

GRADE 11 STUDY GUIDE | 2024

Electricity and Magnetism

Physical Sciences

1. Electric Circuits -- Basic Concepts

Ohm's Law: $V = IR$ (V in Volts, I in Amperes, R in Ohms)**Power: $P = VI = I^2R = V^2/R$** **Energy: $E = Pt = VIt = I^2Rt$**

- EMF (epsilon): energy per unit charge supplied by the battery
- Terminal voltage: $V = \text{epsilon} - Ir$ (where r = internal resistance)
- Current (I): rate of flow of charge; same everywhere in a series circuit

2. Series Circuits

 $R_{\text{total}} = R_1 + R_2 + R_3 + \dots$ **I is the SAME through all components** **$V_{\text{total}} = V_1 + V_2 + V_3 + \dots$**

3. Parallel Circuits

 $1/R_{\text{total}} = 1/R_1 + 1/R_2 + 1/R_3 + \dots$ **V is the SAME across all branches** **$I_{\text{total}} = I_1 + I_2 + I_3 + \dots$** **Example: Two resistors: 6 Ohm and 3 Ohm in parallel**

$$1/R = 1/6 + 1/3 = 1/6 + 2/6 = 3/6 = 1/2$$

$R = 2 \text{ Ohm}$ (less than either individual resistor!)

4. Mixed (Series-Parallel) Circuits

Strategy: 1) Simplify parallel sections to a single equivalent resistance. 2) Add in series. 3) Use total R and EMF to find total current. 4) Work back through the circuit.

5. Magnetic Fields

A magnetic field exists around magnets and around current-carrying conductors.

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Right-hand rule (straight conductor): point thumb in direction of conventional current; fingers curl in direction of field lines

- Right-hand rule (solenoid/coil): curl fingers in direction of current; thumb points to North pole
- Field lines go from North to South outside the magnet
- Stronger field: lines closer together

6. Force on a Current-Carrying Conductor in a Magnetic Field

$$F = BIL \sin(\theta)$$

Where: **B** = magnetic field (T), **I** = current (A), **L** = length (m), **theta** = angle between **I** and **B**

Direction: use the LEFT-hand rule (for conventional current) or right-hand rule for electron current. Fingers point in current direction, bend toward B, thumb points in force direction.

KEY: Fleming's Left-Hand Rule: First finger = Field (B), Second finger = Current (I), Thumb = Motion/Force direction.

This is the principle behind electric motors.