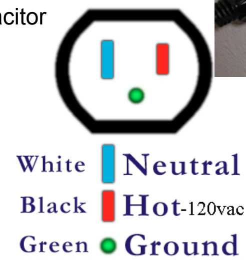
PHY132H1F Introduction to Physics II
Class 16 – **Outline:**

- Resistors connected in Parallel
- Electric Ground
- Resistor-Capacitor (RC) Circuits



Quick Ch. 32 reading quiz..

In an RC circuit, "RC" stands for

A. Right Circular
B. Resistor Capacitor
C. Remote Control
D. Radio Controlled
E. Robot Chicken

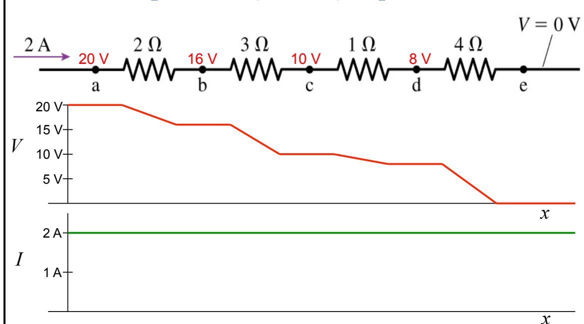
Quick Ch. 32 reading quiz..

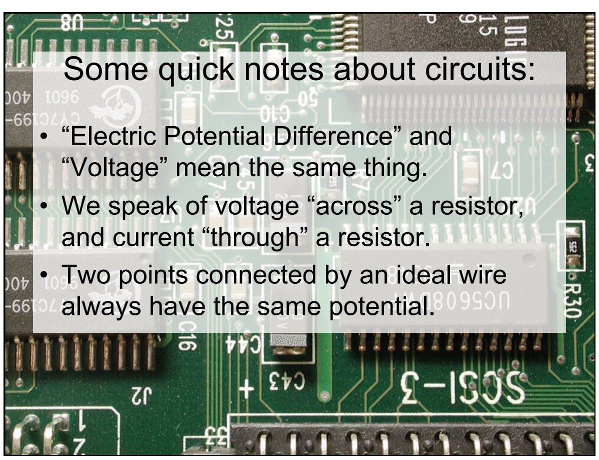
The most important single property of an RC circuit is its

A. capacitance in Farads
B. resistance in Ohms
C. voltage in Volts
D. charge in Coulombs
E. time constant in seconds

$$\tau = RC$$

Recall discussion question from last class..
What is the potential (current) at points a to e ?





Some quick notes about circuits:

- "Electric Potential Difference" and "Voltage" mean the same thing.
- We speak of voltage "across" a resistor, and current "through" a resistor.
- Two points connected by an ideal wire always have the same potential.

Parallel Resistors

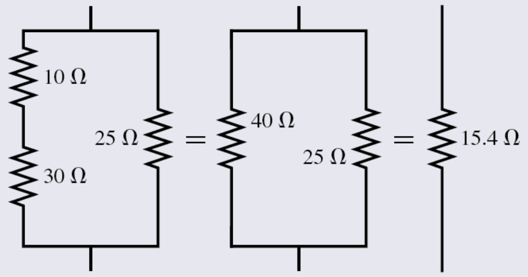
- Resistors connected *at both ends* are called **parallel resistors** or, sometimes, resistors "in parallel."
- The left ends of all the resistors connected in parallel are held at the same potential V_1, and the right ends are all held at the same potential V_2.
- The potential differences ΔV are the *same* across all resistors placed in parallel.
- If we have N resistors in parallel, their **equivalent resistance** is

$$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}\right)^{-1} \quad \text{(parallel resistors)}$$

The behavior of the circuit will be unchanged if the N parallel resistors are replaced by the single resistor R_{eq}.

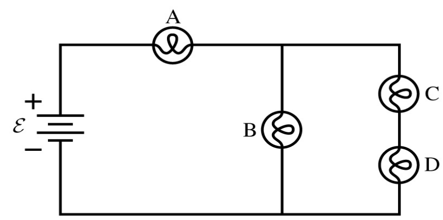
A figure from Example 32.10 in Knight.

FIGURE 32.27 The combination is reduced to a single equivalent resistor.



Example
Four identical light bulbs, each with resistance 240 Ω, are powered by a 120 V DC-Power supply, as shown.

