Essay 1 (10 points)
How would you use an ammeter to determine the amount of current flowing in a series circuit containing two batteries and two light bulbs? Draw a picture of the circuit with the ammeter connected. How would you use a voltmeter to determine the voltage across the two batteries in this circuit? Draw a picture of the circuit with the voltmeter connected.

Essay 2 (10 points)
In the circuit in Essay 1, how would the reading on the ammeter change if more bulbs were placed in series in the circuit? Why? What experiment have you done which would lead you to think this? In the circuit in Essay 1, how would the reading on the voltmeter change if you added more bulbs in series? Why? What experiment have you done which would lead you to think this?

Problem 1, 20 points
a) A student does the spring experiment and gets the following equation: $l = 3.2\ \text{cm/g} * w + 22\ \text{cm}$, where l is the length of the spring and w is the weight hanging from the spring. Draw a graph of their result. Make sure to label and name your axes. Describe what the two "constants" of the spring are that can be extracted from this equation, and how would you extract them from the graph.
b) A "spring constant" traditionally is expressed in units of g/cm. Describe the graph you would make to extract this quantity from the slope. How would it be related to the slope in part a? How would you extract the other constant (you derived in part a) if you are plotting the graph as in part b?

Problem 2 (10 points)
Rank the bulbs marked A-H on the drawing on the next page according to their brightness. If two or more bulbs are equal in brightness, indicate that. Rank the points marked 1-10 in the circuits by the arrows by the amount of current flowing through that point in the circuit. If two or more points in the circuits have equal current, indicate that.

Essay 3
Explain how you would find the polarity (which terminal is positive and which is negative) of a battery whose terminals are taped using a long wire and a compass. Draw clear pictures of what if you see would allow you to say which terminal is positive. Assume that the battery can create a current that is strong enough to create a magnetic field.

Picture for Problem #2: