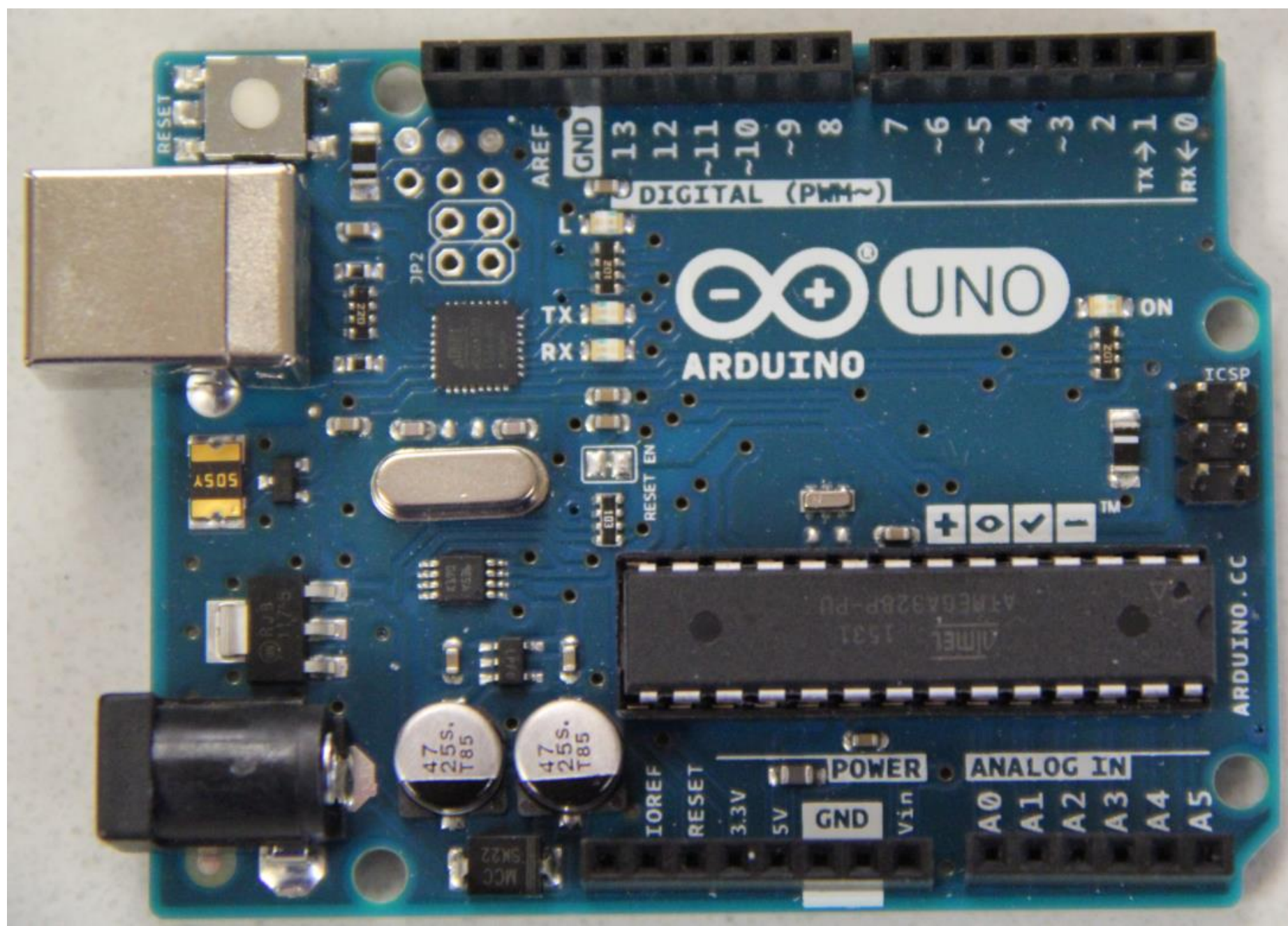


# Incorporating Arduinos into an Electronics Course

Will Roach



Lynchburg College



RESET

AREF

GND

13

12

~11

~10

9

8

7

~6

~5

4

~3

2

1

TX →

RX ← 0

DIGITAL (PWM ~)



UNO

ARDUINO

ON

TX

RX

3P2

RESET EN

TCSP



ARDUINO.CC



Atmel 1531  
ATMEGA328P-PU

IOREF

RESET

3.3V

5V

GND

Vin

POWER

ANALOG IN

A0

A1

A2

A3

A4

A5

47  
25S.  
T85

47  
25S.  
T85

505Y

MCC  
SK22

```
RC_time_constant | Arduino 1.8.5
File Edit Sketch Tools Help
RC_time_constant
//This notebook measures the voltage across a capacitor in a series RC circuit
//and outputs it to the serial port.

const int outputPin = 13; //pin used to charge/discharge circuit
const int inputPin = 0; //pin used to read the voltage on the capacitor
int timeStart; //this variable will hold the time at which the charging starts

void setup() {
  //Start serial communication and set pin modes
  Serial.begin(9600);
  pinMode(outputPin, OUTPUT);
  pinMode(inputPin, INPUT);

  //charge circuit for 20 seconds
  digitalWrite(outputPin,HIGH);
  delay(20000);

  //turn off the output pin in order to start discharging
  digitalWrite(outputPin, LOW);
  timeStart=millis();
}

void loop() {

  //Display the time elapsed since the start of charging and the current voltage value
  Serial.print((millis()-timeStart)/1000.0,3);
  Serial.print("\t");
  Serial.println(analogRead(inputPin)*5.0/1023.0,5);

  while(((millis()-timeStart)/1000.0)>1){}

}

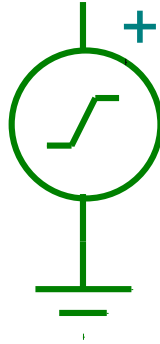
Done uploading.
Sketch uses 4066 bytes (12%) of program storage space. Maximum is 32256 bytes.
Global variables use 204 bytes (9%) of dynamic memory, leaving 1844 bytes for local variables. Max
```

COM14 (Arduino/Genuino Uno)

