8.) Some tests are performed on an electric motor used to operate a grain auger. (A grain auger is a agricultural tool used to lift and move grain.) The motor operates on 240 V RMS, 60 Hz AC power. When there is no grain in the auger the motor is loaded only by the friction of bearings and belt losses. Then the current is found to be about 9.5 A RMS. When the auger is fully loaded with grain the current is found to be about 18 A RMS.

a.) The farm where this motor is used does not have a meter to measure the power factor. A datasheet that came with the motor states that the power factor is typically 0.80. The datasheet mentions that this is “typical” for near-full-load conditions. This number is used as an estimate for the power factor. With these measurements and assumptions, how much electrical power will calculations show the motor draws when the auger is unloaded and when it is loaded?

b.) Upon further investigation the power factor is measured. It is 0.4 when the auger is unloaded and 0.85 when the auger is loaded. Repeat the power calculations for unloaded and loaded conditions based on the new information.

c.) Since power factor is more difficult to measure than voltage or current, it is tempting to just estimate it based on the manufacturer’s rating. Is estimating power factor a reasonable method? Why or why not.

9.) What are the resistances of the following common electrical devices:

a.) A 65 W automotive low-beam headlight bulb that operates on direct current at 12.6 V.

b.) An incandescent 65 W household flood lamp that operates on 117 V, 60 Hz AC?
(All incandescent lamps have a power factor of unity.)

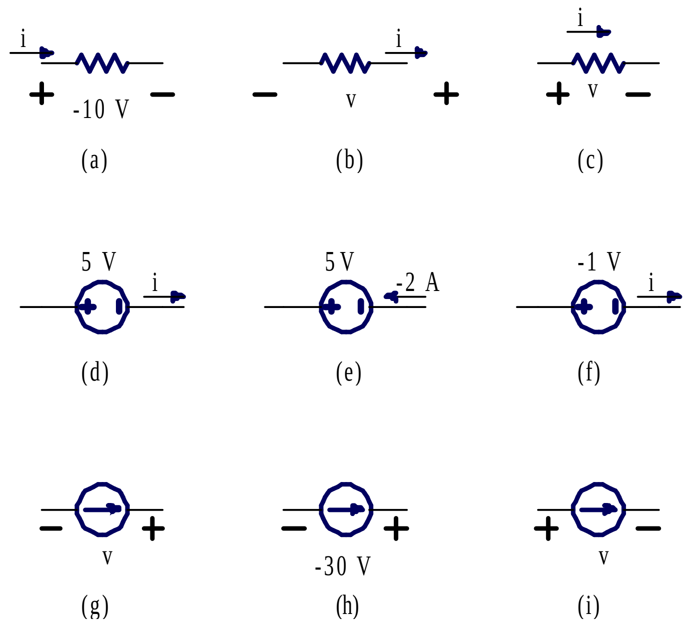
c.) A 1500 W electric heater that operates on 117 V, 60 Hz AC? (The power factor is unity.)

d.) A 1500 W range-top burner for a residential kitchen cook-stove? The burner operates on 240 V at 60 Hz AC with unity power factor.

e.) A flashlight-bulb that operates on four D-cell batteries in series so that their voltages add together.
Then the entire lamp current flows through each battery, one after the other.
Each battery provides 1.5 V. The lamp draws 300 mA.

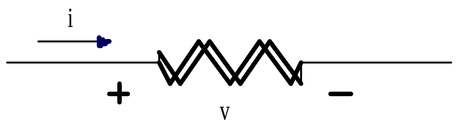
f.) A key-chain-fob LED-type flashlight lamp that operates on two lithium coin-style batteries, 3.0 V each, in series so that their voltages add and the lamp current flows through each battery. The LED lamp draws 30 mA.

10.) Which of the nine illustrations below (a through i) show labels in agreement with the passive sign convention? Explain your answers.



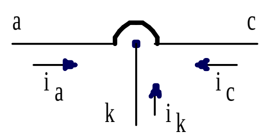
11.) Which of the following fictional and fanciful devices would be classified as a *simple circuit element* if it actually existed?

a.) A "signed square-law resistor" has the symbol and voltage-current relationship shown below. The value of the signed square-law resistor is given the symbol Γ (capital gamma), and is measured in units of "ohms per amp." For example, if $\Gamma = 10\ \Omega/\text{A}$ and if $i = -2$ A, then $v = -40$ V.

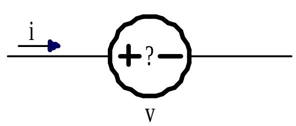



$$v = \Gamma i|i|$$

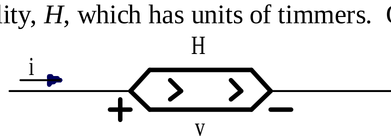
b.) A "dordtolator" has terminals marked "a," "c," and "k" as shown in the diagram below. The value of the dordtolator, symbolized by μ (lower-case mu) is dimensionless, but can be cited as "volts per volt." Under all conditions $i_a = -i_c$ and $i_k = 0$ and $v_{ac} = \mu v_{kc}$. In this notation the subscripts indicate which two points are used to measure the voltage, the first subscript being the positive labeled terminal. In other words, $v_{ac}$ is the voltage of terminal "a" with respect to terminal "c." Likewise, $v_{kc}$ is the voltage of terminal "k" with respect to terminal "c."




c.) A "noise source" has the symbol shown below. The voltage across the noise source changes constantly with time in an unpredictable way. Although the average of many sample measurements taken over time will be close to zero, at any particular time the voltage can be any amount up to 1000 V, regardless of the amount of current flowing.




d.) A "timmeratortor" has the symbol shown below. The voltage across the device is proportional to the second derivative of the current through the device. The value of the device is symbolized by the constant of proportionality, *H*, which has units of timmers. One timmer is equal to a volt-second squared per amp squared.




$$v = \mathrm{H}\frac{d^2 i}{dt^2}$$