Physics 150 (Opportunity II)  November 27, 2006

Make sure your name and student ID number are on all pages of your test. **Show all work clearly!!!** The question is wrong if all work is not clearly shown. It is your responsibility to make sure you understand the question before attempting it. Assume ideal conditions unless otherwise stated. Label things clearly. The final answer must include units where appropriate. If you notice someone cheating, you may report it to me in confidence.

1a) Which of the following is the **safest**?
   a) Holding a soldering iron by the hot end.
   b) Checking to see if a soldering iron is on by touching it with your tongue.
   c) Removing your safety goggles so you will not have an obstructed view when desoldering a solder joint.
   d) Removing your safety goggles so you will not have an obstructed view when clipping the leads from a soldered connection.
   e) Wearing your safety goggles while soldering, desoldering and clipping electrical leads.

1b) Which of the following is/are hallmarks of a good solder joint.
   a) Lots of excess solder on the joint.
   b) Beads of solder on the joint.
   c) A solder joint in which the solder melts and flows into the joint.
   d) A cold solder joint.
2) a Derive the equation that gives the gain of a non-inverting amplifier in terms of the resistors $R_1$ and $R_2$. Reference op-amp golden rules where appropriate.

b) If $R_1 = 20\, \text{k}\Omega$ and $R_2 = 580\, \text{k}\Omega$ and a the rails of a 741 op-amp are connected to $+15\, \text{V}$ and $-15\, \text{V}$, and the input is a triangle wave, as shown below, carefully sketch the output in the space provided below. Be very careful, this is a tricky problem.
3a) Use a single op amp and some resistors to design an electrical circuit that will invert the input and amplify it by a factor of 10. The smallest resistor should be a 10kΩ resistor. Give the values of all resistors.
4) Consider the Three-Wire Current-Voltage Analyzer trace shown in the figure, for a particular transistor. The top curve is for a base current of 75 μA, the middle curve is for a base current of 45 μA and the bottom trace is for a base current of 15 μA

a) Roughly, what is the base emitter $V_{\text{be}}$ turn on voltage?

b) What is the constant collector current $I_c$ for a base current of 45 μA?

c) What is the gain for the 45 μA base current curve?

d) What is the gain for the 75 μA base current curve?