

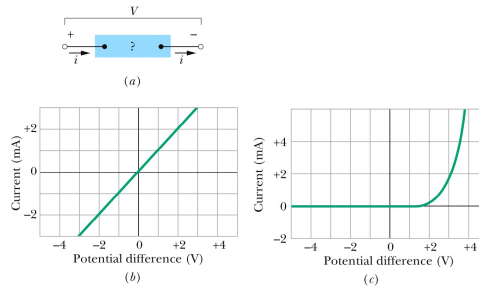
Lesson 14: Ch. 26 (4-5) – Ohm's Law and Electric Power

1 Ohm's Law

A resistor is defined by its ability to impede or limit the flow of current at a given potential. In electrostatics we could instantly move charge from one spot to another. With resistors the flow of charge is no longer instant but instead is provided over time as a current.

We can talk about a current (i) raised by a given potential difference (V) in a particular resistor (R) – this is called Ohm's Law.

- States that the amount of current flow in a circuit depends on the potential and the resistance to the current.
- $V = iR$
- For a given V , more R means less i
- V must be linear with current – more current, more V !
- Many non-Ohmic devices exist in circuits, for them V is not equal to IR .
- Resistors are Ohmic, Batteries and Capacitors are not.



2 Power in Electrical Circuits

Remember that energy per unit time was the concept of power. Doing 100 Joules of work in 10 seconds required a power of 10 W (or 10 Joules every second). If we did 100 Joules of work in only 1 second, we would need a power of 100 W (W, or 100 Joules in the second). In physics energy is a constraint which must be satisfied to make something happen. Power says how quickly you can provide enough energy to make it happen.

Each Ohmic device dissipates power in the form of thermal energy (heat)

- Charges release or require more energy by going through a potential difference.

- $W = qV$
But q and W can change in time for a constant V . Take derivative.
- $\frac{dW}{dt} = \frac{dq}{dt}V$
- We get $P = iV$, true for all circuit elements.
- Remember though that $V=iR$ for Ohmic devices.....so....
- $P = iV = i^2R = \frac{V^2}{R}$ for Ohmic devices

Exercise 1: In a DC circuit, a current of 0.5 A exists in a $60\ \Omega$ lamp. Calculate the potential difference applied to the lamp.

Exercise 2: A rod of length 2.0 m has a square cross section of $2.0\ \text{mm} \times 2.0\ \text{mm}$. It is made from steel which has a resistivity of $6.0 \times 10^{-8}\ \Omega \cdot \text{m}$. If a potential difference of 0.50 V is then placed across the ends of the rod, at what rate will heat be generated in the rod?

Exercise 3: Thermal energy is produced in a resistor at a rate of 100 W when the current is 3.00 A. What is the resistance?