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# Chapter 8 – Voltage, Current, Resistance & Ohm’s Law

### After you have completed this chapter you will able to:

1. Explain how electric current results from the separation of charge and the movement of electron.
2. Apply the laws of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to electron flow in a circuit.
3. Define: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
4. Draw circuit diagrams using appropriate symbols.
5. Distinguish between\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_ energy – static electrical energy and current electricity and conventional current and electron flow.

## Section 8.1 – Electric Potential Energy & Voltage

Where can batteries be found? Give 6 examples.

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In order for electricity to be **useful** it must be \_\_\_\_\_\_\_\_\_\_\_\_and \_\_\_\_\_\_\_\_\_\_\_\_. One of the most common techniques to store electricity is a \_\_\_\_\_\_\_\_\_\_\_\_. A \_\_\_\_\_\_\_\_\_\_\_\_is a collection of smaller **units** called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, which convert \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**energy** to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**energy**.

In these \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_the \_\_\_\_\_\_\_\_\_\_\_\_and \_\_\_\_\_\_\_\_\_\_\_\_**charges** are separated resulting in \_\_\_\_\_\_\_\_\_\_\_\_where connections are made. When the \_\_\_\_\_\_\_\_\_\_\_\_are connected, \_\_\_\_\_\_\_\_\_\_\_\_at the **negative** terminal travel to the **positive** terminal (opposite charges attract).

Every battery has two terminals called \_\_\_\_\_\_\_\_\_\_\_\_. Each \_\_\_\_\_\_\_\_\_\_\_\_is usually made up of a different \_\_\_\_\_\_\_\_\_\_\_\_that is surrounded by substance called an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, which conducts electricity between the two \_\_\_\_\_\_\_\_\_\_\_\_\_\_ (positive is called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_, negative is called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_).

There are two main types of batteries: Dry Cell and Wet Cell. Identify the key parts of each type of battery in the diagram below.

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| **Dry Cell** |  | **Wet Cell** |
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| Different types of batteries: | Common Electrodes | Common Electrolytes |

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| Define **energy**: |  |

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| What is the difference between **kinetic** and **potential** energy? |  |
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In electricity we use a special for form of potential energy called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_. The amount of electrical potential per one **coulomb** is called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The unit for measuring \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ difference is the \_\_\_\_\_\_\_\_ (\_\_) named after the Italian physicist Allesandro Volta who invented the first battery.

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| Explain how a battery produces a potential difference between two electrodes. |  |
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| What is a **voltmeter** and what does it do? |  |
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| We use the symbol | Macintosh HD:Users:Jason:Documents:School:Curriculum Material:Jason's Course Material:Science 9:BC Science 9 Resources:Images:Unit 3 - Physics:images_ch_08:bc9_u3c8_p284 BLANK.jpg | to represent a voltmeter in a circuit drawing. |

**How to use and read a Voltmeter**

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| To use a voltmeter you \_\_\_\_\_\_\_\_\_\_\_\_\_\_ one end of the device to one side of the battery (red to positive) and the other end to the other side of the battery (black negative). If the voltage you get is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that means you have your connections \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.  To read a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, you simple read where the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ points on the scale. Many voltmeters have different \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ so make sure you read the **appropriate** scale. | Macintosh HD:Users:Jason:Desktop:Voltmeter5VCNC_1740_6_M NB.png |

## Section 8.2 – Electric Current

In order to utilize electric potential energy in a **battery** a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ has to be made from one \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to another \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, this connection is called an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Generally, within an electric circuit we want to \_\_\_\_\_\_\_\_\_\_\_\_\_ electrical energy into another form of energy, which is called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the circuit.

What are some examples of an electric load?

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There are many different kinds of **circuits** that perform a variety of operations; however, there are \_\_\_\_\_\_\_ (\_\_\_) basic kinds of components in a circuit, which include:

