1. The circuit diagram of an operational amplifier is shown. Consider the capacitors to be open circuits.
   (a) Draw a ground symbol connected to the lower input. Use your pencil to mark the path (or paths) that a signal takes from the upper input to the output.
   (b) Identify the connection of each transistor, i.e. common emitter, diode connected, current mirror, etc.
   (c) Draw an up arrow at the upper input and trace the “ups and downs” along the signal path (or paths) identified in part (a). Is the upper input the inverting or the non-inverting input?

Path 1: Up at $Q_1$ B, down at $Q_1$ C, down at $Q_3$ E, down at $Q_6$ B, up at $Q_7$ B, down at $Q_7$ C, down at $Q_{10}$ B and $Q_{11}$ B, down at Output.
Path 2: Up at $Q_1$ B, up at $Q_1$ E, up at $Q_2$ E, up at $Q_4$ B, up at $Q_4$ E, up at $Q_7$ B, down at $Q_7$ C, down at $Q_{10}$ B and $Q_{11}$ B, down at Output.
Both paths are inverting. Thus the upper input is inverting.

2. An operational amplifier circuit is shown. Solve for $v_{o1}$, $v_{o2}$, and $v_{o3}$ as functions of $v_{i1}$ and $v_{i2}$.

$$v_{o1} = 6v_{i1} \quad v_{o2} = -3v_{i2} \quad v_{o3} = 9v_{o1} - 8v_{o2} = 54v_{i1} + 24v_{i2}$$