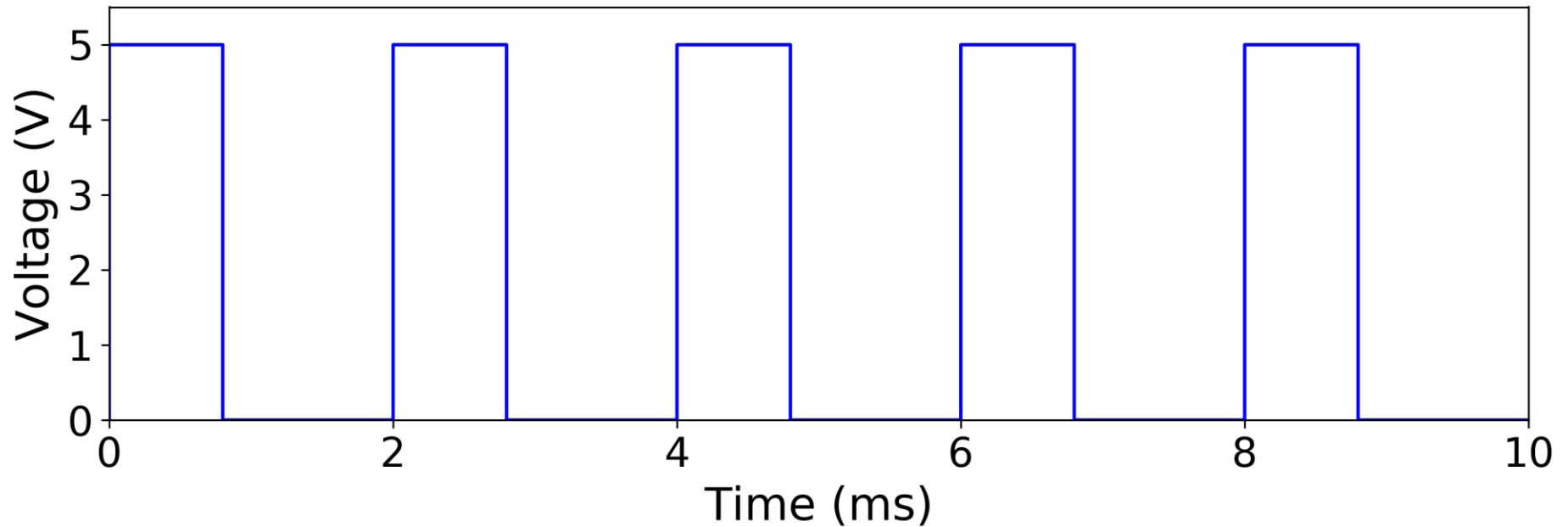
0.000	4.96090
0.001	4.89736
0.002	4.84360
0.004	4.78983
0.005	4.74096
0.010	4.30108
0.026	3.75855
0.042	3.29423
0.058	2.89345
0.073	2.53666
0.088	2.22385
0.105	1.95015
0.120	1.71554
0.135	1.50538
0.151	1.32454
0.167	1.16813
0.183	1.02151
0.198	0.89932
0.213	0.79179
0.229	0.69892
0.245	0.61584
0.260	0.54252
0.276	0.47410
0.291	0.42033
0.307	0.36657
0.323	0.32747
0.338	0.28837
0.354	0.25415
0.370	0.21994
0.385	0.19550
0.401	0.17107
0.416	0.15152
0.431	0.13196
0.448	0.11730
0.463	0.10264
0.478	0.09286
0.494	0.07820
0.510	0.06843
0.526	0.06354
0.541	0.05376
0.556	0.04888
0.573	0.04399
0.588	0.03910
0.603	0.02933
0.619	0.02933
0.635	0.02444
0.650	0.01955