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|  | | **Explanation** | **Symbol** | |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Were the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ comes from (e.g. \_\_\_\_\_\_\_\_\_\_\_\_\_) | | Macintosh HD:Users:Jason:Documents:School:Curriculum Material:Jason's Course Material:Science 9:BC Science 9 Resources:Images:Unit 3 - Physics:images_ch_08:bc9_u3c8_p282_fig8_10.jpg |  |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | How the electric energy \_\_\_\_\_\_\_\_ from the source  (e.g. \_\_\_\_\_\_\_\_\_\_) | | Macintosh HD:Users:Jason:Documents:School:Curriculum Material:Jason's Course Material:Science 9:BC Science 9 Resources:Images:Unit 3 - Physics:images_ch_08:bc9_u3c8_p282_fig8_10.jpg | \_\_\_\_\_\_\_\_\_\_\_\_ |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | A device that \_\_\_\_\_\_\_\_\_\_\_ electric energy into another form of energy  (e.g. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) | | Macintosh HD:Users:Jason:Documents:School:Curriculum Material:Jason's Course Material:Science 9:BC Science 9 Resources:Images:Unit 3 - Physics:images_ch_08:bc9_u3c8_p282_fig8_10.jpg | \_\_\_\_\_\_\_\_\_\_\_\_ |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | A device that can turn the circuit \_\_\_\_ or \_\_\_\_ by opening or closing the circuit (e.g. \_\_\_\_\_\_\_\_\_\_) | | Macintosh HD:Users:Jason:Documents:School:Curriculum Material:Jason's Course Material:Science 9:BC Science 9 Resources:Images:Unit 3 - Physics:images_ch_08:bc9_u3c8_p282_fig8_10.jpg |  |

There are many ways one can explain an **electric circuit**, but the most common and easiest way is with a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. A \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ uses \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. to represent the different components of the circuit. In order for a circuit diagram to be useful it must be organized correctly as well as:

* **Neat** and **tidy** (i.e. use a ruler)
* Make all connecting wires and leads with **straight-lines** at **90o angles** (i.e. perpendicular).
* **Avoid** drawing conductors over top one another
* Your finished diagram should be **square** or **rectangular**.

Draw a **circuit diagram** for the following **electric circuit**.

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Without a **complete** circuit the battery has nowhere to \_\_\_\_\_\_\_\_ electrons. With a competed circuit, electrons **flow** from the \_\_\_\_\_\_\_\_\_\_\_\_\_ terminal through a \_\_\_\_\_\_\_\_\_\_\_\_, to a \_\_\_\_\_\_\_\_, then finally to the \_\_\_\_\_\_\_\_\_\_\_\_ terminal of the battery. This flow of electrons within a circuit is called \_\_\_\_\_\_\_\_\_\_\_\_\_ (\_\_) and can thought of as concept of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

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| What is an **ammeter** and what does it do? |  |
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| We use the symbol | Macintosh HD:Users:Jason:Documents:School:Curriculum Material:Jason's Course Material:Science 9:BC Science 9 Resources:Images:Unit 3 - Physics:images_ch_08:bc9_u3c8_p284 BLANK.jpg | to represent an ammeter in a circuit drawing. |

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| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is defined as the amount of \_\_\_\_\_\_\_\_\_\_\_ passing a point in a conductor every \_\_\_\_\_\_\_\_\_\_ (\_\_). It is measured in \_\_\_\_\_\_\_\_\_\_\_\_\_ (\_\_), named after the French physicist Andre-Marie Ampere . In order to measure current we use a device called an \_\_\_\_\_\_\_\_\_\_\_\_\_\_. Unlike a **voltmeter** where you connect **across** two points in a circuit, an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ must be connecting \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ with the circuit. (note: 1.0 A = 1000 mA). | Macintosh HD:Users:Jason:Desktop:U49808_01_Analog-Ammeter.jpg |

According to **Benjamin Franklin** he believed charged objects flowed from \_\_\_\_\_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_\_\_\_ as the positive charge contained more **‘electric fluid’**. This is contrary to our current understanding were \_\_\_\_\_\_\_\_\_\_\_\_\_ flows form \_\_\_\_\_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_\_\_\_. For historical reasons we refer to Franklin’s idea as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as it is still used today to calculate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in a circuit.

## Section 8.3 – Resistance & Ohm’s Law

As \_\_\_\_\_\_\_\_\_\_\_\_\_ flow through a circuit, they do not do so \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. As we saw with \_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_ some objects transfer electrons more **effectively** that others. In circuits we use the term \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(\_\_\_) to measure how easily **electrons** flow in a circuit.

For example, the **filament** (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) in a light bulb resist the movement of electron and in the process creates a large amount of \_\_\_\_\_\_\_\_\_ that makes the filament glow to create \_\_\_\_\_\_\_\_\_\_\_\_.

