TeachEngineering

STEM Curriculum for K-12

Let's Get Cracking! Force Sensor Instructions

Force Sensor Parts List (prices accurate December 2019)

Quantity	Description	Price
1	HX711 Amplifier (Weight Weighing Load Cell Conversion Module for Arduino Microcontroller)	$7.69
1	Mustcam 5 Megapixel USB Digital Microscope with Measurement Software for Windows/Mac	$39.99
1	50 kg Platform Scale Sensor Weighting Sensor Load Cell Sensor for Electronic Balance	$13.99
1	Adafruit Motor/Stepper/Servo Shield for Arduino v 2.3 Kit	$19.95
1	Arduino UNO	$22.00
1	400mm Length Travel Linear Stage Actuator with Square Linear Rails + CBX1605 Ball Screw 1605 Ballscrew Motorized XY XYZ Linear Stage Table with Nema23	$132.28
1	Digi-Key AC/DC 3.3V 6.6W Power Supply	$13.47
	TOTAL	$249.37

50 KG LOAD
CELL SENSOR

AC/DC 3.3V 6.6W
POWER SUPPLY

ADAFRUIT MOTOR SHIELD V2.3 MOUNTED TO ARDUINO UNO

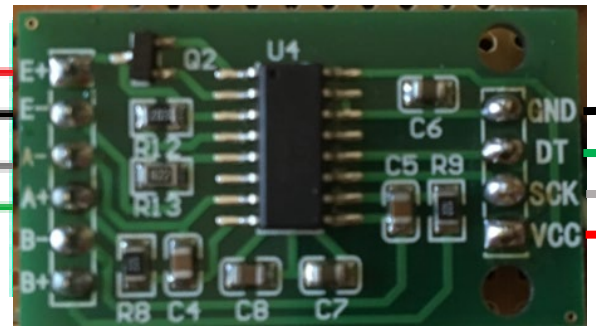
