# Physics PreLab 212-3

## Circuit Networks

**Name** ______________________________

**Section** ____________ **Date** ________

### Circuit Diagrams

Circuits can be drawn in many different ways. Sometimes two diagrams that look quite different can be completely equivalent circuits. In the following questions there are several diagrams with a battery and light bulbs (or resistors). You are asked to determine which circuits are the same, and which are different.

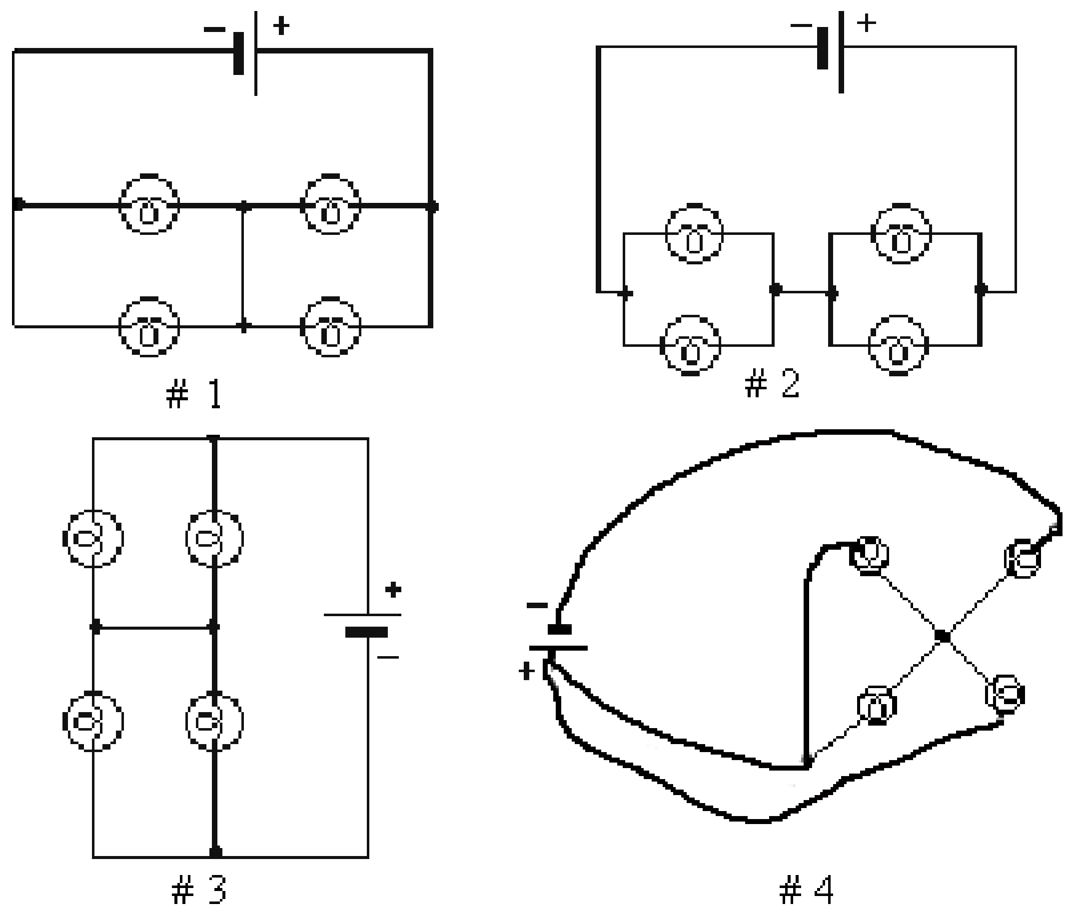


Figure 1. Four circuit diagrams*

* Figure adapted from *Real Time Physics*, © 1993 University of Oregon, Tufts University, Dickinson College

**Q1[8']** Which of the four circuits in Figure 1 are the same electrically? Explain your answers. (Note that the circuit elements resembling a circle with a curved wire inside are light bulbs.)

