Ohm’s Law
Objective of Lecture

- Explain the relationship between resistance, current, and voltage (Ohms Law).
  - Chapter 3.1
- Discuss what a short circuit and open circuit mean using Ohms Law.
Ohm’s Law

Voltage drop across a resistor is proportional to the current flowing through the resistor

\[ v = iR \]

Units: \( V = A\Omega \)
where \( A = C/s \)
Example 1

- If 2V is used to force a current through a 1kΩ resistor, the current that flows through the resistor is:

\[ I = \frac{V}{R} \]

\[ = \frac{2V}{1k\Omega} \]

\[ = \frac{2V}{1000\Omega} \]

\[ = 2x10^{-3} A = 2mA \]
Example 2

If the 2kΩ resistor in Example 1 was changed to a 5kΩ resistor, then the current would decrease to:

\[ I = \frac{V}{R} \]
\[ = \frac{2V}{5k\Omega} \]
\[ = \frac{2V}{5000\Omega} \]
\[ = 4 \times 10^{-4} A = 0.4mA \]
Example 3

If the resistor in Example 1 was changed to a 5kΩ resistor and we wanted the current flowing through the resistor to remain equal to 2mA, then the magnitude of the voltage source would have to increase to:

\[ V = IR \]

\[ = 2 \text{mA}(5k\Omega) \]

\[ = 2 \times 10^{-3} \text{A}(5000\Omega) \]

\[ = 1.0 \times 10^1 \text{V} = 10\text{V} \]
If the resistor is a perfect conductor (or a short circuit) $R = 0 \, \Omega$, then $v = iR = 0 \, V$ no matter how much current is flowing through the resistor.
Open Circuit

If the resistor is a perfect insulator, \( R = \infty \ \Omega \)

then

\[
i = \lim_{{R \to \infty}} \frac{v}{R} = 0 \ \text{A}
\]

no matter how much voltage is applied to (or dropped across) the resistor.
Summary

- **Ohms Law**: The force required to have a specific current flow through a resistor is given by $v = iR$.
  - This is an important relationship (learn it).
    - A short circuit has zero resistance and, therefore, no voltage is needed to allow current to flow through it.
    - An open circuit has infinite resistance and, therefore, no current flows across an open circuit no matter how large a voltage applied across the open circuit.