p** Electric Dipole Moment *(Coulomb Meter)*
- **q** Electric Charge *(Coulomb)*
- **Q** Charge *(Coulomb)*
- q_1 Charge 1 *(Coulomb)*
- q_2 Charge 2 *(Coulomb)*

- Q_{pt} Point Charge *(Coulomb)*
- r Separation between Charges *(Meter)*
- r_1 Inner Radius of Cylinder *(Meter)*
- r_2 Outer Radius of Cylinder *(Meter)*
- r_{ring} Radius of Ring *(Meter)*
- R_s Radius of Sphere *(Meter)*
- s Distance between Deflecting Plates *(Meter)*
- u Energy Density *(Joule)*
- U Energy Stored in Capacitor *(Joule)*
- U_e Electrostatic Potential Energy *(Joule)*
- U_{free} Potential Energy of Point Charge *(Joule)*
- V Voltage *(Volt)*
- $V_{capacitor}$ Voltage in Capacitor *(Volt)*
- x Distance from Center Point *(Meter)*
- ΔV Electric Potential Difference *(Volt)*
- ε Permittivity
- ε_{free} Free Permittivity
- ε_r Relative Permittivity
- θ Angle between any Two Vectors *(Degree)*
- λ Linear Charge Density *(Coulomb per Meter)*
- σ Surface Charge Density *(Coulomb per Square Meter)*
- ϕ Electrostatic Potential *(Volt)*

Constants, Functions, Measurements used

- Constant: **[Coulomb]**, 8.9875E+9
  Coulomb constant
- Constant: **[Permitivity-vacuum]**, 8.85E-12
  Permittivity of vacuum
- Function: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Electric Charge** in Coulomb (C)
  Electric Charge Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Capacitance** in Farad (F)
  Capacitance Unit Conversion
- Measurement: **Linear Charge Density** in Coulomb per Meter (C/m)
  Linear Charge Density Unit Conversion
- Measurement: **Surface Charge Density** in Coulomb per Square Meter (C/m²)
  Surface Charge Density Unit Conversion

- Measurement: **Electric Field Strength** in Volt per Meter (V/m)
  Electric Field Strength Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion
- Measurement: **Electric Dipole Moment** in Coulomb Meter (C*m)
  Electric Dipole Moment Unit Conversion

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