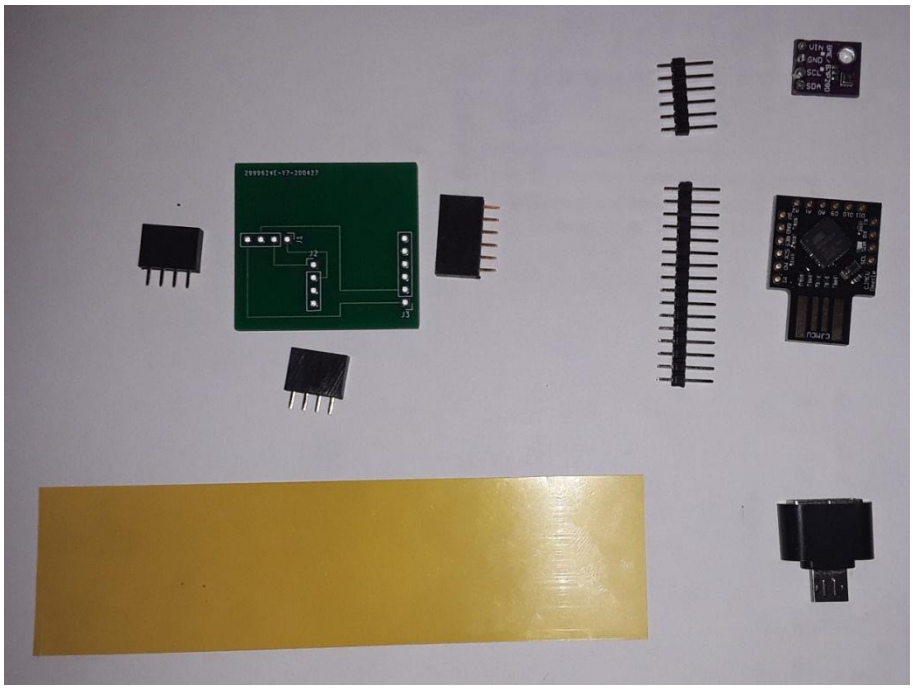
Assembling your Practice Altimeter



Parts provided:

- 1x magenta BME280 Sensor with 4 small mounting holes and 1 row 6-pin male header
- 1x green circuit board with two sets of 4 small mounting holes and 1 set of 6 small mounting holes
- 1x 6-pin female header and 2x 4-pin female headers
- 1x Arduino Leonardo Board in the Beetle form factor and 1 row 16-pin male header
- 1x female USB-A to male Micro-B USB adapter
- 1x sheet of yellow Kapton tape, 1.20” x 4.55”
- Display software for Android phone (download instructions below)
- Driver software for hardware (already “burned” to micro-processor)

Additional parts required:

- A couple inches of electrical tape to seal Kapton tape around circuit board
- A soldering iron and preferably 60/40 Sn/Pb flux core solder, 23 gauge
- A multi-meter with a continuity check, or an ohm meter
- A small cutting tool, or scissors for cutting headers

Recommended parts, but optional:

- A Helping Hand Tool, as pictured on the next page

Step 1:

Insert the 3 female headers (1x 6-pin, 2x 4-pin) into the top of the circuit board so that the female headers are on top and the short pins go through the holes, as pictured below. Note that the top of the circuit board is the side with printing. The backside is blank.

Make sure that each header is fully and squarely seated into the holes as shown below.

Step 2:

If Helping Hands were used as shown above, now remove the circuit board from the Helping Hands, being careful to keep all 3 headers fully seated in their holes.

