

Grade 12 Physical Sciences: Electricity & Magnetism Study Guide

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Free Study Resources for South African Matric Learners

1. Electric Circuits

Ohm's Law:

$$V = IR$$

Power:

$$P = VI = I^2 R = V^2 / R$$

Energy:

$$E = Pt = VIt \quad (\text{J})$$

Series R:

$$R_{\text{total}} = R_1 + R_2 + R_3$$

Parallel R:

$$1/R = 1/R_1 + 1/R_2 + 1/R_3$$

EMF:

$$\text{emf} = V_{\text{terminal}} + I \cdot r \quad (r = \text{internal resistance})$$

Series vs Parallel

- Series: same current through all; voltages add up; R_{total} is largest
- Parallel: same voltage across all; currents add up; R_{total} is smaller than smallest branch
- In parallel: adding more resistors DECREASES total resistance -> increases current from source

2. Electrostatics

Coulomb's Law:

$$F = k \cdot Q_1 \cdot Q_2 / r^2 \quad (k = 9 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2)$$

Electric field E:

$$E = F/q = kQ/r^2 \quad (\text{N/C})$$

Potential diff V:

$$V = W/q \quad (\text{J/C} = \text{V})$$

TIP Electric field lines point FROM positive TO negative. A positive test charge follows the field direction. Denser field lines = stronger field.

3. Electromagnetic Induction

Faraday's Law:

$$\text{emf} = -N \cdot \Delta \phi / \Delta t$$

Magnetic flux phi:

$$\phi = B \cdot A \cdot \cos(\theta) \quad (\text{Wb})$$

AC Generators vs DC Motors

- AC generator: converts mechanical -> electrical energy (slip rings -> AC output)
- DC motor: converts electrical -> mechanical energy (commutator -> unidirectional rotation)
- Lenz's Law: induced current opposes the change in flux that caused it

4. Photoelectric Effect

Planck's equation:

$$E = hf \quad (h = 6.63 \times 10^{-34} \text{ J} \cdot \text{s})$$

Threshold frequency:

$$f_0 = W/h \quad (W = \text{work function})$$

Max KE of e-:

$$\text{KE}_{\text{max}} = hf - W$$

Speed of light:

$$c = f \cdot \lambda \quad (c = 3 \times 10^8 \text{ m/s})$$

TIP Intensity of light increases number of electrons ejected, NOT their kinetic energy. Higher frequency -> higher KE of ejected electrons.