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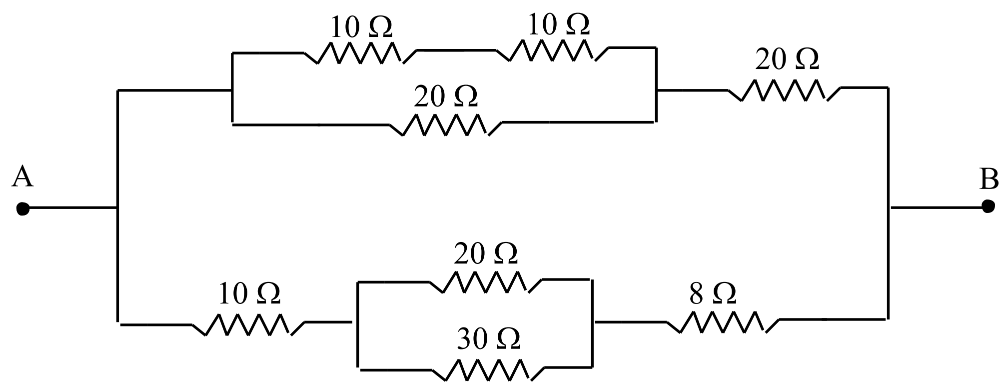


Figure 2. A resistor network

**Q2[2']** What is the equivalent resistance of the network in Figure 2 between points A and B? Show your work below.

$R_{AB}$ = ____________ [Ω]

You are going to examine the characteristics of voltmeters and ammeters (current meters).

**Q3[5']** Indicate on the circuit diagram in Figure 2 how you would connect an ammeter to measure the current through the 8-Ω resistor. Why is the ammeter connected in this way?

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**Q4[5']** What is it about the design of a good ammeter that allows you to connect it in the way indicated above without appreciably affecting the current through the 8-Ω resistor?

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**Q5[5']** Indicate on the circuit diagram in Figure 2 how you would connect a voltmeter to measure the voltage across the 8-Ω resistor. Why is the voltmeter connected in this way?

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**Q6[5']** What is it about the design of a good voltmeter that allows you to connect it in the way indicated above without appreciably affecting the voltage across the 8-Ω resistor?

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In this lab, you will also be working with time-dependant RC circuits (circuits that have only a Resistor, a Capacitor, a battery, and a switch). Study the simple RC circuit below:

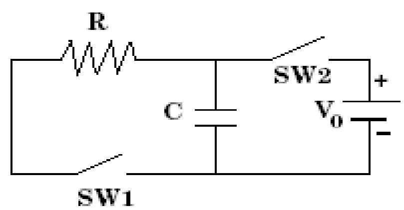


Figure 3. A simple RC circuit

Before time t=0, the capacitor is fully charged to voltage $V_0$ by closing **SW2** while **SW1** is open. **SW2** is then opened while **SW1** is still open. At t=0, **SW1** is closed. Sketch the voltage across C as a function of time. **Mark on the time axis the time when the voltage across C falls to half the initial voltage ($V_0$/2).**

**Q7[8']**


**Q8[5']** If the resistance is cut in half, will the time for the voltage across the capacitor to fall to $V_0/2$ change? If so, how will it change?

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**Q9[5']** If the capacitor's capacitance is doubled (instead of halving the resistance), will the time for the voltage across the capacitor to fall to $V_0/2$ change? If so, how will it change?

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The previous labs have been mostly qualitative, trying to explore the concepts of fields and potentials. In this lab we will start making *quantitative* measurements, and comparing them to theoretical predictions. Qualitative comparisons ("the measurement and prediction are pretty close") should always be supplemented by *quantitative* comparisons. There are two basic ways to do this, and *you should do both whenever you are asked in lab to compare two values*:

1. absolute comparison (the absolute value of the difference of the values):
   $\Delta = |A-B|$
2. percentage difference (the relative difference of the values):
   $\%\Delta = |A-B|/B$

For example, if the prediction is 2.0 volts, and you measured 2.1 volts, then

$\Delta = 0.1$ volts, $\%\Delta = (2.1-2)/2 = 0.05 = 5\%$.

[You may wonder *which* value goes on the bottom. This can be a subtle question. In general, you should divide by the number you trust more – if you are comparing a measured resistance to one calculated using Ohm's law, probably you would put the theoretical prediction in the denominator; if you were comparing a complicated theoretical model to an experimental measurement, then probably the measurement would go on the bottom. You won't need to worry about this in Physics 212. As long as the two values are fairly similar, you'll get about the same %Δ no matter which goes on the bottom.]

**Q10[2']** Your lab partner tells you that his measured resistance was higher than his prediction by 1.3 Ω. Since this claim is meaningless by itself, you ask him what he actually measured. He says 10.1 Ω. What is the percentage difference %Δ between the measured value and theoretical prediction?

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