TO DC
BARREL JACK

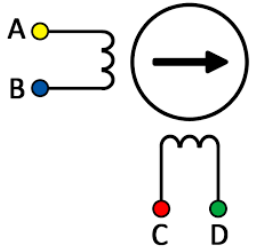
VIN JUMPER
REMOVED

BLACK GND to GND
GREEN DT to A1
WHITE SCK to A0
RED VCC to 5V

HX711 AMPLIFIER

RED E+
BLACK E-
WHITE A-
GREEN A+





NEMA23 STEPPER
MOTOR ON RAILS

TO STEPPER MOTOR

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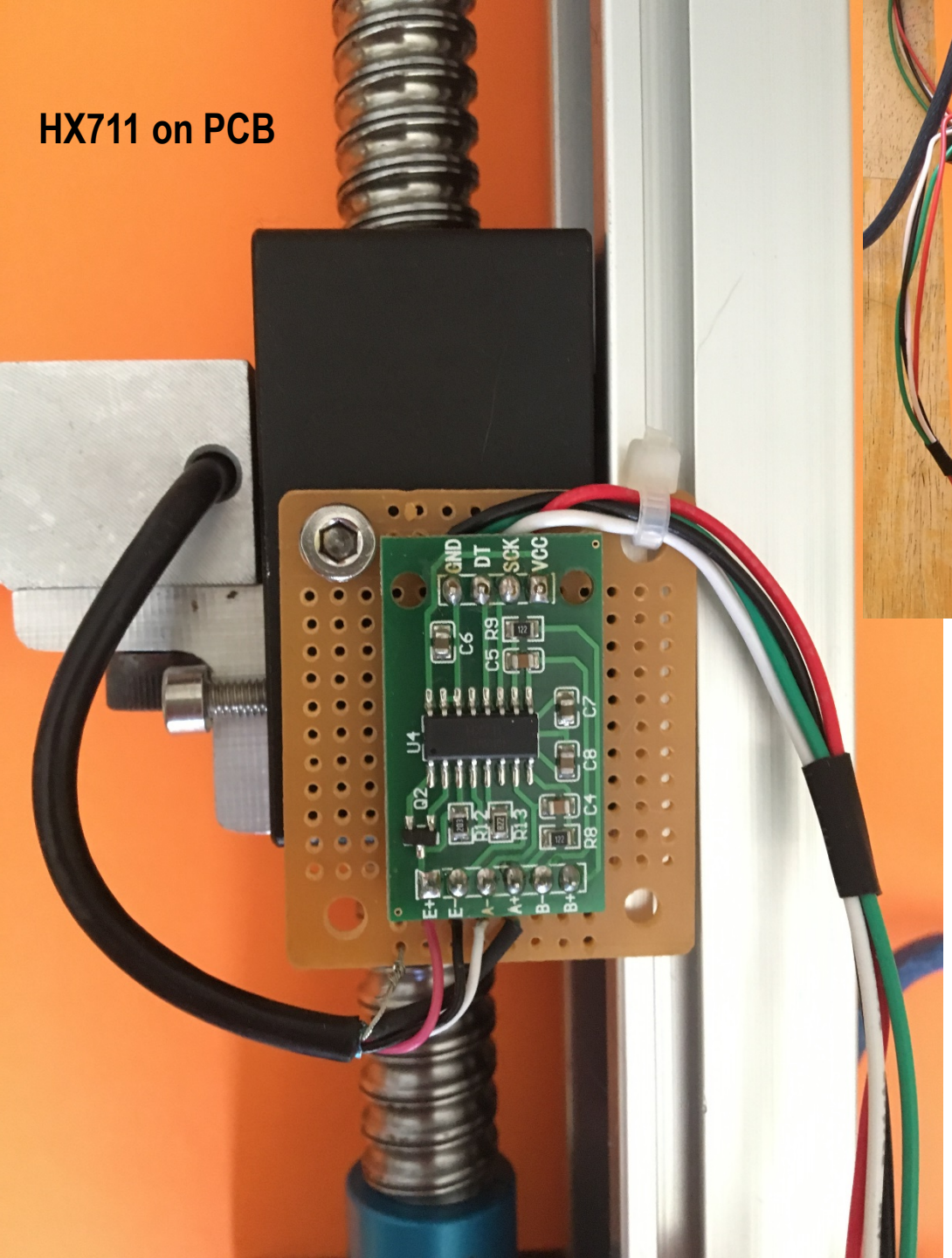
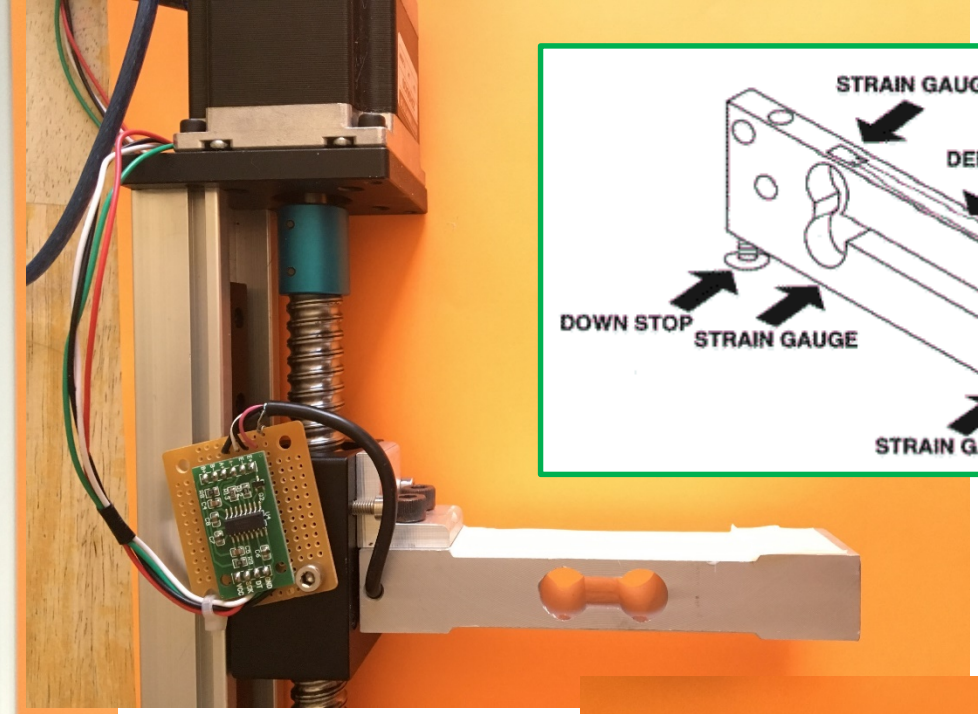
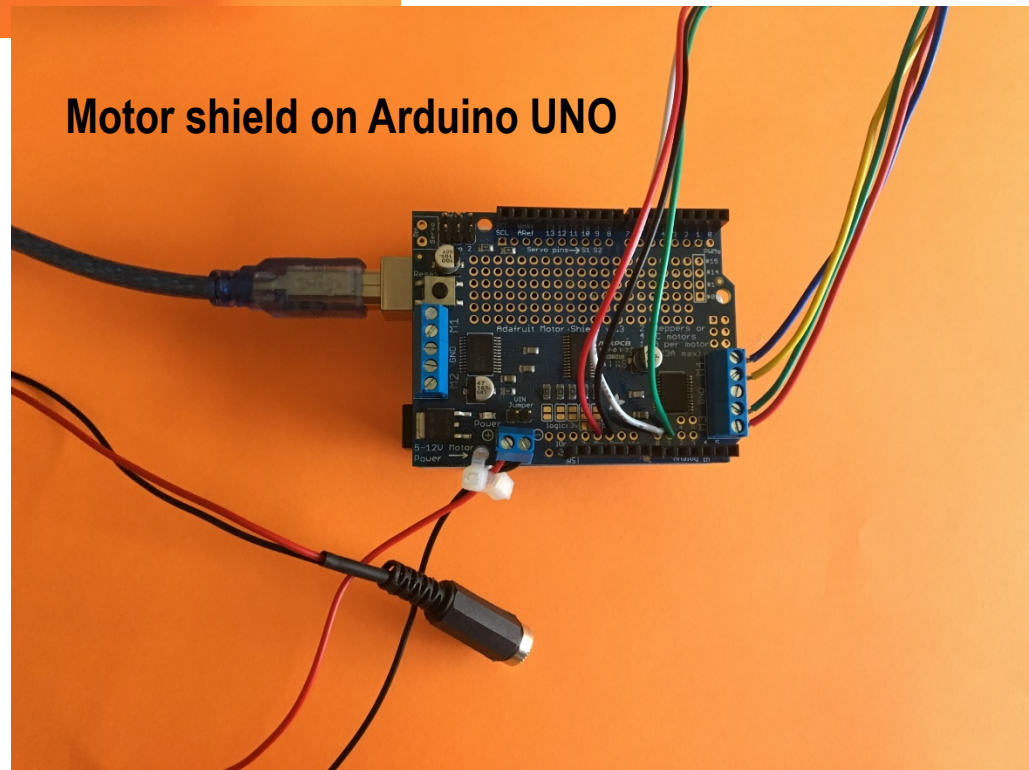
Force Sensor Wiring Diagram

