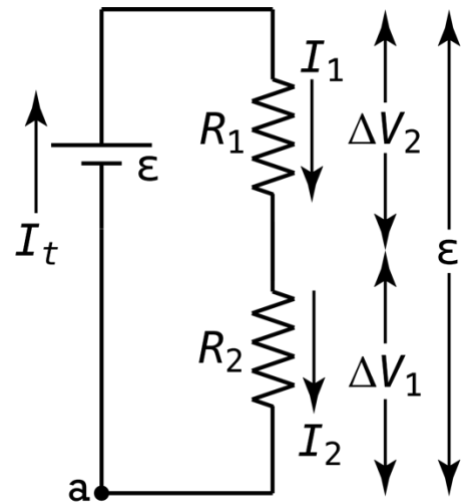
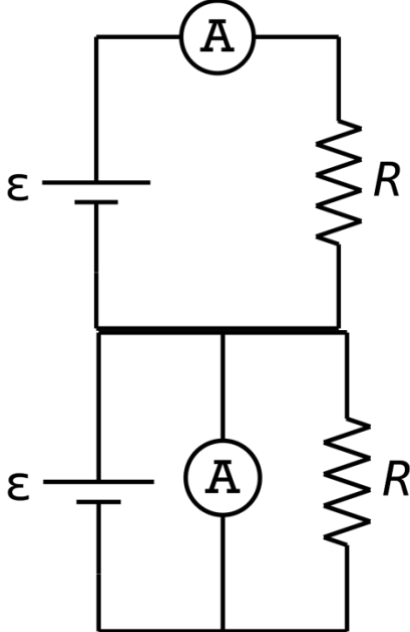
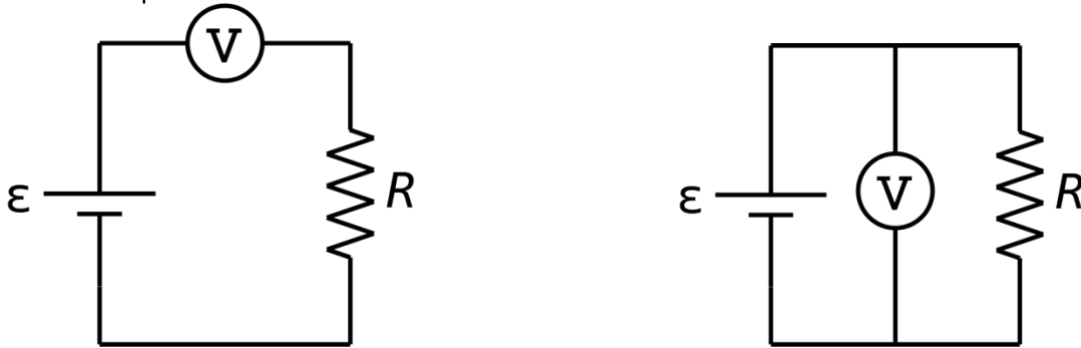


Let's discuss how to use the tools which measure current and electric potential difference. Starting with the ammeter which measures current or amperes. We need to decide if an ammeter needs to be put in series or parallel with the circuit element it is meant to measure the current through. So, let's look at what happens when we attempt to measure the current through a resistor using an ammeter in series and in parallel with a resistor:



Hopefully you recognize that placing an ammeter in parallel with a resistor will not measure the current through the resistor because the current through the ammeter and the resistor are not the same. Therefore, an ammeter needs to be placed in series with a circuit element to measure the current through that circuit element. Also, the resistance of an ammeter needs to be *very* small. In the above example, if the resistance of the ammeter is not *very* small, it will increase the equivalent resistance of the circuit and decrease the current through the resistor you are trying to measure the current through. Unless otherwise indicated, ammeters in this class are considered to have zero resistance.

And now let's attempt to measure the electric potential difference across a resistor using a voltmeter either in series or in parallel with a resistor:



Hopefully you recognize that placing a voltmeter in series with a resistor will not measure the electric potential difference across the resistor because the voltage across the voltmeter and the resistor are not the same. Therefore, a voltmeter needs to be placed in parallel with a circuit element to measure the voltage across that circuit element. Also, the resistance of a voltmeter needs to be *very* large. In the above example, if the resistance of the voltmeter is not *very* large, it will decrease the equivalent resistance of the circuit, increase the current delivered by the battery, and change the overall properties of the circuit. Unless otherwise indicated, voltmeters in this class are considered to have infinite resistance.

To review:

<ul style="list-style-type: none"> ● Ammeters: 	<ul style="list-style-type: none"> ● Voltmeters:
<ul style="list-style-type: none"> ○ Measure current 	<ul style="list-style-type: none"> ○ Measure electric potential difference
<ul style="list-style-type: none"> ○ Placed in <i>series</i> with the circuit element 	<ul style="list-style-type: none"> ○ Placed in <i>parallel</i> with circuit element
<ul style="list-style-type: none"> ○ Have nearly <i>zero</i> resistance* 	<ul style="list-style-type: none"> ○ Have nearly <i>infinite</i> resistance*

* You may see this called impedance in product literature for Voltmeters and Ammeters, due to the fact that there is more to the behavior of these devices than just resistance. For the purpose of this class and the AP Physics C Electricity and Magnetism exam, it will be called resistance unless otherwise noted.