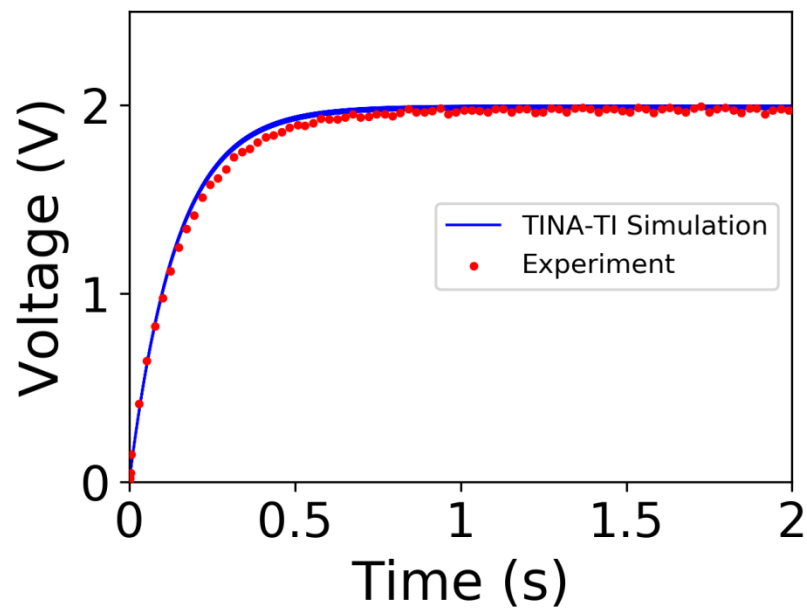
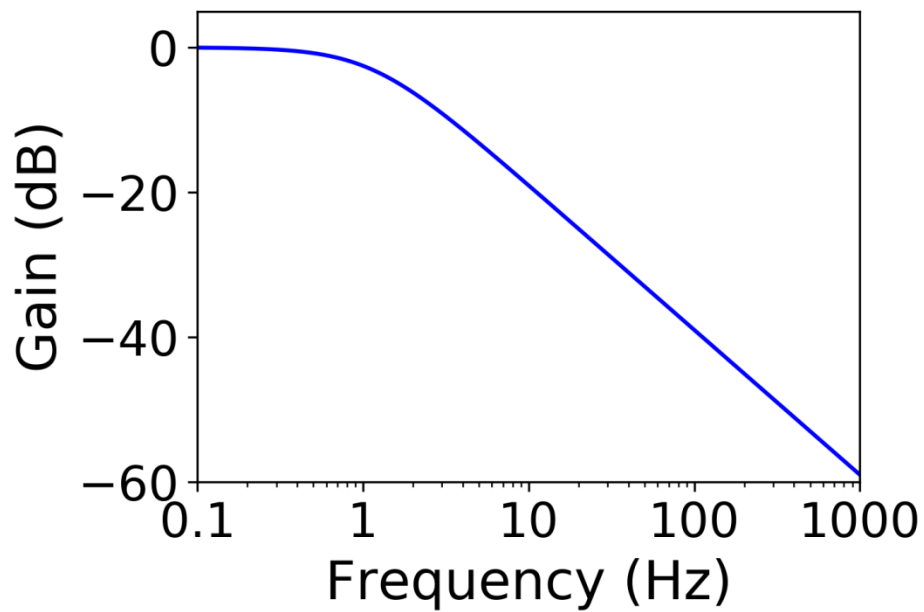
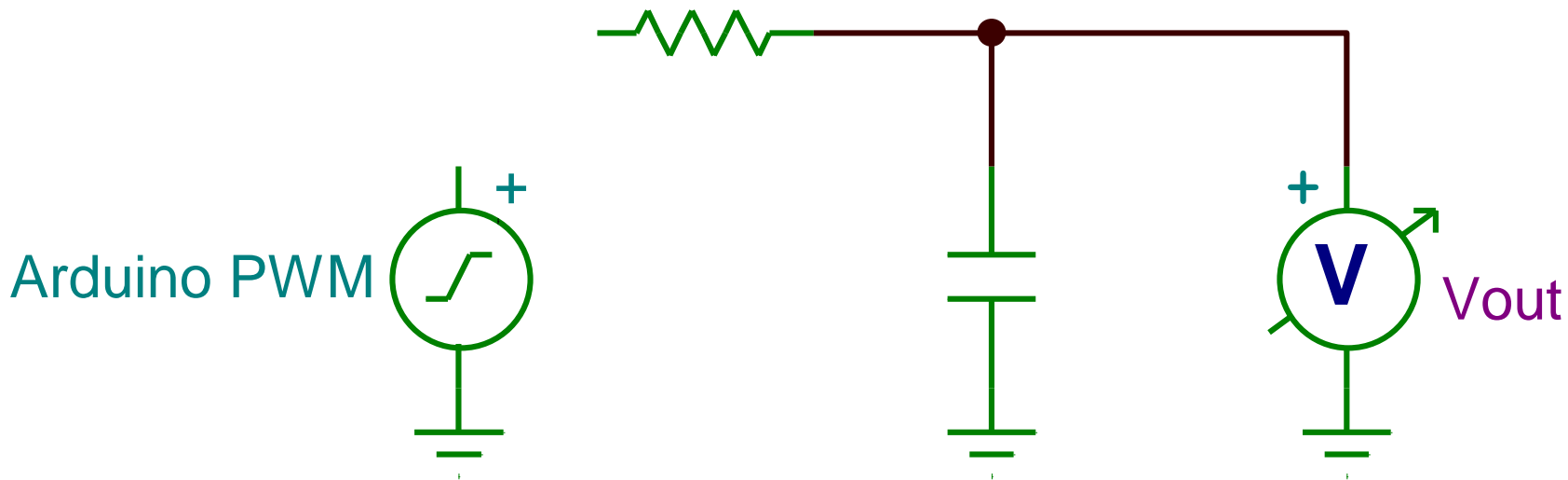