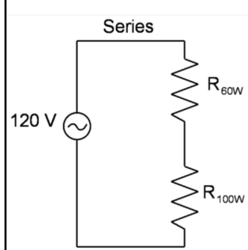
1. **What is the power dissipated by bulb A?**
2. **If bulb C is unscrewed, breaking the circuit at that point, what will be the power dissipated by bulb A?**

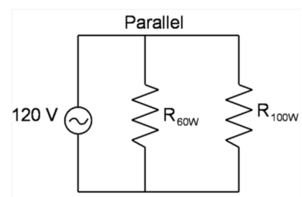


An interesting little note, from Knight, Example 32.4:

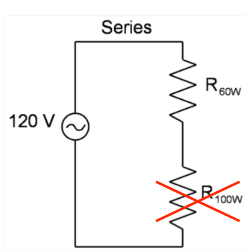
MODEL Most household appliances, such as a 100 W lightbulb or a 1500 W hair dryer, have a power rating. The rating does *not* mean that these appliances *always* dissipate that much power. These appliances are intended for use at a standard household voltage of 120 V, and their rating is the power they will dissipate *if* operated with a potential difference of 120 V. Their power consumption will differ from the rating if they are operated at any other potential difference.

Demonstration. Two ways of wiring two different light bulbs.
Note: A circle with a wavy line in it represents an Alternating Current (AC) power supply. It is like a battery, except the voltage flips direction 60 times per second.

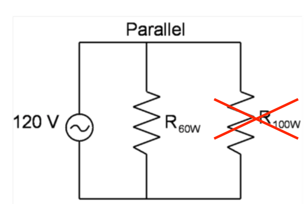




Demonstration. In Class Discussion Question.
If the bulbs are wired in series and the 100 W bulb is unscrewed, what will happen to the 60 W bulb?
A. It will light up.
B. It will not light up.



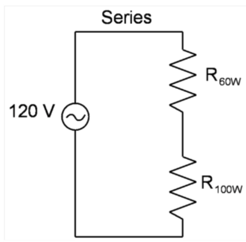
Demonstration. In Class Discussion Question
If the bulbs are wired in parallel and the 100 W bulb is unscrewed, what will happen to the 60 W bulb?
A. It will light up.
B. It will not light up.



Demonstration. In Class Discussion Question

If the bulbs are wired in series, which bulb will consume more power?

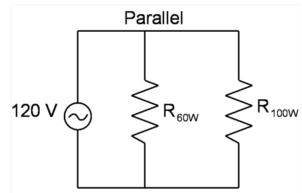
A. The 60 W bulb.
B. The 100 W bulb.
C. both will consume the same power.



Demonstration. In Class Discussion Question

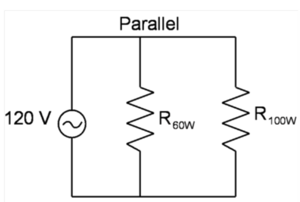
If the bulbs are wired in parallel , which bulb will consume more power?

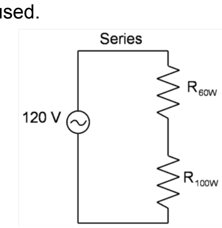
A. The 60 W bulb.
B. The 100 W bulb.
C. both will consume the same power.



Demonstration. The moral:

- The thing that is the same for resistors in parallel is voltage. Use $P = V^2 / R$ to compare power. Higher power corresponds lower resistance.
- The thing that is the same for resistors in series is current. Use $P = I^2 R$ to compare power. Higher resistance corresponds to higher power.
- In your house, Parallel is ***always*** used.





RC Circuits

- Consider a charged capacitor, an open switch, and a resistor all hooked in series. This is an *RC* Circuit.
- The capacitor has charge Q_0 and potential difference $\Delta V_C = Q_0/C$.
- There is no current, so the potential difference across the resistor is zero.
- At $t = 0$ the switch closes and the capacitor begins to discharge through the resistor.
- The capacitor charge as a function of time is

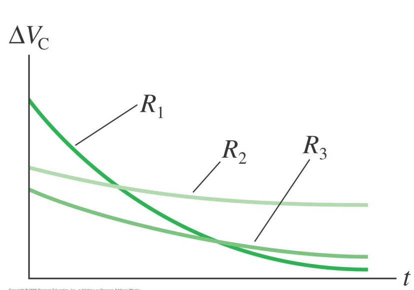
$$Q = Q_0 e^{-t/\tau}$$

where the time constant τ is

$$\tau = RC$$

The figure shows the voltage as a function of time of a capacitor as it is discharged (separately) through three different resistors. Which resistor has the highest resistance?

A. R_1
B. R_2
C. R_3



Before Next Class:

- Problem Set 7 on MasteringPhysics is due tonight by 11:59pm. It is based on the last parts of Ch.31, and the first half of Ch. 32.
- There is also a Practice Problem Set on MasteringPhysics, based on the last half of Ch. 32, which is not for marks.
- There are NO PRACTICALS this week! Catalina and Graham may be holding extra office hours.
- I will do some review of Chs. 26, 27, and 29-32 on Monday.
- *Test 2 is on Tuesday.*

See you Monday!