Electric Power: Putting Charges to Work
Lesson Notes

Learning Outcomes
- What is meant by electrical power?
- How do you calculate power?

Putting Charges to Work
- Circuits are designed for a purpose: to *power* a device.
- Electrical energy is supplied to the circuit by the electrochemical cell (or the utility company) as it does work upon the charge to move it from low V to high V.
- Electrical energy is removed from the circuit by the **load**.
    - Light bulbs: transform electrical E to light E and thermal E
    - Fans and motors: transform electrical E to mechanical E
    - Toasters, heaters: transform electrical E to thermal E
    - Speakers, doorbells: transform electrical E to sound E

What is Power?
Definition of Power:

The rate at which work is done.

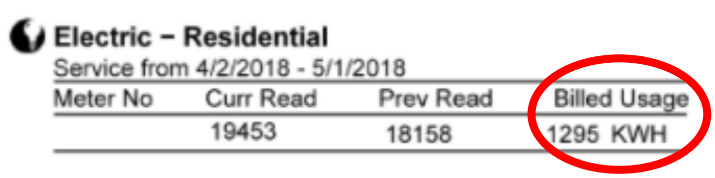
For circuits, power refers to the rate at which work is done by the energy source upon the charge OR. the rate at which energy is delivered to the load.

$$\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{\Delta\text{Energy}}{\text{Time}}$$

Unit: Joule/second (J/s) which equals a **Watt** (**W**)

A 60-Watt light bulb is a bulb that *draws* 60 J of electrical energy each second and converts it to light and heat.

The kilowatt•hour (KWH)
An electric utility company charges its customers for the amount of kW•hr of electricity they used. What is a kW•hr?


Electric – Residential

Service from 4/2/2018 - 5/1/2018

Meter No	Curr Read	Prev Read	Billed Usage
	19453	18158	1295 KWH

kW•hr stands for kiloWatt•hour.

Power (kilo Watt) **Time** (hour)

kW•hr is a unit of energy

$$\text{Power} = \frac{\Delta\text{Energy}}{\text{Time}} \Rightarrow \Delta\text{Energy} = \text{Power}\cdot\text{Time}$$

$$1\ \text{kW}\cdot\text{hr} \cdot \frac{1000\ \text{W}}{1\ \text{kW}} \cdot \frac{3600\ \text{s}}{1\ \text{hr}} \cdot \frac{1\ \text{J}}{1\ \text{W}\cdot\text{s}} = 3\ 600\ 000\ \text{J}$$

Calculating Power

Equation 1

$$P = \frac{\Delta E}{t}$$

Equation 2

$$\Delta V = \frac{\Delta E}{Q}$$

Equation 3

$$I = \frac{Q}{t}$$

From **Equation 2**, we can state that **$\Delta E = \Delta V \cdot Q$**.

This **ΔE** expression can be substituted into **Equation 1**.

$$P = \frac{\Delta V \cdot Q}{t} \quad \text{rearrange ...} \quad P = \Delta V \cdot \frac{Q}{t}$$

But since **Q/t** is I (**Equation 3**), we can claim …

$$\boxed{P = \Delta V \cdot I}$$

Power (the rate at which energy is supplied to a device) depends upon the **current** and the **electric potential difference** impressed across the device.

Practice Problem

Alfredo deDarke often leaves household appliances on for no good reason (at least according to his parents). The deDarke family pays 10¢/kilowatt-hour ($0.10/kW•hr) for their electricity. Fill in the table below.

Power (W)	t (hrs)	Energy (kW•hr)	Cost (¢)	Cost ($)
60 Watt Bulb	1	0.060 kW•hr	0.6 ¢	$0.006
60 Watt Bulb	4			
120 Watt Bulb	2			
100 Watt Bulb		10 kW-hr		
60 Watt Bulb			1000 ¢	$10
	100	60 kW-hr		