Autoscroll    No line ending    9600 baud    Clear output

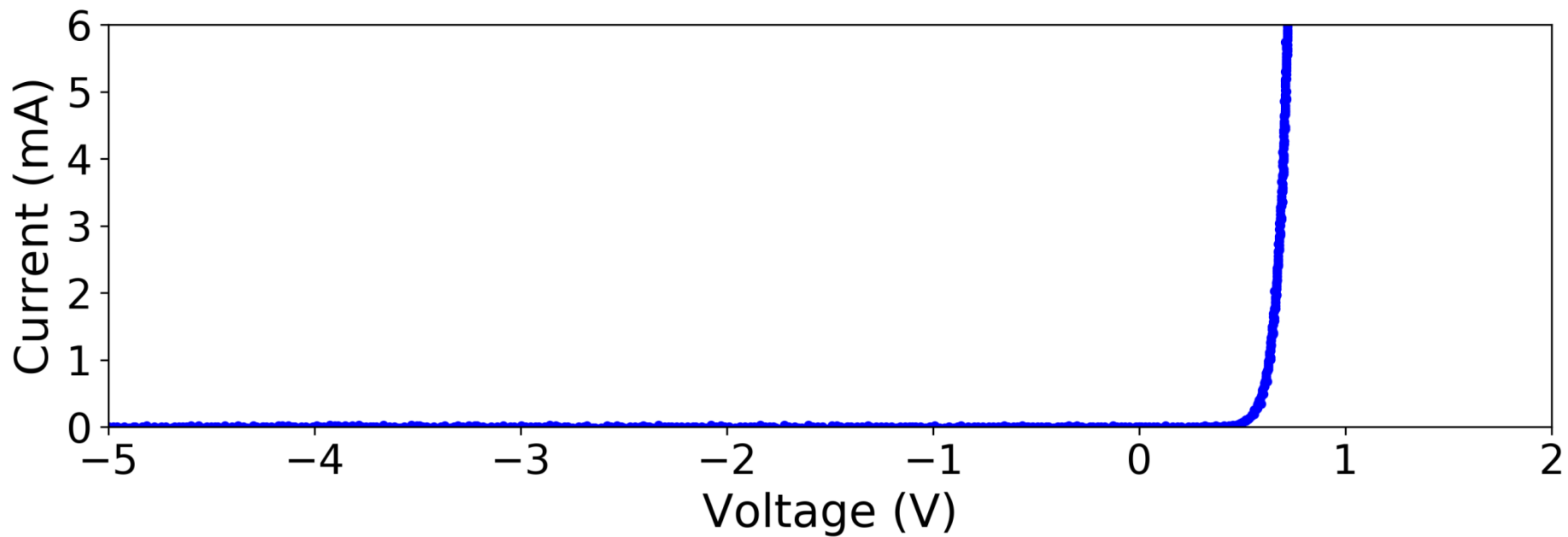
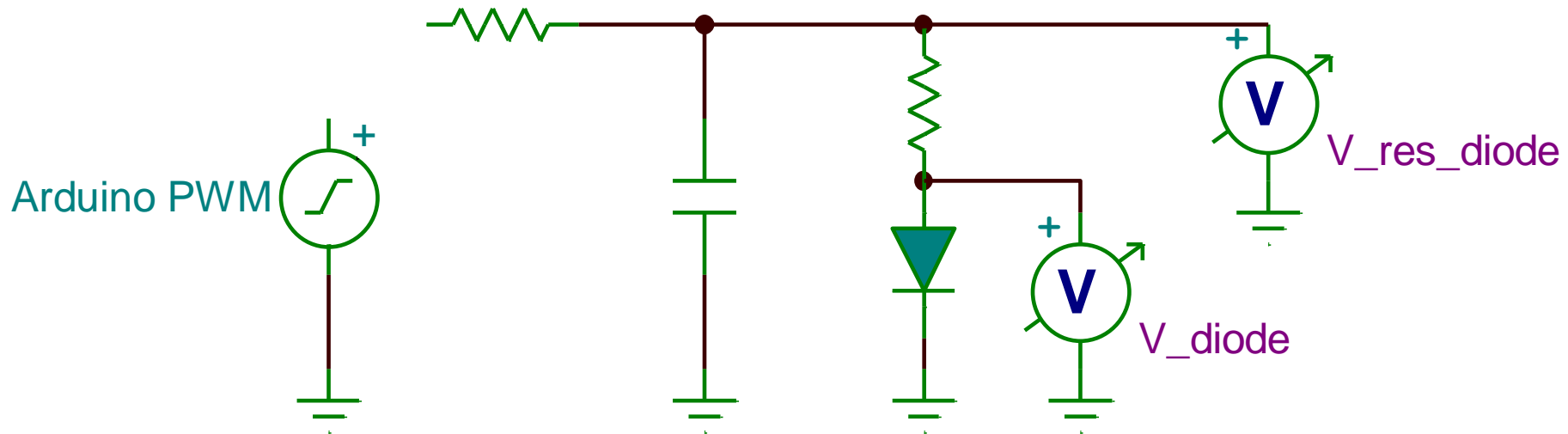
Arduino PWM

