|  |  |
| --- | --- |
| **Electricity** | IB Physics Content Guide |

# Big Ideas

* Electricity consists of charged particles moving in a continuous circuit
* Voltage, Current, and Resistance are related to each other though Ohm’s Law
* The total current flowing into a junction must equal the total current flowing out of that same junction
* The voltage dropped around a continuous loop traced in a circuit must equal the voltage provided
* Resistors can be combined in different ways to produce different results
* It is possible that the act of taking a measurement will change the value being measured
* The resistance of a wire is affected by its thickness, length, and material resistivity

# Content Objectives

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 – Electrical Current |  | | | |
| I can quantify charge in terms of Coulombs | |  |  |  |
| I can calculate the charge of a certain # of electrons and the # of electrons for a given charge | |  |  |  |
| I can describe current in terms of amps and coulombs per second | |  |  |  |
| I can describe the subatomic properties of a conductor to allow charge to flow | |  |  |  |
| I can the electron drift speed for a given current and wire | |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 2 – Electrical Properties |  | | | |
| I can describe the properties of Voltage, Current, Resistance, and Power | |  |  |  |
| I can use Ohm’s Law to mathematically relate these electrical properties and solve for an unknown | |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 3 – Circuits |  | | | |
| I can describe the direction of conventional current compared to the movement of charges | |  |  |  |
| I can identify component combinations as parallel or series | |  |  |  |
| I can describe how current flows through parallel and series resistors | |  |  |  |
| I can describe the set up to measure current and voltage in a circuit | |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 4 – Calculating Resistance |  | | | |
| I can describe the property of resistivity and how it and the wire dimensions affect resistance | |  |  |  |
| I can calculate the equivalent resistance for combinations of resistors in series and parallel | |  |  |  |
| I can step through the calculation of the equivalent resistance for a complex combination | |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 5 – Voltage Dividers and Batteries |  | | | |
| I can use Kirchhoff’s First Law to determine an unknown current at a junction | |  |  |  |
| I can use Kirchhoff’s Second Law to determine an unknown current at a junction | |  |  |  |
| I can calculate voltage, current, and resistance for every component in a series or parallel circuit | |  |  |  |
| I can compare and contrast the properties for simple series and parallel circuits | |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 6 – Potential Dividers |  | | | |
| I can identify the different circuit diagram symbols for different types of resistors | |  |  |  |
| I can describe how environmental changes can affect the resistance of LDRs and Thermistors | |  |  |  |
| I can describe how changing resistor values can affect the voltage drop in a potential divider circuit | |  |  |  |
| I can design a potential divider circuit to perform a certain task | |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 7 – Voltage Dividers and Batteries |  | | | |
| I can connect a meter to measure current or voltage | |  |  |  |
| I can describe the conditions required for an ideal ammeter or voltmeter | |  |  |  |
| I can calculate for a situation when the meter isn’t ideal | |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 8 – Batteries |  | | | |
| I can describe the difference between primary and secondary cells | |  |  |  |
| I can define the electromotive force and describe how is it is different than terminal voltage | |  |  |  |
| I can solve for a circuit that includes a battery with internal resistance | |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Electricity** | | | | | | | Shelving Guide | | | |
| Charge | | | |  | Current | | | | |
| Symbol | q | Unit | Coulombs [C] | Symbol | | I | Unit | Amperes [A] |
| Charge of 1 Electron | | | 1.6 × 10-19 C | Unit in terms of Coulombs | | | |  |
| # of Electrons per Coulomb | | | 6.25 × 1018 e- |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Drift Speed | Variable Symbol | Unit |  | *Data Booklet Equation:* |
| Current | I | A |  |  |
| # of Electrons per m3 | n | --- |  |
| Cross Sectional Area | A | M2 |  |  |
| Drift Speed | v | m s-1 |  | Cross Sectional Area: |
| Charge | q | C |  |

## Electrical Properties

|  |  |  |  |
| --- | --- | --- | --- |
| Property | What is it? | Symbol | Unit |
| Voltage | Potential Difference | V | Volts [V] |
| Current | The rate at which charges move through a wire | I | Amperes [A] |
| Resistance | How hard it is for a current to  flow through a conductor | R | Ohms [Ω] |

## Power

|  |  |  |
| --- | --- | --- |
| In terms of V and I | In terms of I and R | In terms of V and R |
|  |  |  |

## Ohm’s Law

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | |  | |
| Measuring Circuits | | Ammeter | | Voltmeter |
| Ideal Resistance | | R = 0 Ω | | R = ∞ Ω |
| How is it connected to the component being measured? | | Ammeters must be connected in **series** | | Voltmeters must be connected in **parallel** |
| Drawing of meter measuring R1 | |  | |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Resistivity | Variable Symbol | Unit |  | *Data Booklet Equation:* |
| Resistivity | ρ | Ω m |  |  |
| Resistance | R | Ω |  |
| Cross Sectional Area | A | m2 |  | Cross Sectional Area: |
| Length | L | m |  |
| Ohmic Resistor | Non-Ohmic Resistor | |
|
|

## Equivalent Resistance

|  |  |  |
| --- | --- | --- |
|  | Drawing with R1 and R2 | Equation |
| Series |  |  |
| Parallel |  |  |

## Kirchhoff’s Laws

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | |  | | | |
| The total current coming into a junction must equal the total current leaving the same junction | | | | The sum of the voltages (potential differences) provided must equal the voltages dissipated across components | | | |
| Across resistors | Always Negative | | |
| Entering Junction | 🡪 | ● | Positive | Negative to Positive | 🡪 |  | Positive |
| Exiting Junction | ● | 🡪 | Negative | Positive to Negative | 🡪 |  | Negative |

## Voltage Dividers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Light-Dependent Resistor | | Thermistor | |
| Symbol |  | |  | |
| Relationship | Light | Increases | Light | Increases |
| Resistance | Decreases | Resistance | Decreases |
| Circuit | Switch turns on in the dark: | | Switch turns on in a fire: | |

## Batteries

|  |  |
| --- | --- |
| Primary Cells | Secondary Cells |
| *Cannot be recharged* | *Can be recharged by passing a current through the battery in the opposite direction as it would normally travel* |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Variable Symbol | Unit |  | *Data Booklet Equation:* |
| Electromotive Force (e.m.f) | ε | V |  |  |
| Current | I | A |  |
| Circuit Resistance | R | Ω |  |  |
| Internal Resistance | r | Ω |  |  |