EXAM 1

MAIN TOPICS

Force on charged particles.

Like charges repel

Unlike charges attract

Coulomb’s Law

\[ F = k \frac{Q_1 Q_2}{r^2} = \frac{1}{4\pi \varepsilon_0} \frac{q_1 q_2}{r^2} \]
Electric Field

\[ E = \frac{1}{4\pi \epsilon_0} \frac{q}{r^2} \]

Electric Field Lines

Start on positive

End on negative

Force on charge in Electric Field

\[ F = qE \]
Gauss’s Law

\[ \sum E A_\perp = 4\pi k Q_{encl} \]

Induction

Charged ball induces charges on the interior and exterior of the bucket.
Electric Potential

\[ V = k \frac{q}{r} \]

Capacitance

\[ C = \frac{Q}{V} \]

Parallel Plate Capacitor

\[ C = \frac{\epsilon_0 A}{d} \]

Capacitors in Circuit

\[ \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} \text{ for series} \]

\[ C_{eq} = C_1 + C_2 \text{ for parallel} \]
Energy in Capacitor

\[ U = \frac{1}{2} \frac{Q^2}{C} = \frac{1}{2} CV^2 = \frac{1}{2} QV \]

Energy Density in Electric Field

\[ u = \frac{1}{2} \varepsilon_0 E^2 \]

DIELECTRICS

\[ \varepsilon = K \varepsilon_0 \]

\[ C = KC_0 \]

\[ C = K \frac{Q_0}{V} \]

\[ V = \frac{V_0}{K} \]

\[ E_D = \frac{E_0}{K} \]
Resistivity and Resistance

\[ R = \frac{L}{\rho A} \]

Ohm’s Law

\[ V = IR \]

Power Dissipated

\[ P = IV = I^2R = \frac{V^2}{R} \]

Batteries – Internal Resistance
Resistors in Circuits

\[ R_{\text{equivalent}} = R_1 + R_2 + R_3 \text{ for series} \]

\[ \frac{1}{R_{\text{equivalent}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \text{ parallel} \]

**KIRCHHOFF’S RULES**

**Junction Rule**

The sum of the currents into a junction is zero.

**Loop Rule**

The sum of the potential differences in a loop is zero.
Charging Capacitor

\[ Q = C \varepsilon \left( 1 - e^{-\frac{t}{RC}} \right) \]
\[ i = \frac{\varepsilon}{R} e^{-\frac{t}{RC}} \]

Discharging Capacitor

\[ Q = Q_0 e^{-\frac{t}{RC}} \]
\[ I = I_0 e^{-\frac{t}{RC}} \]