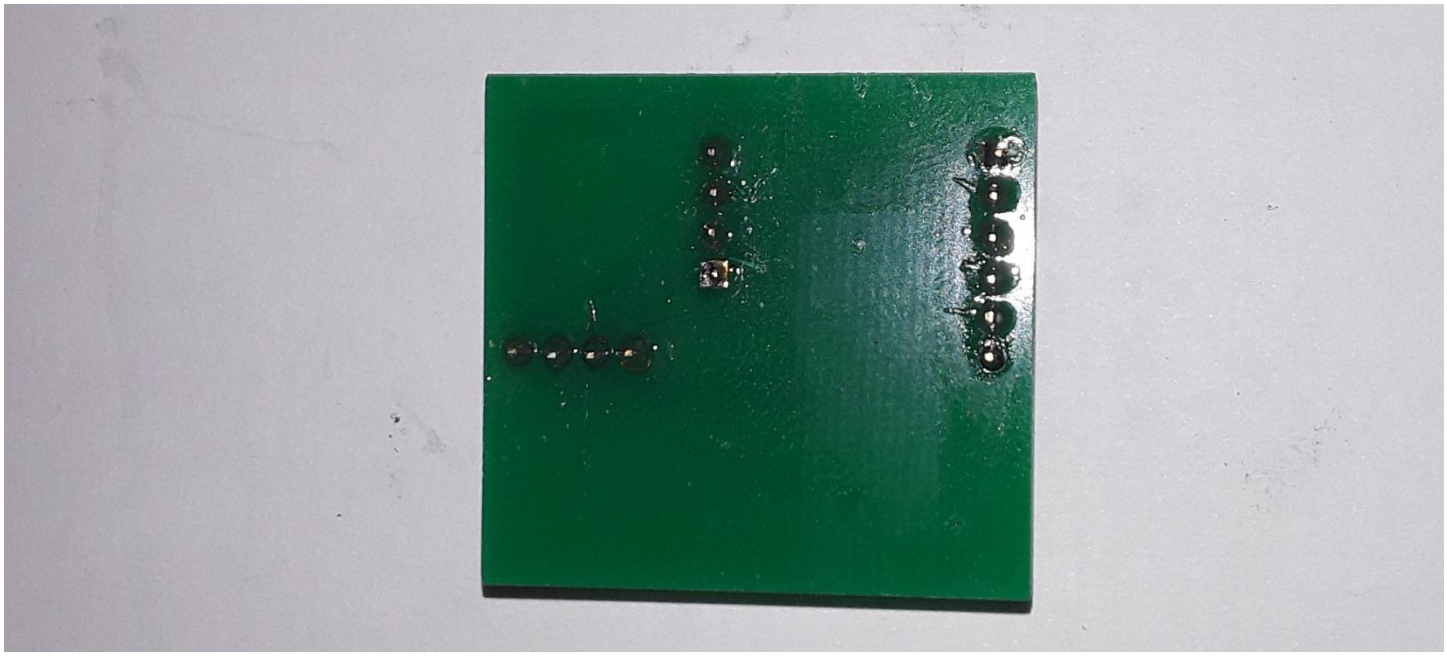
Some pieces of tape may be used temporarily to keep all 3 headers squarely seated.

Now flip the board over to the backside, being careful to keep all headers in place, and place the board down on a level surface as show below.

Orient the board so that the 6-pin row is to the right and the two 4-pin rows are on the left, as shown below.

Then solder the pins to the backside of the board to make sure that all headers are held in place, as shown below.

Periodically check the front side of the board to make sure all female headers are fully inserted and perpendicular to the board.

