Exam 1

Physics 181, Friday Oct 6

You may use a 3"x5" card of notes, both sides. NO PHONES.

Present *clear* and *complete* answers.

Unjustified answers will earn no points. Any person who has taken this class should be able to understand what you did just by reading your solution. A diagram and a few words usually help. Start calculations with definitions (*e.g.* $\vec{v} \equiv \frac{d\vec{r}}{dt}$), facts (*e.g.* Newton's laws), or commonly used equations (*e.g.* constant acceleration equations).

1. **Two resistors are in series with a battery. Determine the voltage and current for each resistor.**

2. Two resistors are in parallel with a battery. Determine the voltage and current for each resistor.

3. Calculate the equivalent resistance between any two points in a resistor network.

4. Analyze a circuit using Kirchoff's rules. This means

   (a) writing the voltage and current equations
   (b) determining the current through any branch
   (c) calculating the voltage across any element
   (d) calculating the power for each element.

5. Describe how to measure the IV characteristic of a passive element. Provide text and a circuit diagram.

   What information can you get from the IV curve of a passive element?

6. What is a resistive, or ohmic, element? Describe its behavior and give an example. Equations and diagrams/graphs are always helpful.

   What is an ideal voltage source? Describe its behavior and give an example. Equations and diagrams/graphs are always helpful.

7. Describe how to measure the load curve of an active element. Provide text and a circuit diagram.

   What information can you get from the load curve of an active element?

   What type of resistance is considered a "large load"? Explain.

8. (a) What does a voltage divider do?

   (b) Derive the output of an unloaded voltage divider,

   $$V_{\text{out}} = \frac{R_2}{R_1 + R_2} V_{\text{in}}$$

   (c) Design a voltage divider to output a desired output voltage. You'll be given an input voltage, a load resistance, and a maximum power for the circuit. You'll have to provide resistor values, a circuit diagram, and specify the input and output terminals.

9. What is equivalent between the Thévenin equivalent circuit and the circuit it models?

10. (a) How can you measure a circuit's Thévenin equivalent voltage and resistance? In addition to text, include a circuit diagram.

    (b) Analytically determine the Thévenin equivalent of a circuit consisting of resistors and voltage sources.

11. Derive the following expressions for the Thévenin equivalent voltage and resistance for a voltage divider.

    $$V_{\text{Th}} = V_0 \frac{R_2}{R_2 + R_1}$$

    $$R_{\text{Th}} = \frac{R_1 R_2}{R_1 + R_2}$$

    where V_0 is the input voltage to the divider and the output is taken across R_2.

12. A circuit is designed to deliver power and voltage to a load (R_L). The circuit will provide

    (a) a maximum voltage when $R_L \gg R_{\text{Th}}$
    (b) maximum power to the load when $R_L = R_{\text{Th}}$.

    Derive the above results. Start with the circuit diagram for the Thévenin equivalent circuit, a Kirchoff loop, and $V = IR$. Explain your steps.

13. Measured quantities have uncertainties. Determine the uncertainty of a value calculated from measurements.

    For example, $E = kq/r^2$. If $q = 2.05\text{nC} \pm 0.03\text{nC}$ and $r = 6.1 \pm 4\%$, calculate $E \pm \Delta E$

Items 1 and 4a will definitely be on the test. They're all or nothing problems; no partial credit. They're the first 3 problems of the test. You will not be allowed to use your notecard for these 3 problems.