1. Switch Circuit
Build the circuit shown to the right, using 5V and GND from the Arduino for the power connections. SWITCH OUTPUT is a wire connected between the switch and the resistor, which is the output that would normally run to an Arduino pin for reading the switch. When complete, with your DMM, measure the voltage of the SWITCH OUTPUT wire when the switch is open and when the switch is closed. It should be 5V when open, 0V when closed. Note, you should test circuits like this before you plug them into anything else, like an Arduino.

Wait for the instructor before proceeding. If working in pairs, the other person should build the next circuit. Even better, both of you build all circuits.

HINT: In order for the Arduino to read switches, you will need to wire them up with the 10K Ohm pull-up resistor and issue the command: pinMode( pinNumber, INPUT). However, you can also skip adding the resistor+5V pull up if you issue the pinMode(pinNumber, INPUT_PULLUP) command. This command basically adds the pull-up internally.

2. Relay Coil Circuit
Build the circuit shown below, which will turn the relay on and off. See the 1-page schematic sheet for the pinout of the 2N3904 transistor. The pinout of the relay is shown below. The coil is connected to the two pins on the left. Polarity of the coil does not matter. Double-check orientation of the relay before wiring. Insert the relay into the breadboard so that the long dimension runs parallel to the long dimension of the breadboard and the pins of the relay straddle the trough of the breadboard. Consult the instructor if unsure of how to place the relay. Vc is the control wire that runs to the 1K resistor. Touch the control wire Vc to 12V and listen for the relay coil switching state.
3. Bi-Directional Motor with On-Off Control
Build the MANUAL CONTROL circuit on the top left of the Bi-Directional Motor Activity Schematic. Note, you are adding directly onto the previously-build relay coil circuit. To operate, touch the control lines Vc1 and Vc2 to 12V. Try all four combinations of 12V and no 12V on the two control lines to understand how the direction and on-off control works.

Wait for the instructor before proceeding to the next activity. While waiting, help others at your table to finish their circuit.

4. Arduino Controlled Bi-Directional Motor
Build the ARDUINO CONTROL circuit on the bottom left of the Bi-Directional Motor Activity Schematic. This is the same as the manual control circuit except now the control lines run to Arduino pins. You do not have to use the same control pins that are on the schematic. Important: Connect the Arduino ground to the battery minus as shown in the schematic.

Write a program that controls the motor from the Arduino and that demonstrates on-off and direction control. Perhaps write a program that runs the motor for 2 s in one direction, stops for 1 s and then runs the motor 2 s in the reverse direction.

When working, show off what you have done to the instructor.