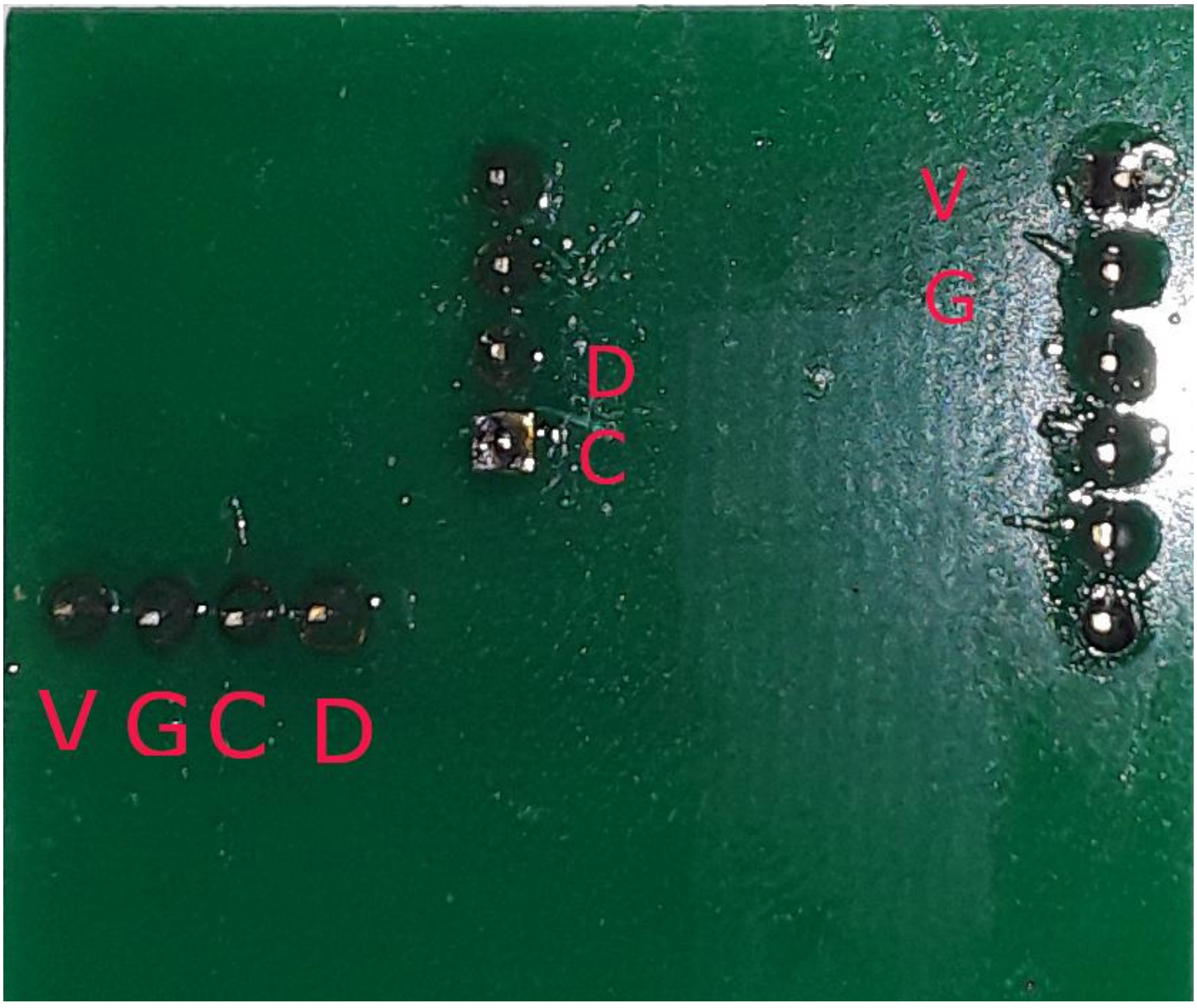


Step 3:

Use a multi-meter to check that none of the 3 headers have a pin that has been short-circuited to its neighbor.

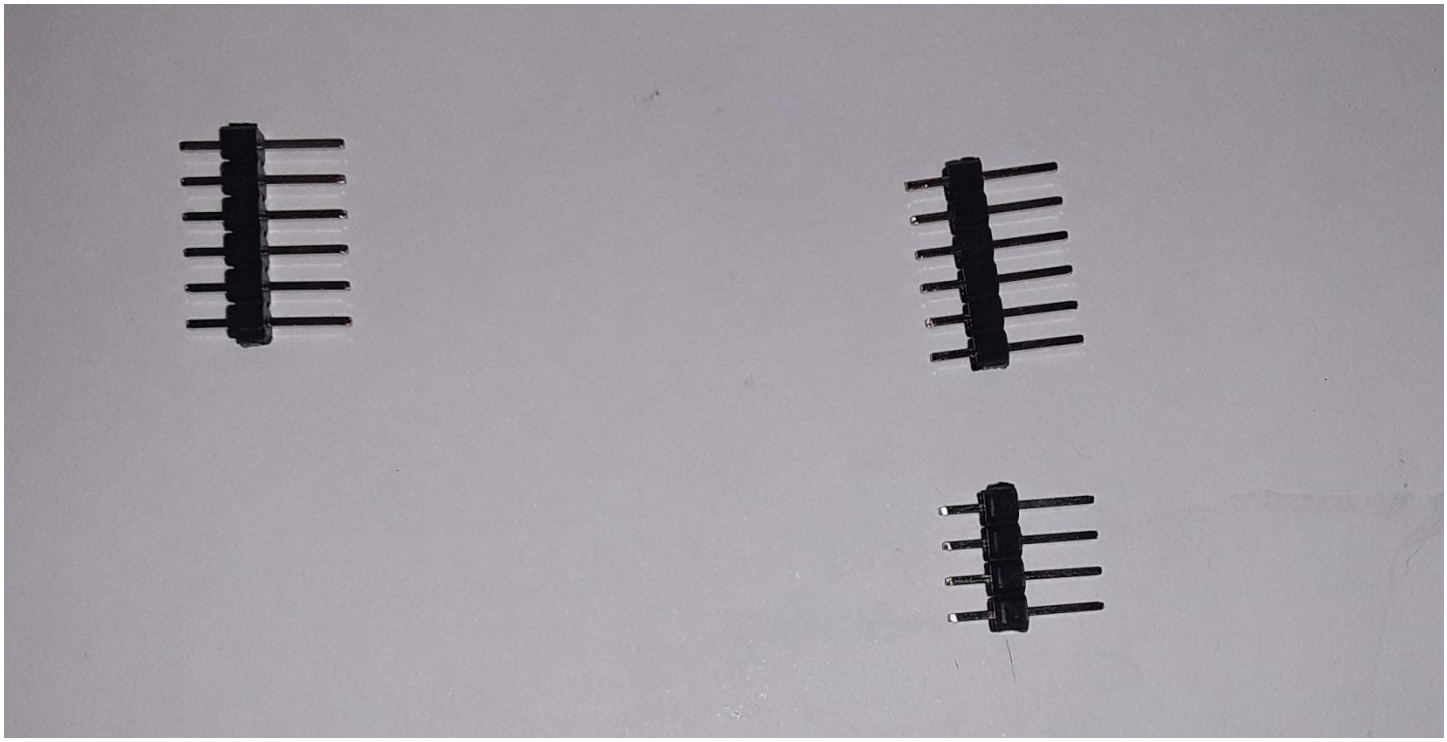
Using a multi-meter, verify that there is a connection between the following 4 pairs of pins on the back side of the board as pictured below:

- continuity between V on the lower 4-pin row and V on the 6-pin row
- continuity between G on the lower 4-pin row and G on the 6-pin row
- continuity between C on the lower 4-pin row and C on the other 4-pin row
- continuity between D on the lower 4-pin row and D on the other 4-pin row



Step 4:

Now carefully cut away from the male header of 16-pins, to create one row of 6-pins and another row of 4-pins, as shown below. You will need a small cutting tool or pair of scissors.