HX711 on PCB





Motor shield on Arduino UNO



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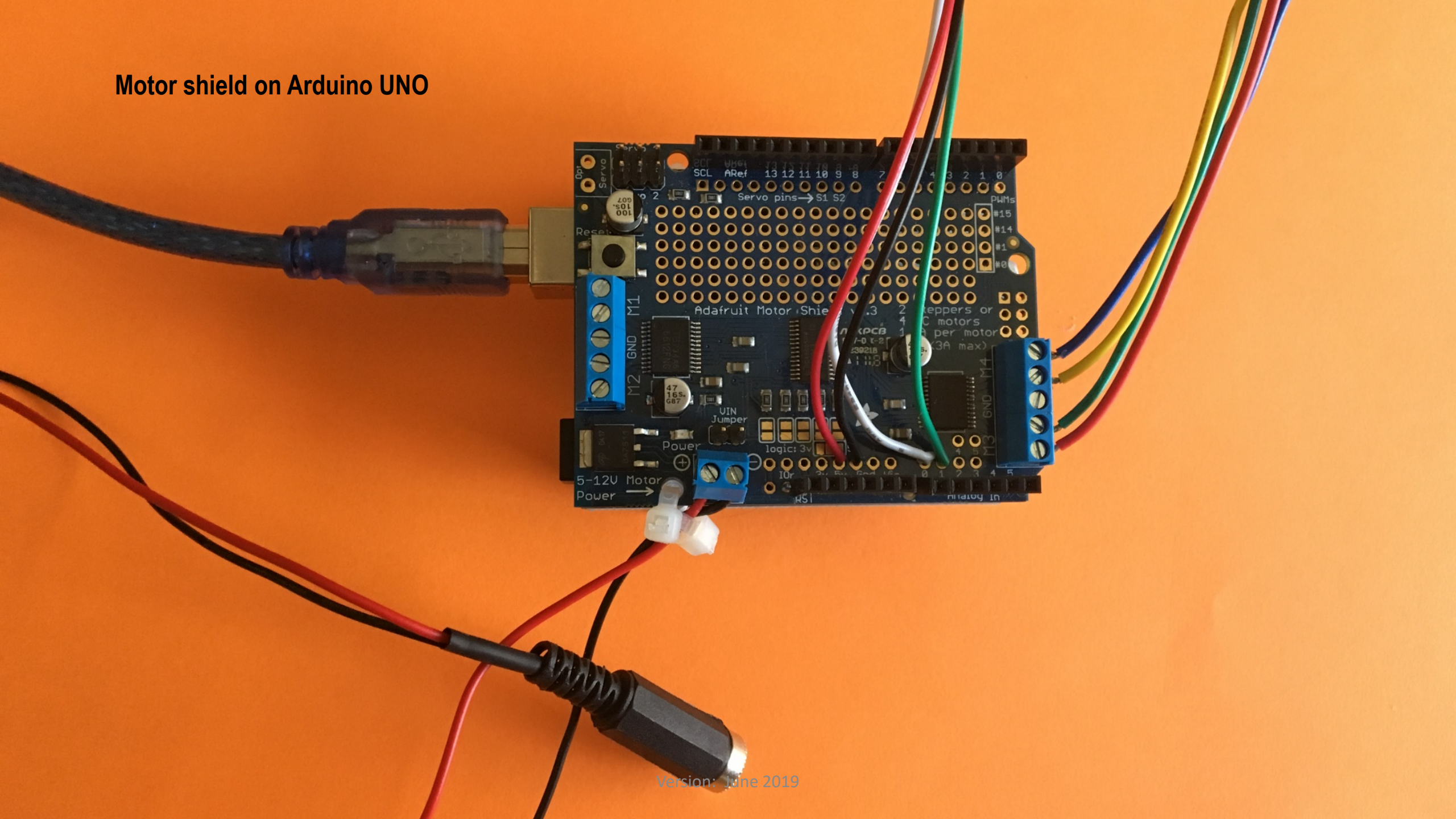
Motor shield on Arduino UNO



The Software Side of Things…

1. Connect the Arduino UNO Board to your computer using the USB cable.
2. You will need to download and install two libraries (see https://www.arduino.cc/en/Guide/Libraries):
   - Adafruit_Motor_Shield_V2_Library-master.zip
   - HX711-master.zip
3. You will need to include them in the Arduino sketch.

```
#include <HX711.h>
#include <Adafruit_MotorShield.h>
```

4. Use the *NoBonesAboutIt.ino* code shown on the next page or write your own.
5. Check for compiling errors and then upload to the Arduino board.
6. Connect the power supply to the motor shield to power the motor.
7. Calibrate the scale using the procedure (in two pages).
8. After you set the scale calibration value in the code, you will need to re-compile *NoBonesAboutIt.ino* and upload to the Arduino board again.
9. Finally, open a Serial Window (newline) and type type *U* and *D* for up and down using the interleave stepping function or *u* and *d* to use the microsetepping function; in either case, you will be prompted to enter the number of steps. Type *t* for tare and *m* for measure.