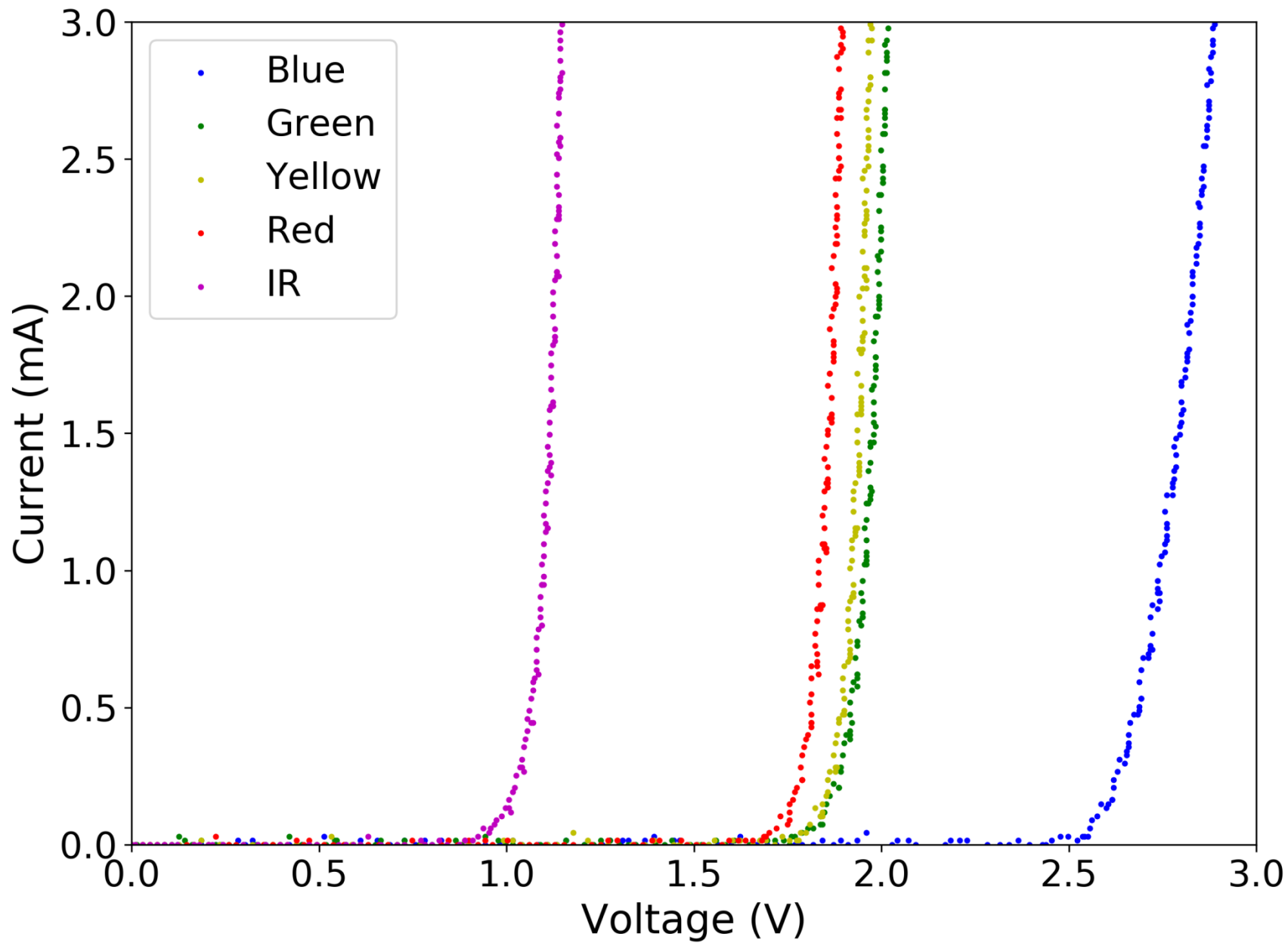


## Pulse Width Modulation (PWM)

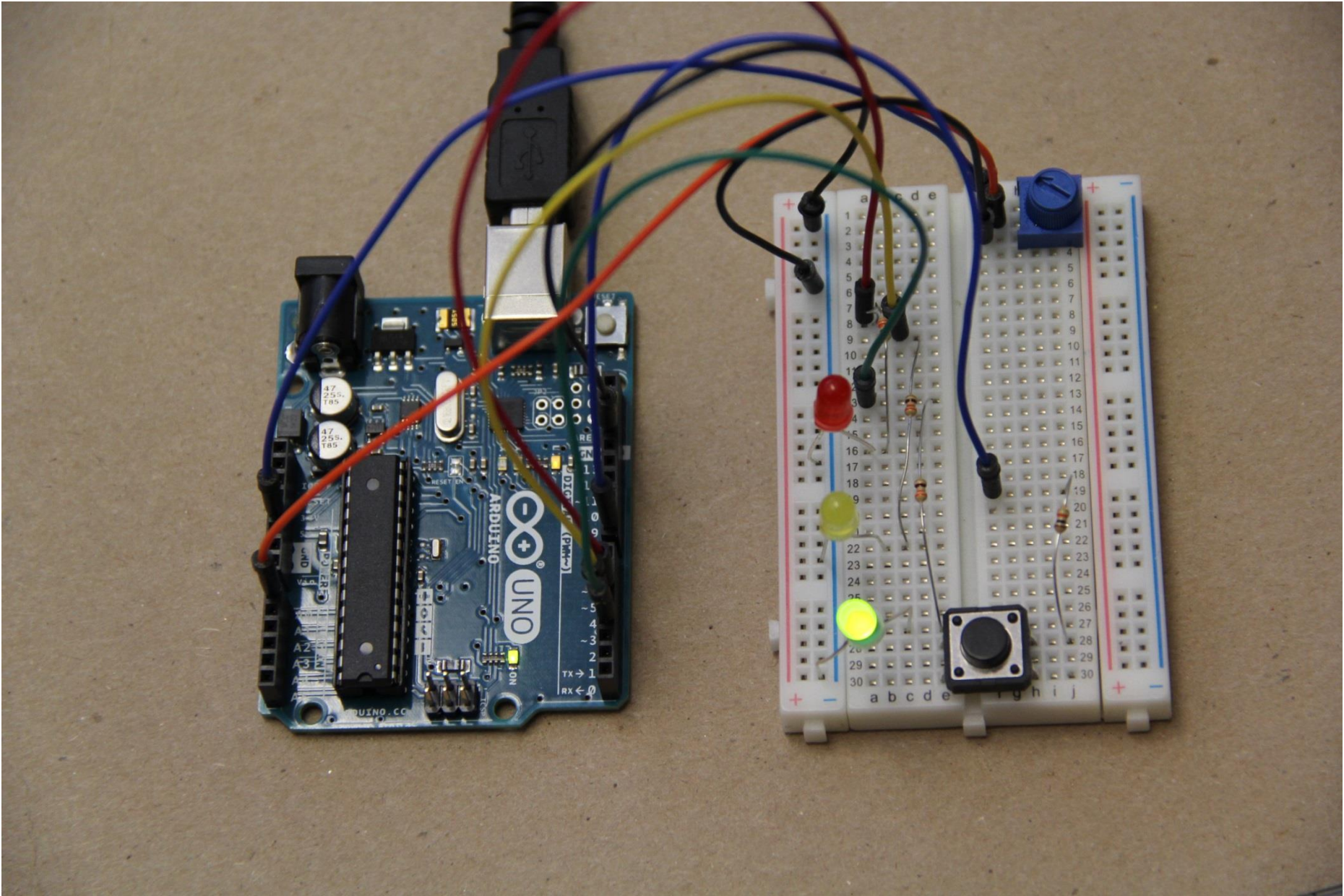