Step 5:

Now orient the green PCB (printed circuit board) board so that the 6-pin female header is on the left.

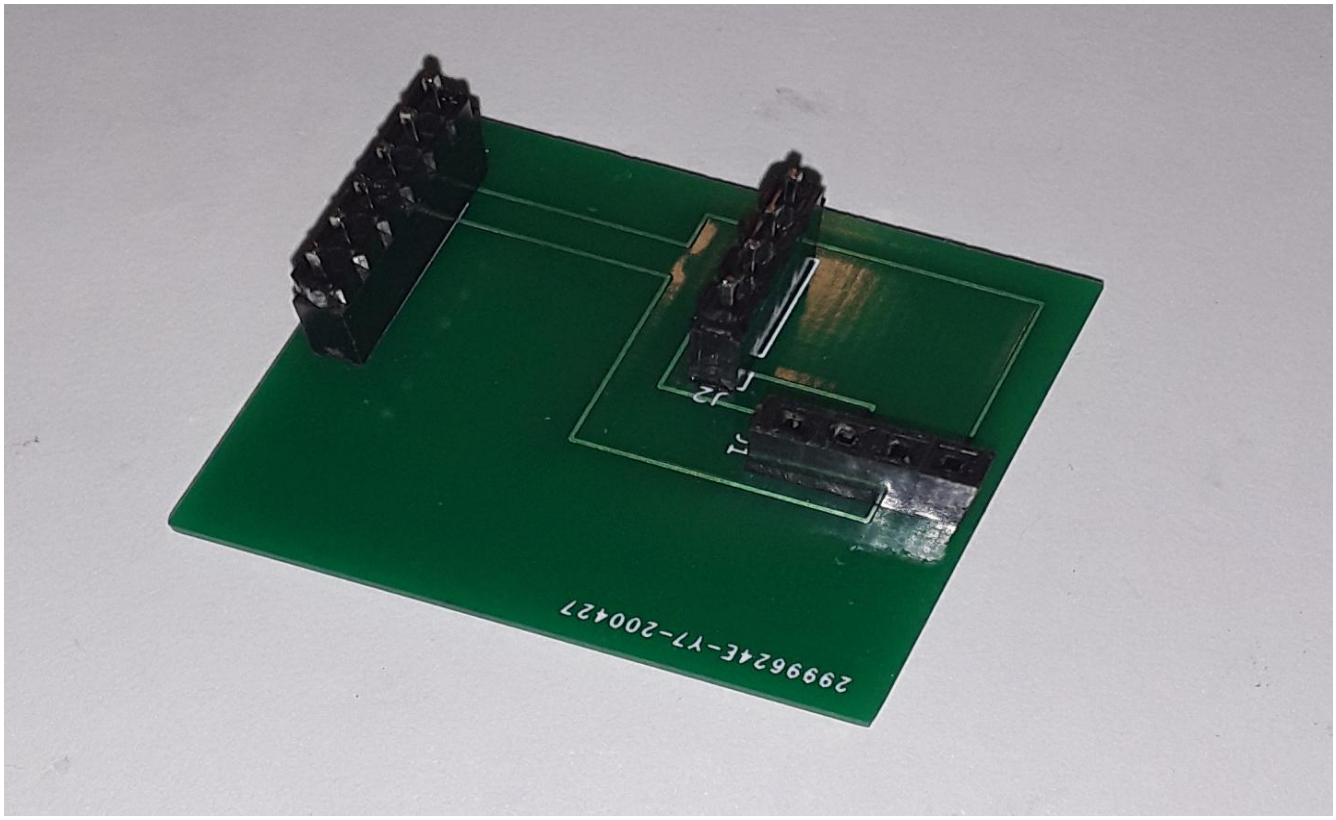
Place the 6-pin male header that you created in **Step4** into the 6-pin female header on the PCB.

Place the 4-pin male header that you created in **Step4** into the 4-pin female header in the center of the board (it runs parallel to the 6-pin header).

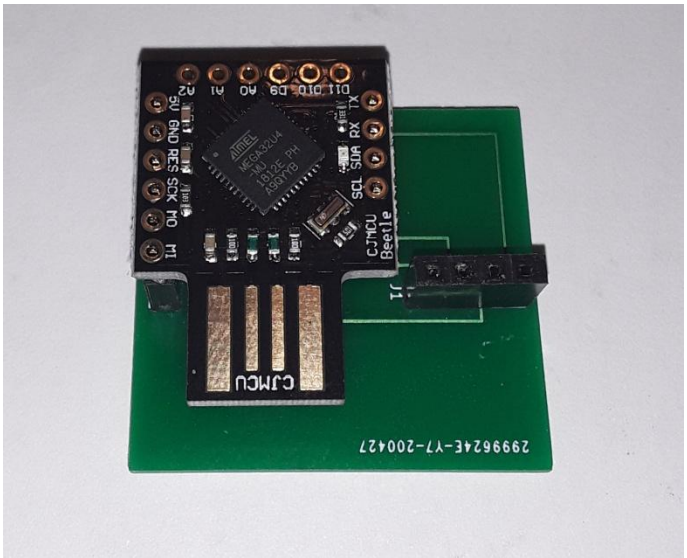
Make certain that ***the long pins*** go into the female headers. Do not insert the short pins into the female headers.

