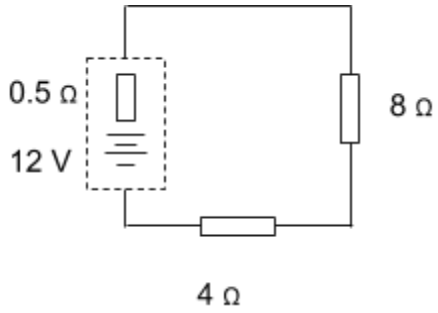
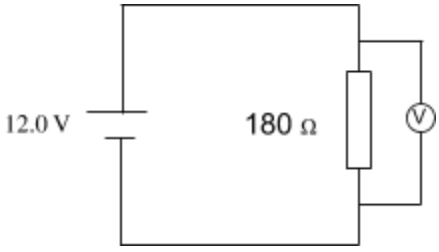
Non-Ideal Circuit Elements

1. A circuit is wired as shown. The battery has internal resistance 0.5 Ω and EMF 12 V.
    a. Calculate the current in the circuit.
    b. Determine the terminal voltage of the battery.
    c. Calculate the power dissipated by the internal resistance of the battery.
    d. Describe the effect this power dissipation would have on the battery.

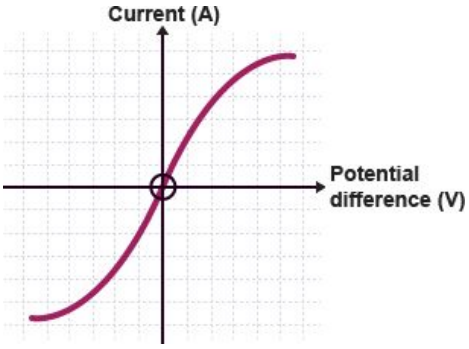


2. An ideal 12 V battery is wired in series with an ammeter, 18 Ω, and 6 Ω resistor.
    a. Draw the circuit diagram.
    b. Calculate the current read by the ammeter if it is ideal.
    c. Now assume the ammeter is non-ideal, and has an internal resistance of 0.5 Ω. Calculate the effective resistance of this circuit and the current reading for the ammeter.

3. Given the circuit diagram.
    a. Determine the voltage read by the voltmeter if it is ideal.
    b. Calculate the current through the 180. Ω resistor and the voltmeter.
    c. Now assume the voltmeter is non-ideal, and has an internal resistance of 1000. Ω. Calculate the new effective resistance of this circuit and determine the voltage read by the voltmeter.
    d. Calculate the current through the 180. Ω resistor and the voltmeter.
    e. Describe the effect on the current of using a voltmeter that has a larger resistor.

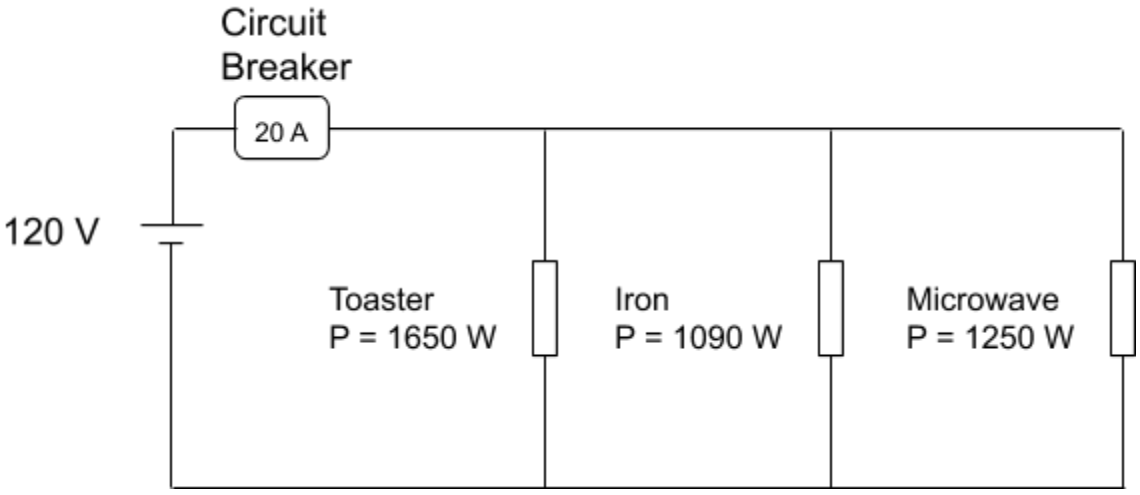


4. The current vs voltage graph for a tungsten filament bulb is given on the right.
    a. Determine how the resistance of the filament changes with voltage.
    b. Explain how this is different than the resistors you have encountered.
    c. What physical property of the filament may cause this behavior?



5. A student wants to measure the current through a 3300 Ω resistor wired to a 10 V power supply. The student accidentally uses the ammeter in parallel rather than series. Assume the ammeter has an internal resistance of 0.5 Ω.
    a. Draw the circuit diagram.
    b. Calculate the current that flows through the ammeter.
    c. In the ammeter, there is a fuse designed to break at 0.5 A of current. Does the fuse break?
    d. Explain why the fuse is designed to break.

6. Circuit breakers are resettable automatic switches that open when a given current value is exceeded. A 1650 W toaster, 1090 W iron, and a 1250 W microwave oven are turned on in a kitchen. As the drawing shows, they are all through a 20 A circuit breaker to a 120 V power supply.



    a. Obtain the total current delivered by the power supply if all three devices are used at the same time and determine if the circuit breaker will open.
    b. Explain the purpose of the circuit breaker.
    c. Compare a circuit breaker and a fuse.