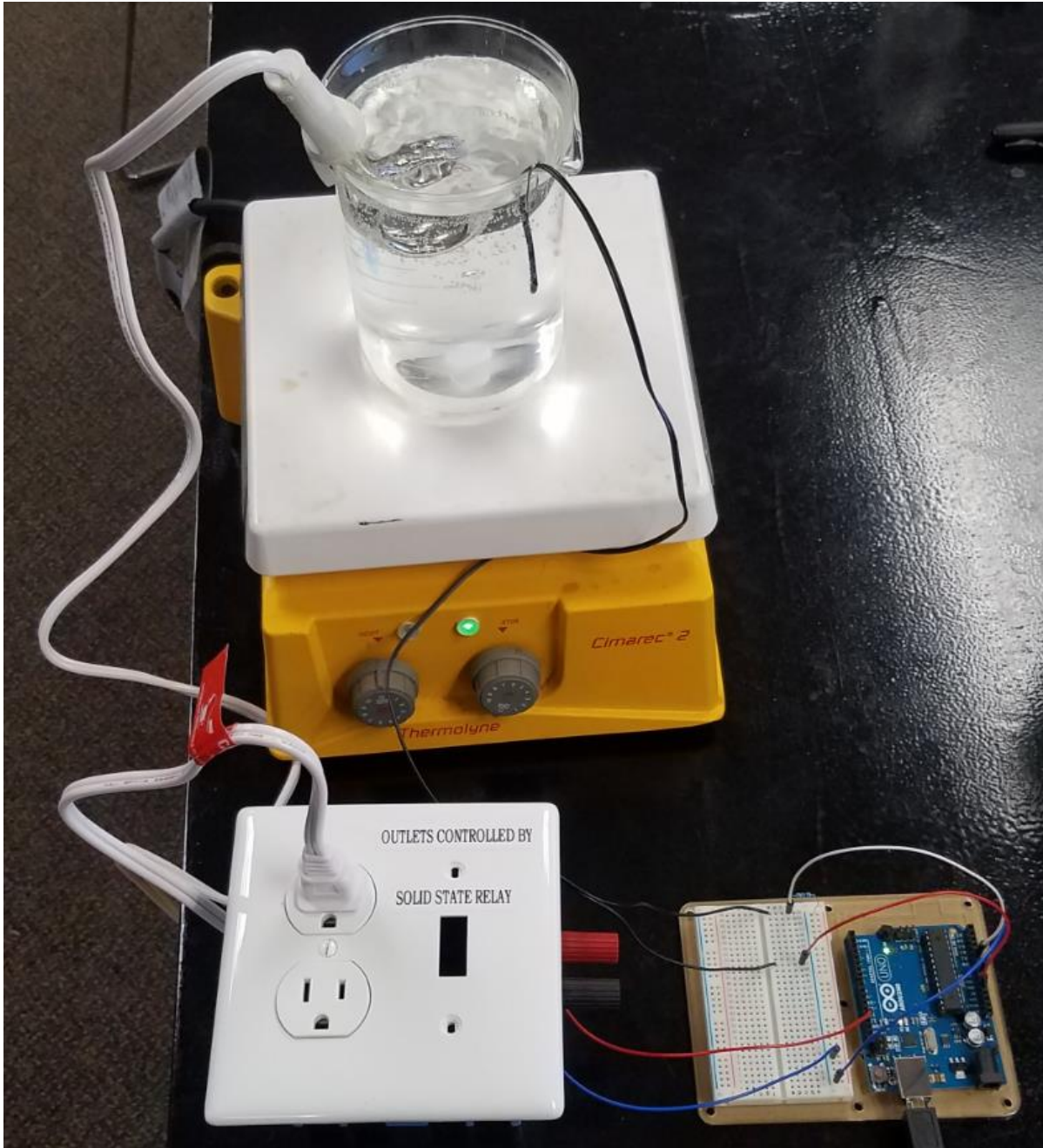


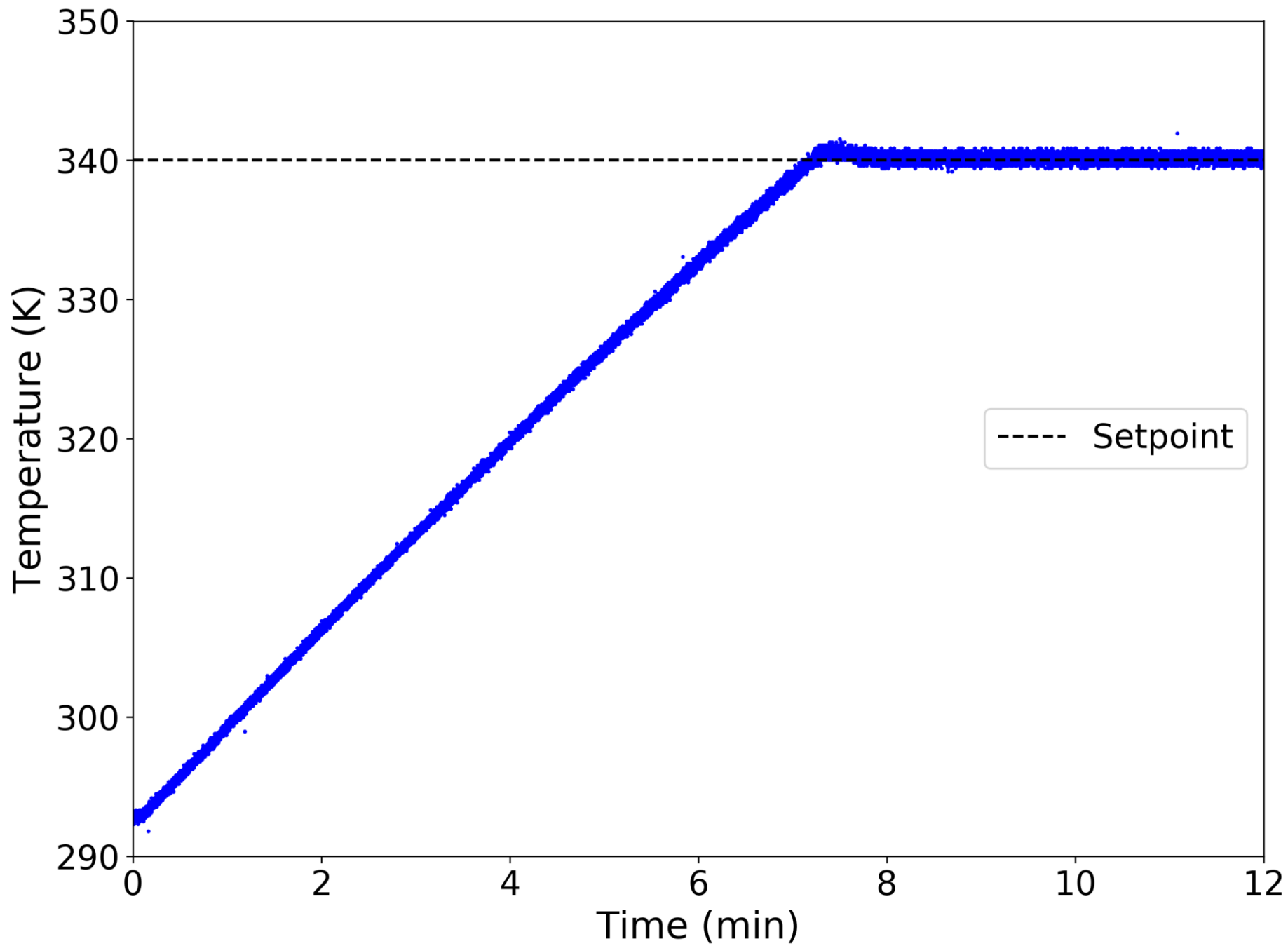