Make certain all the pins are inserted into the female headers, and that none are "hanging out" due to having offset the placement of the male pins.

Everything should be as pictured below.



Now insert the “Leonardo” board on top of the male header pins, as shown below.

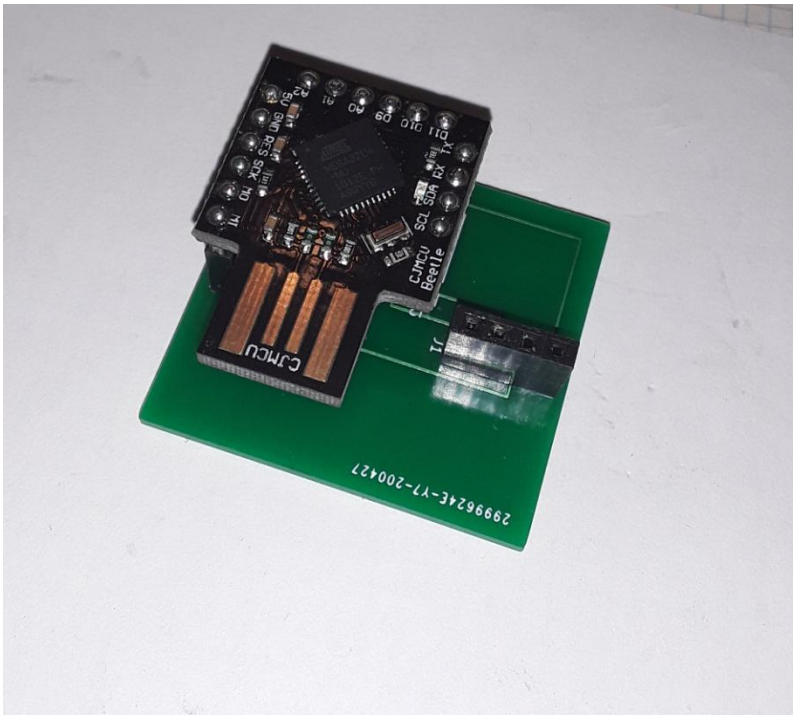


Solder the 6-pin header and 4-pin header, on the topside of the “Leonardo” board, while checking periodically to make sure that the headers are fully seated.

Step 6:

Cut out a 4-pin male header from the 6-pin header that accompanied the BME280 sensor, and place the 4-pin male header into the remaining 4-pin female header of the PCB as shown below.

Make certain that the long pins go into the female header and that the short pins are in the open.

