Honors Physics Take-Home Test on Chapters 20 – 23
Due in room 330 by 2:00 PM Tuesday, May 29

Instructions: Write your name at the top right of the this page, and staple this page to the top of your answer sheets. Number all problem solutions consecutively, starting with the first problem. Show all work and circle all answers. No answers should appear on this sheet. You may consult any source and work with other students to obtain solutions. If you have questions while working on these problems, send me email (gilbert_elchinger@ccpsnet.net).

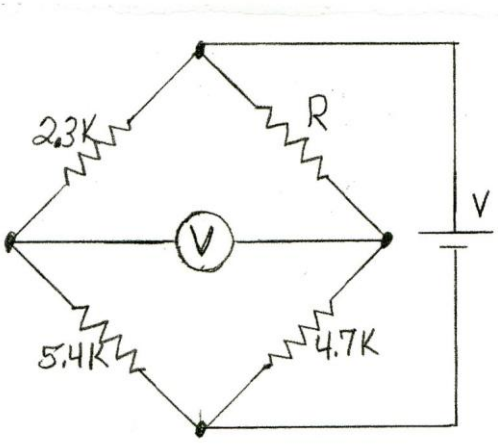
1. A 10 gram pith ball having a charge of $1\mu C$ is electrostatically attracted to one of the inside surfaces of a large parallel plate capacitor by an electric field between the plates. The plates are vertically oriented so that the electric field between the plates is horizontal. The distance between the plates of the capacitor is 10 cm, and the coefficient of static friction between the pith ball and the plate is 0.5. What is the minimum voltage needed to keep the ball from sliding down the plate from gravity? Draw a picture to show all forces on the pith ball.

2. A parallel plate capacitor consists of two flat conducting plates uniformly separated by a distance, d, each of area A. It has a capacitance defined as $C = \frac{Q}{\Delta V}$, where ΔV is the potential difference between the plates. What is the attractive force (in Newtons) of one plate on the other of a $1\mu F$ capacitor charged to potential difference of 100 volts and having a plate separation of 1mm?

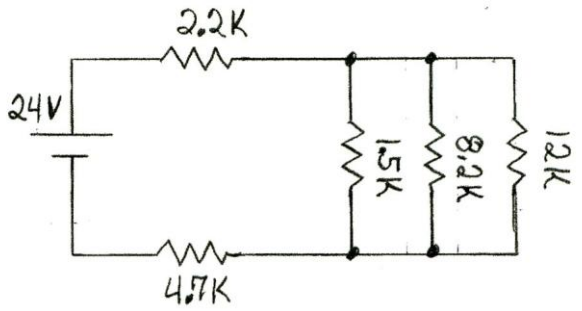
3. An electronic device that runs on a configuration of rechargeable cells draws a DC current of 500mA at 4.8V. It must run for 15 hours before recharging.
   a. Devise a minimum configuration of 1.2V cells, each rated at $2A \cdot hrs$ of energy when fully charged, that will deliver this voltage and current requirement for the specified length of time.
   b. How much electrical power (in watts) does the electronic device require?
   c. How much electrical power can your configuration of cells deliver over 15 hours?

4. A person is building an electronic circuit and needs a $3.1k\Omega$ resistor that he doesn't have on hand. It's a holiday and the local Radio Shack is closed. Wanting to complete the circuit that day, he searches through his stock of resistors and finds the following values: $10k\Omega$, $5.2k\Omega$, $6.8k\Omega$, and $7.2k\Omega$. He feels that some arrangement of these resistors will yield a net resistance of $3.1k\Omega$. After some time, he found such an arrangement. Now you find it one.

5. In the circuit below, what value of R will make the voltmeter read zero voltage?



6. The voltage dropped across a resistor, multiplied by the current that flows through the resistor, is electrical power that is lost as heat. Resistors are rated by their resistance as well as their ability to dissipate this heat (their wattage rating). In the circuit below, find the minimum wattage rating of each resistor.



7. An older type of electrical meter uses a coil of wire configured in a permanent magnetic field such that when electrical current passes through the coil, a magnetic field is generated that is proportional to that current, and causes the coil to rotate within the permanent magnet. A needle that is attached to the coil records the amount of rotation. Good quality meters can measure currents below $1\mu A$ (millionth of an Ampere). However, when combined with a suitable resistor, these meters can measure either current or voltage. Draw a circuit below using a resistor and a $100\mu A$ meter to measure 10 volts. Determine the resistance value of the resistor that will accomplish this goal given that the resistance of the meter itself is 50Ω. (Remember that ideal voltmeters have infinite resistance.)