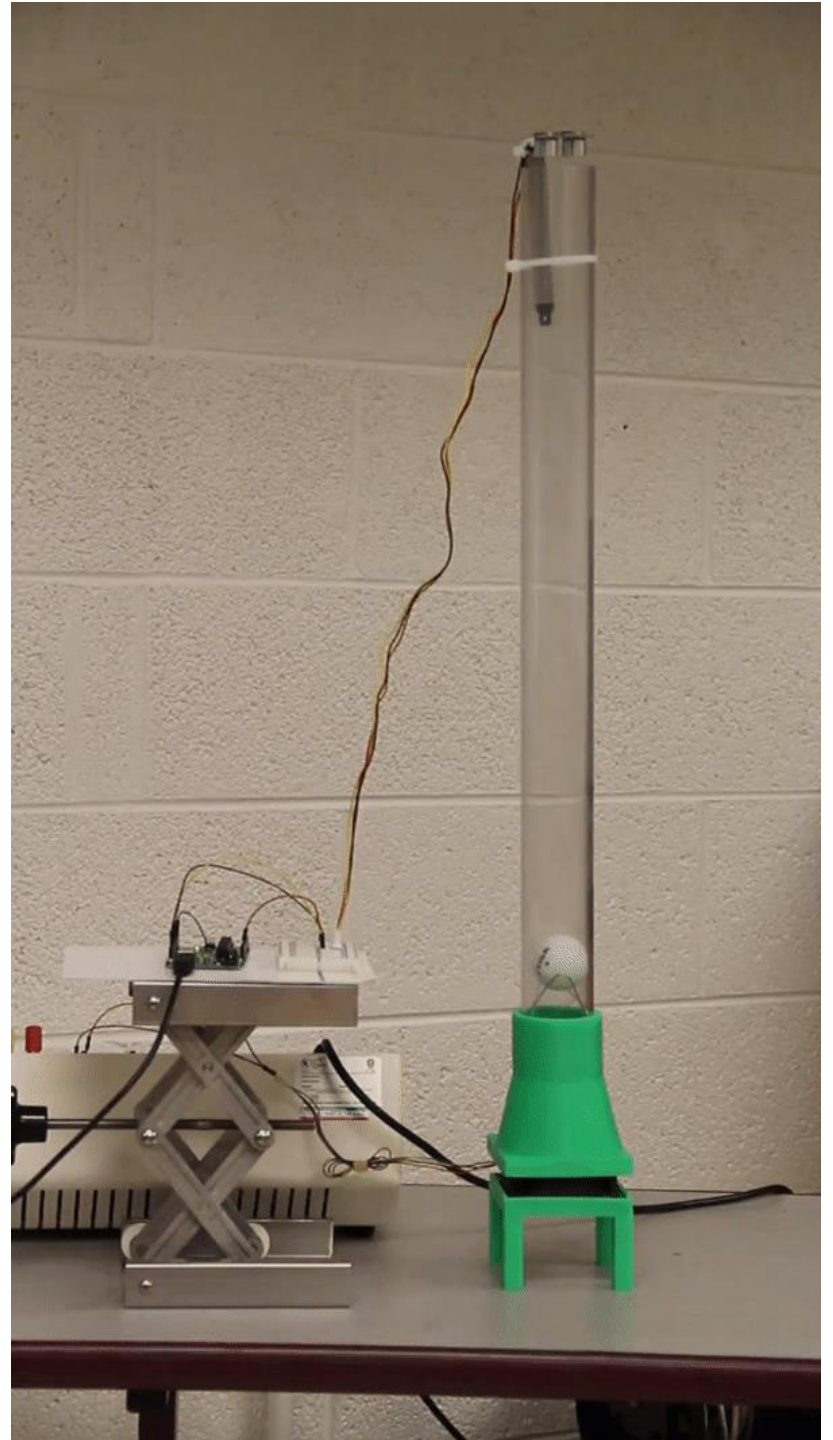
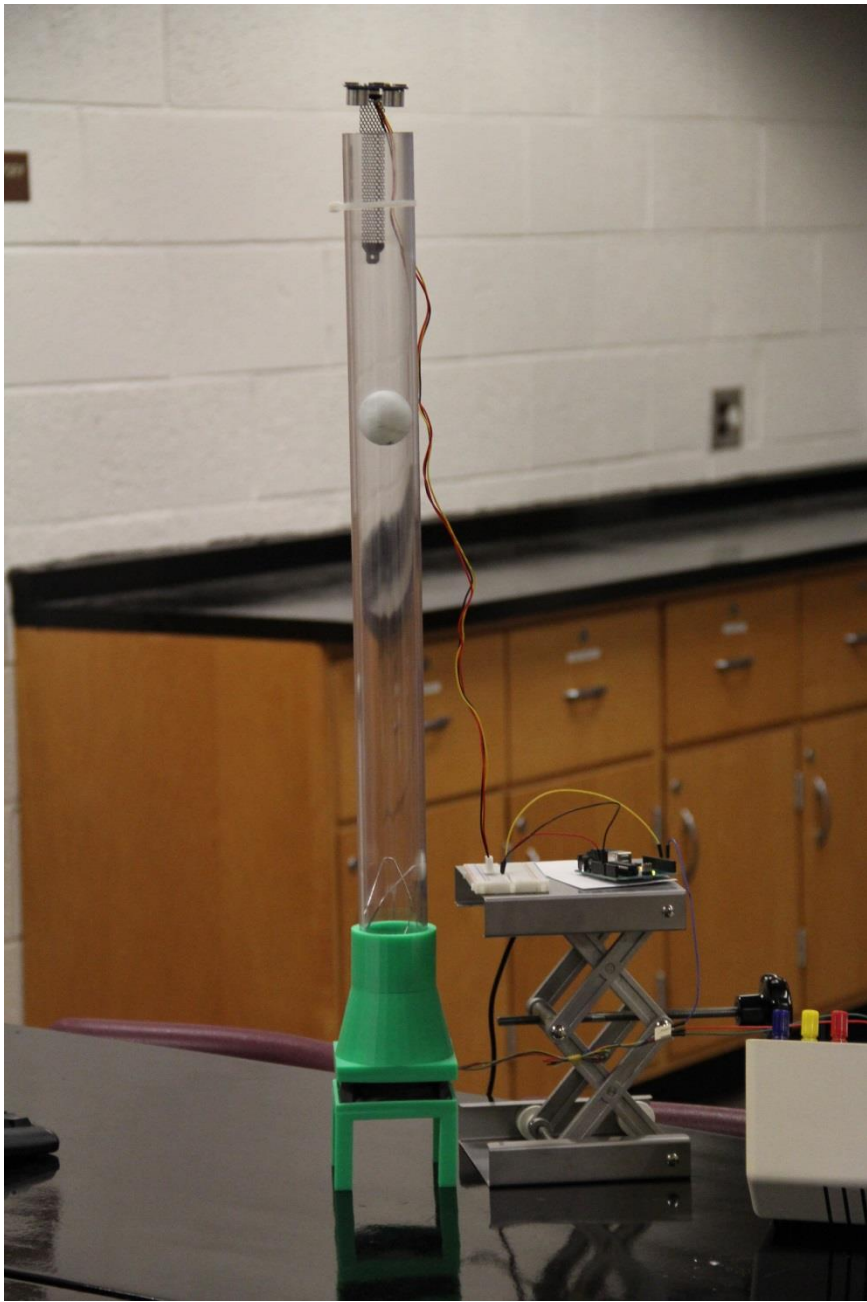