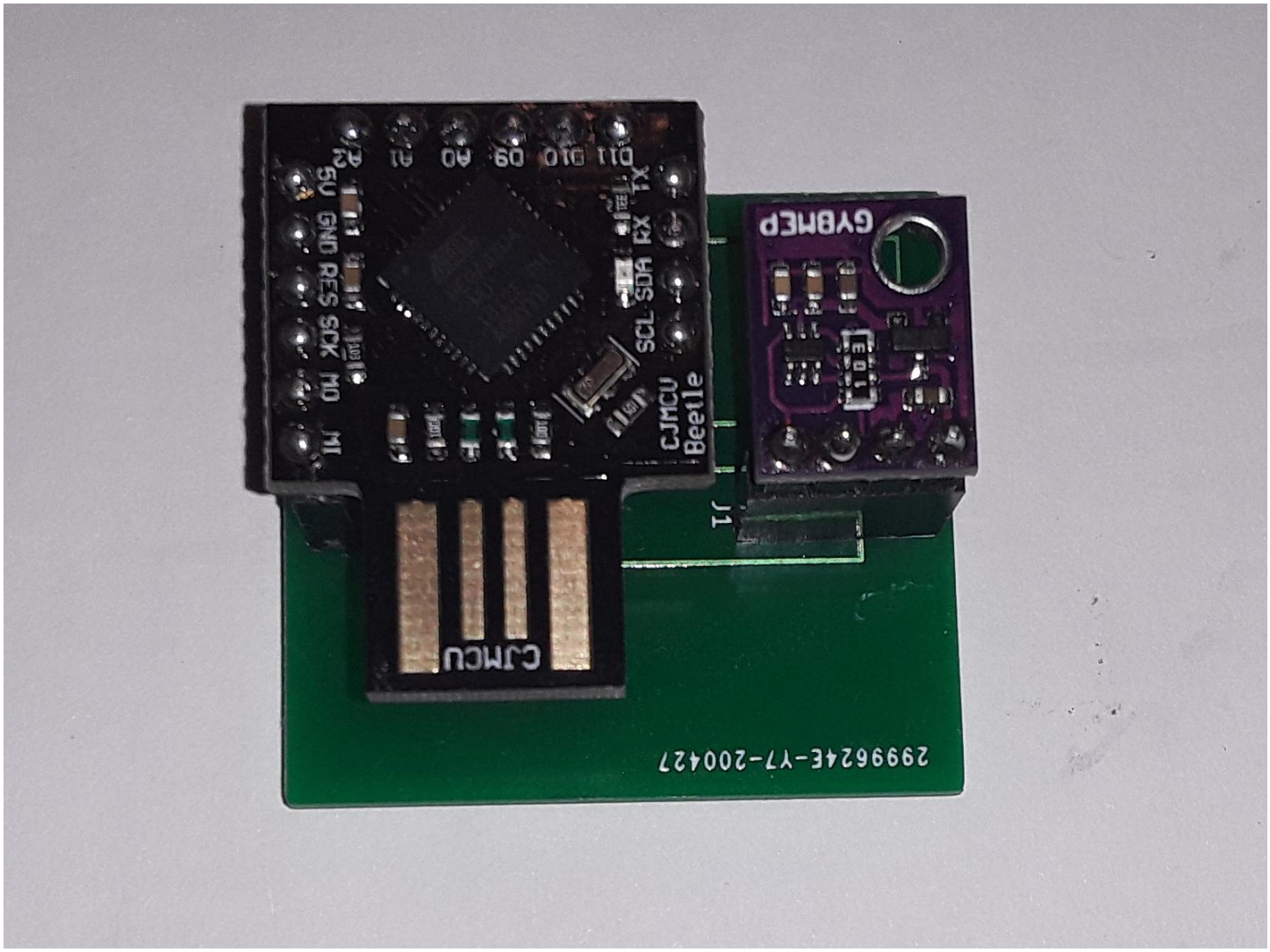


Place the BME280 face down onto the 4 male pins sticking up out of the female header, so that the BME280 hole that is labeled **VIN** next to the edge of the PCB, and the BME280 hole that is labeled **SDA** is next to the “Leonardo” board.

Note that the large hole in the BME280 sensor board will be above the 4-pin header and to the right, near the edge of the board, as show below.

Now carefully solder the 4-pins. ***Exercise great care***, as spilling solder anywhere other than on the pins inside the 4 holes will damage the sensor and make it unusable.

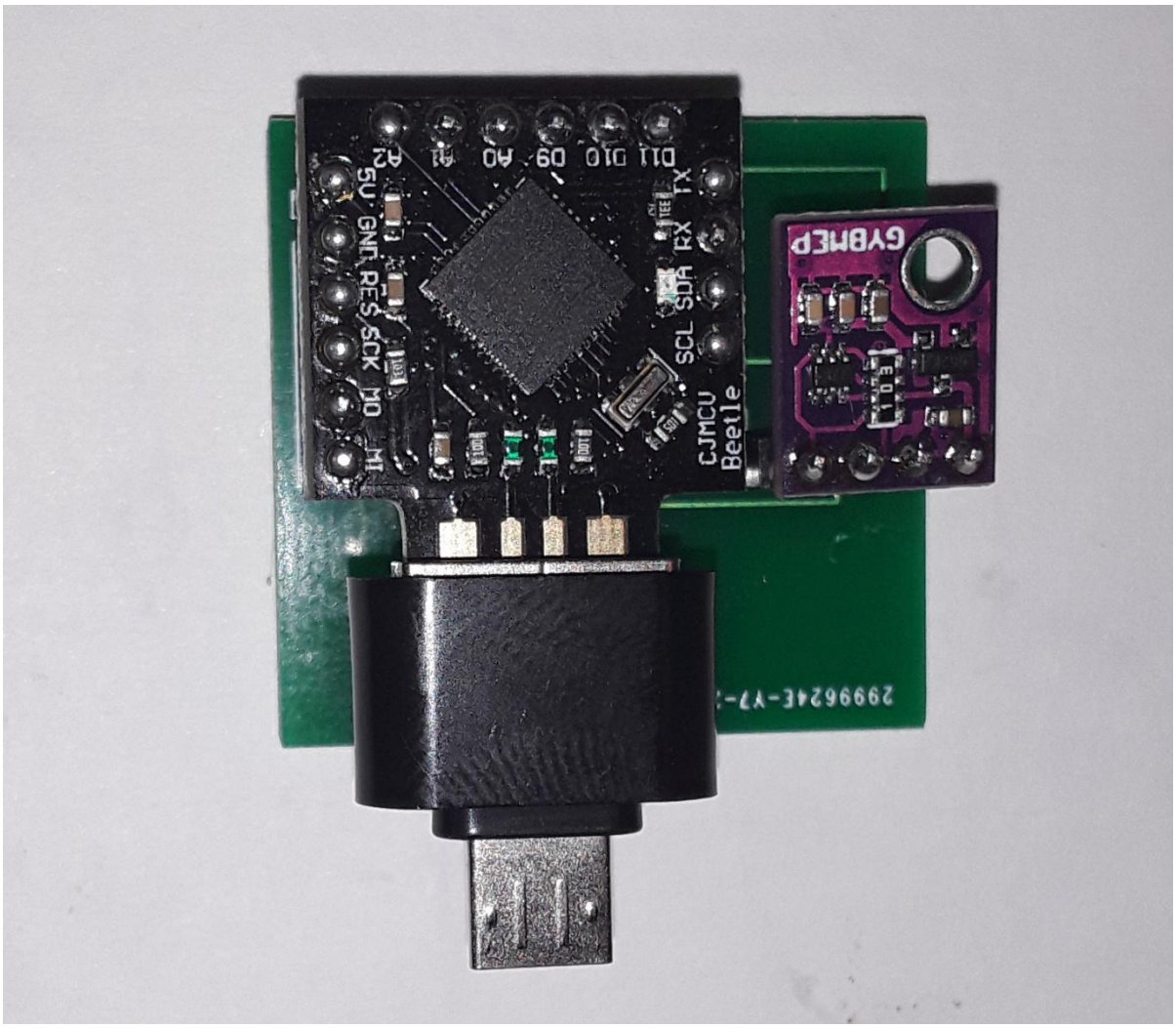
Failure to properly orient the board will destroy the sensor, so make sure it is oriented properly as shown below before soldering the 4 pins holding the sensor.