### A simple Hydraulic Analogy to Explain Circuits

The \_\_\_\_\_\_\_\_\_\_ flowing through the pipes is like the \_\_\_\_\_\_\_\_\_\_\_\_\_ flowing in a circuit. \_\_\_\_\_\_\_\_\_\_\_\_\_ can be thought of as a \_\_\_\_\_\_\_\_, **pushing** water through the system (i.e. more **pressure**); the larger the **pump** (i.e. \_\_\_\_\_\_\_\_\_\_\_) the more **water** (\_\_\_\_\_\_\_\_\_\_\_\_\_) goes through the system. The sizes of the \_\_\_\_\_\_\_\_\_ restrict the flow of water in the system: the **larger** the pipe (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) easier for the water to flow, **smaller** the pipe (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) harder for the water to flow.

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| In 1827,\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ a German physicist found a relationship between \_\_\_\_\_\_\_\_\_\_\_\_ (\_\_\_), \_\_\_\_\_\_\_\_\_\_\_\_\_ (\_\_\_) and \_\_\_\_\_\_\_\_\_\_\_\_\_ (\_\_\_). Now referred to \_\_\_\_\_\_\_\_\_\_\_\_\_ states that the electrical resistance of a circuit is **directly** **proportional** to voltage and **inversely** **proportional** to current (or the ratio of voltage to current). The unit for resistance is the \_\_\_\_\_\_\_ (\_\_\_). | **Formula for Ohm’s Law** |
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### Exercises

1. Convert the following mA and A. 1 mA = 1/1000 A:
2. 12.0 mA = \_\_\_\_\_\_\_\_\_\_ A
3. 0.075 A = \_\_\_\_\_\_\_\_\_\_\_ mA
4. Convert the following k Ω and Ω. 1 k Ω = 1000 Ω
5. 3.0 k Ω = \_\_\_\_\_\_\_\_\_\_\_\_ Ω
6. 45, 000 Ω = \_\_\_\_\_\_\_\_\_\_\_ k Ω
7. Convert the following MV and V. 1 MV = 1, 000, 000 V
8. 14 MV = \_\_\_\_\_\_\_\_\_\_\_\_ V
9. 6,000,000 V = \_\_\_\_\_\_\_\_ MV
10. What is the resistance of a flashlight bulb if there is a current of 0.75 A through the bulb when connected to a 3.0 V battery?
11. What is the voltage across a 12k Ω load that allows a current of 6.0 mA?

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| When designing circuits it is important have a precise amount of \_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_ at a particular point in order for some electrical components to work properly. In order to regulate the \_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_ at a particular point in a circuit a \_\_\_\_\_\_\_\_\_\_\_\_ is used. A \_\_\_\_\_\_\_\_\_\_\_\_ is an electrical component that has a specific \_\_\_\_\_\_\_\_\_\_\_\_. \_\_\_\_\_\_\_\_\_\_\_\_ can be measured with a special device called an \_\_\_\_\_\_\_\_\_\_\_\_. | Symbol  Macintosh HD:Users:Jason:Documents:School:Curriculum Material:Jason's Course Material:Science 9:BC Science 9 Resources:Images:Unit 3 - Physics:images_ch_08:bc9_u3c8_p295_fig8_20.jpg |

\_\_\_\_\_\_\_\_\_\_\_\_ serve a very important function in circuits and as a result there are many different **sizes**. Since **resistors** are so small, \_\_\_\_\_\_\_\_\_\_\_\_ bands are used to identify its size. Each colour corresponds to a particular \_\_\_\_\_\_\_\_\_\_\_\_ and it \_\_\_\_\_\_\_\_\_\_\_\_ on a resistor is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of that digit.

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| To read a resistor correctly the **first** band represents the **first** digit, the **second** band represents the **second** digit, and the **third** band is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (x\_\_\_) **multiplier** (i.e. the number of **zeros** that follow the **second** digit). There is also a **fourth** band on a resistor that represents how \_\_\_\_\_\_\_\_\_\_\_\_ the resistor is to its \_\_\_\_\_\_\_\_\_\_\_\_ value. | **Resistor Colour Coding** | **Numerical Value** |
| Black |  |
| Brown |  |
| Red |  |
| Orange |  |
| Yellow |  |
| Green |  |
| Blue |  |
| Violet |  |
| Grey |  |
| White |  |

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| **Resistor Accuracy:** | Gold = \_\_\_\_% | Silver = \_\_\_\_% | No Band = \_\_\_\_% |

The resistor pictured above has a value of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.