Sample Arduino Code

```
#include <HX711.h>
#include <Adafruit_MotorShield.h>
//-------------


Adafruit_MotorShield AFMS = Adafruit_MotorShield(0x60);

// Connect a stepper motor with 200 steps per revolution
// which is 1.8 degrees
// use motor port #2, M3 and M4

Adafruit_StepperMotor *M2 = AFMS.getStepper(20, 2);
// HX711.DOUT uses pin #A1
// HX711.PD_SCK uses pin #A0
HX711 scale(A1, A0);          // using default parameter gain

void setup() {
  AFMS.begin();          // use default frequency
  M2->setSpeed(10);  // 10 rpm
  Serial.begin(9600);
  scale.set_scale(79.1156);             // this value is obtained by calibrating the scale with
known weights
  scale.tare();              // reset the scale to 0
  Serial.println("Enter 'U', 'D', 'u', 'd', 't', or 'm'.");
}
```

Calibrating the Scale

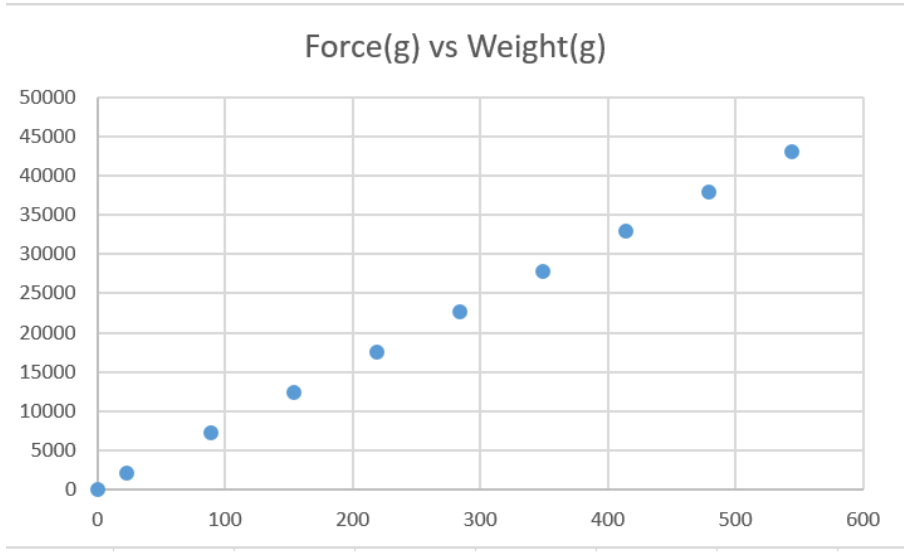
1. Use Arduino to open the *NoBonesAboutIt* program.
2. Remove the scale.set_scale() number. You will replace it later at the end of this procedure.
3. Type *t* for tare. This is your (0, 0) starting point in the graph shown below.

```
void setup() {
 AFMS.begin();          // use default frequency
 M2->setSpeed(10);  // 10 rpm
 Serial.begin(9600);
 scale.set_scale(79.1156);          // this value is obtained by calibrating the scale with
```

REMOVE NUMBER FROM ()

4. Add known weights, beginning with a basket for holding weights and measure each successive force reading. I attached some embroidery floss to a plastic hummus cup as my basket.
5. After verifying that the results are linear, find the slope of the line. This is your scale factor.
6. Add the number to the scale.set_scale(79.1156) line and upload the updated code to the board.

Item	Item Weight	Total Weight(g)	Force(g)
N/A	N/A	0	0
Basket	23.9	23	2116
Plug	65.1	89	7203
Plug	64.9	153.9	12360
Plug	65.1	219	17507
Plug	64.9	283.9	22593
Plug	64.8	348.7	27750
Plug	65	413.7	32899
Plug	65.2	478.9	37890
Plug	65	543.9	43031



$$SCALE\ FACTOR = slope = \frac{(43031 - 0)}{(543.9 - 0)} = 79.1156$$