When soldering is complete, the board shold appear as shown above.

Step 7:

Now it is time to attach the USB adapter, as pictured below. The correct orientation of the USB adapter is such that the wide end of the micro-B is at the top. That will make certain that the gold “fingers” of the USB-A jack of the “Leonardo” make contact with the internal wires of the USB-A to Micro-B adapter.



Step 8:

Now wrap the phone with the provided Kapton tape, and secure the edges of the tape where they meet on the underside of the circuit board.

The assembly of the Practice Altimeter is now complete, and should look like this:

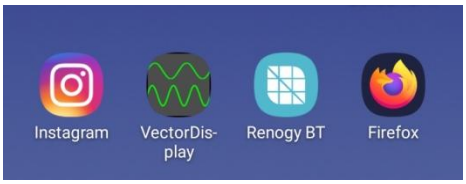
Step 9:

Before connecting the Practice Altimeter to the phone, the display software must be installed from the Play Store.

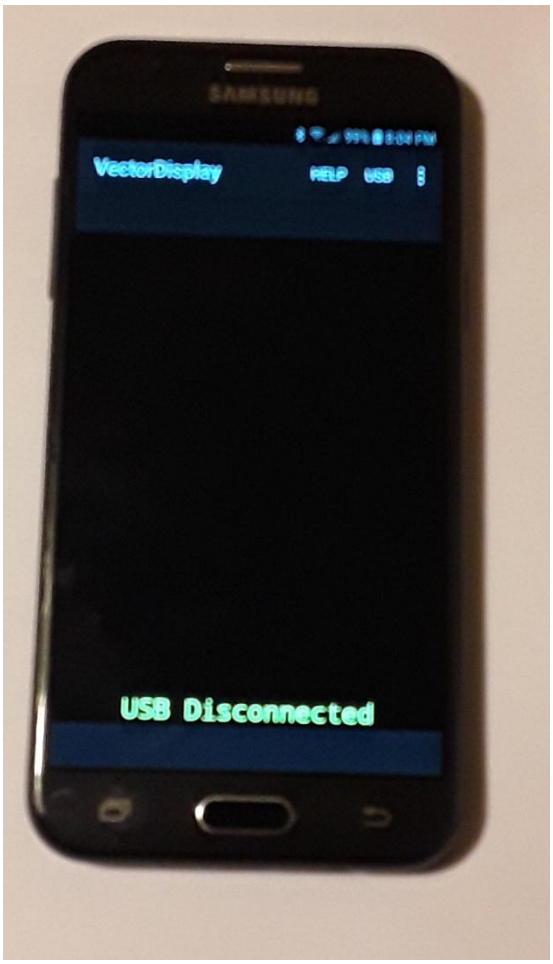
Go to the Play Store on the Android phone. Under Apps, search for “VectorDisplay”.

If more than one App appears, select the one made by “Omega Centauri Software”.

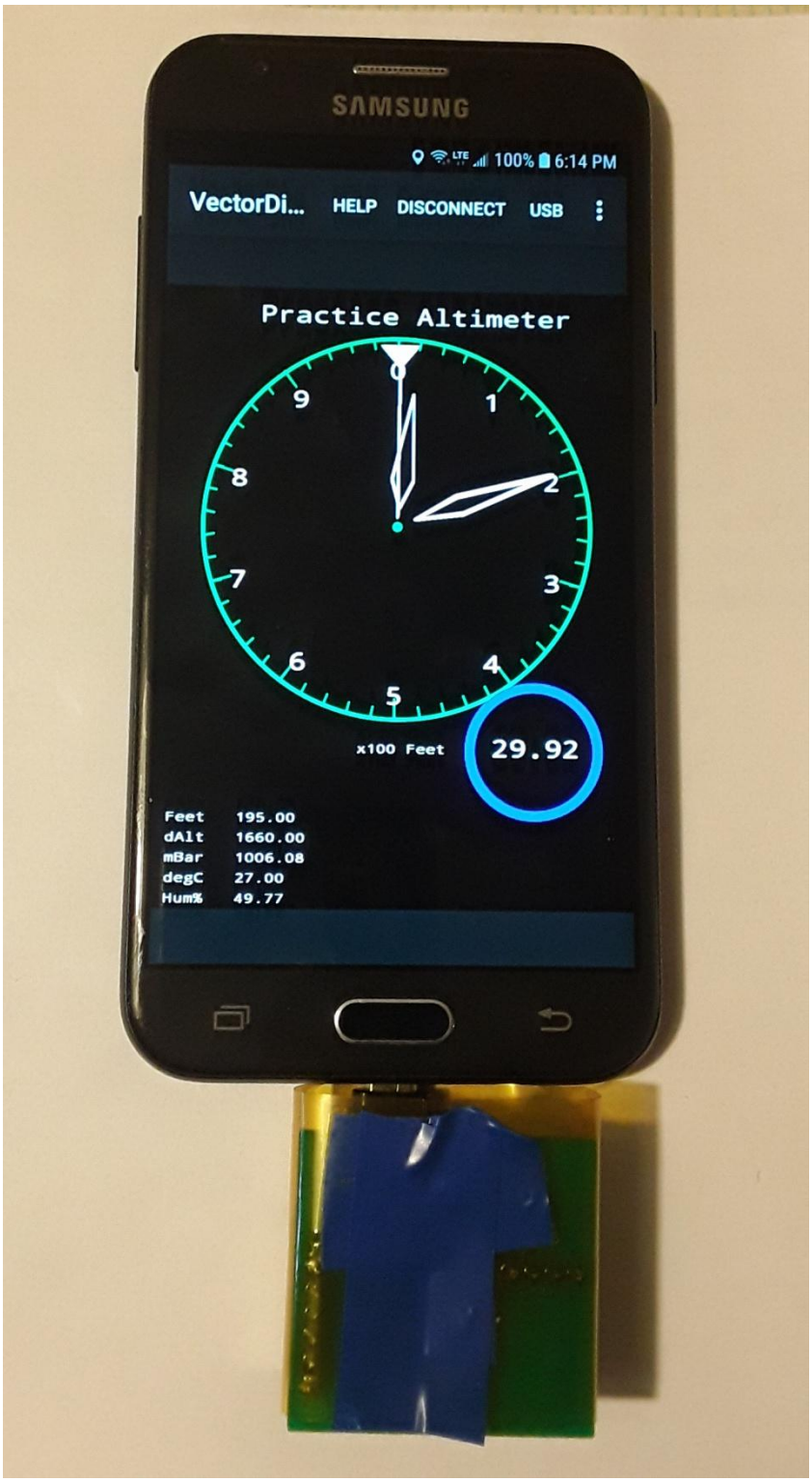
Install VectorDisplay to your Android phone. It should appear as an icon like this:



Startup the VectorDisplay App, and it will say “USB Disconnected”:



Plug the Practice Altimeter into the phone USB jack, and it will prompt you to allow the connection. Select “OK”, and the following screen will appear. Note that the board in this case is upside down, due to the orientation of the phone’s micro-USB jack.



Also displayed in the lower left hand corner is the digital altitude, the density altitude, the temperature in Centigrade, and the percent humidity. Note that the default setting is for an equivalent sea level pressure of 29.92 inches of Hg. That can be changed by entering the menu.

Touch the inner circle of the display, and it will bring up the menu as shown below.

By obtaining a local METAR or AWOS, the Barometer setting can be obtained and entered via the menu keys, which can increment or decrement by 0.01, 0.10, and 1.00 inches of Hg. Pressing the SET key will update the display with the corrected altitude for the given Barometer setting, and return to the full screen display.

Note that the Barometer setting is restricted to 27.50 to 31.50 inches of Hg, inclusively, as in most aviation altimeters.

Bill of Materials

- BME280 Sensor, Amazon #**B07KR24P6P,** 4 pieces at $17.99
- Arduino Leonardo in Beetle form factor, Amazon #**B011AYAOHS,** 2 pieces at $18.60
- USB-A to Micro-B adapter, Amazon #**B07CL6GBTT**, 10 pieces at $5.99
- JLCPCB custom PCB, 10 pieces at $22.05 (includes shipping)
- 4”x6” sheet of Kapton tape, Fry’s #**8220976**, 5 sheets(15 pieces) at $3.99

Average bare cost per unit: 4.50 + 9.30 + 0.60 + 2.21 + 0.27 = 16.88 + 0.17 tax = $17.05

If I sell them individually for $19.99, then I would have a $2.94 buffer to cover cost of packaging and postage, plus tax, if ordered from me. Thus, the break even cost would be $19.99 for the kit.