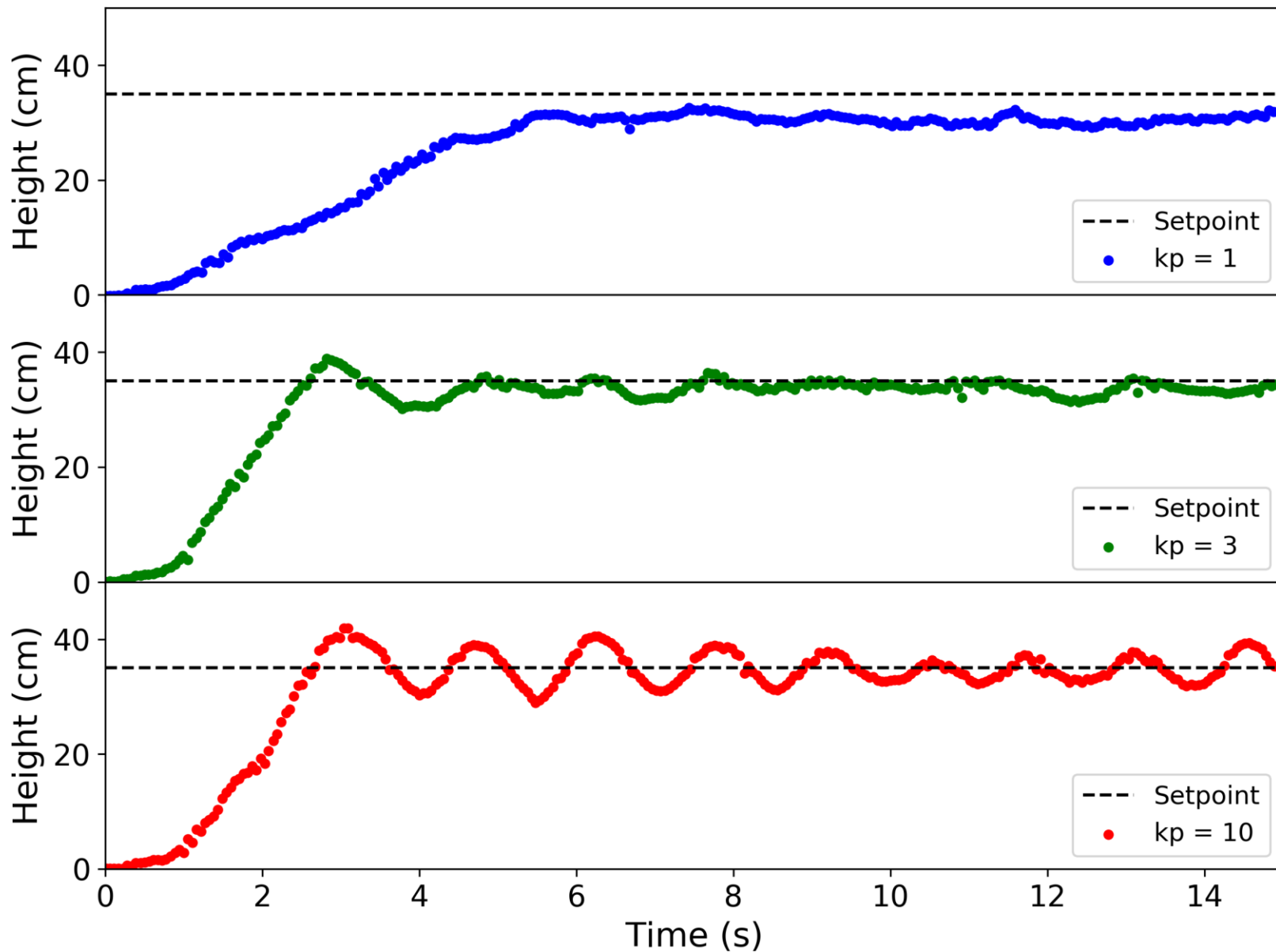














# ALPhA's Laboratory Immersion



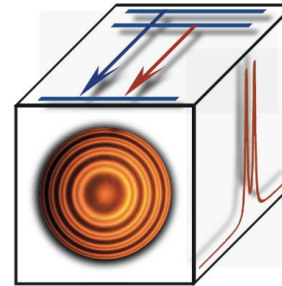
## **BFY III**

Conference on Laboratory Instruction  
*Beyond the First Year of College III*

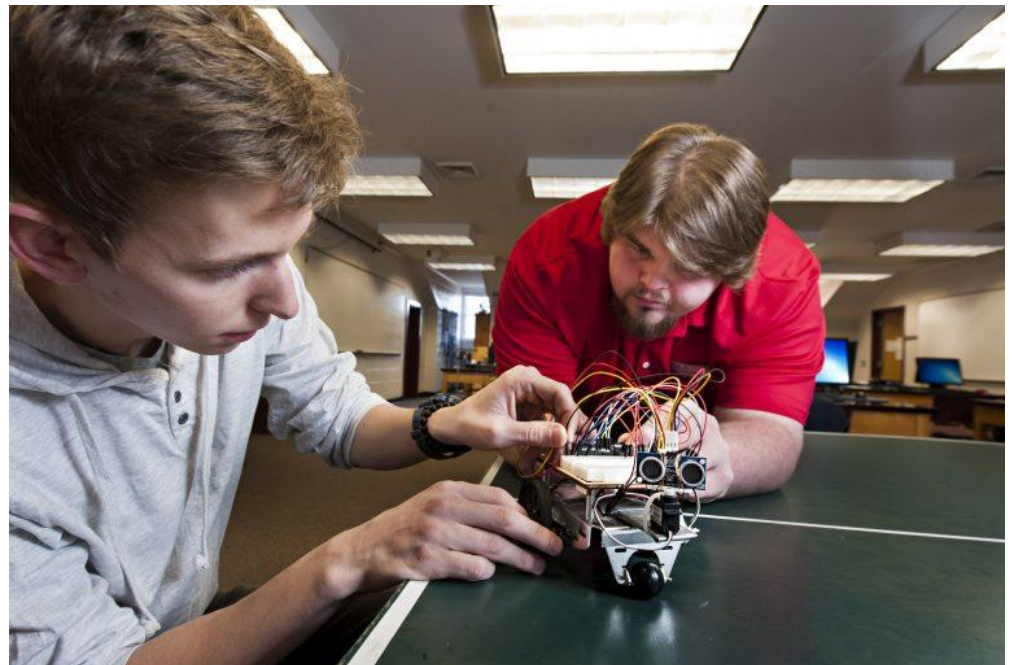
**Loyola University  
Maryland**

**July 25 - 27, 2018**

*3D Physics: Integrating  
Experiment, Theory, and  
Computation*

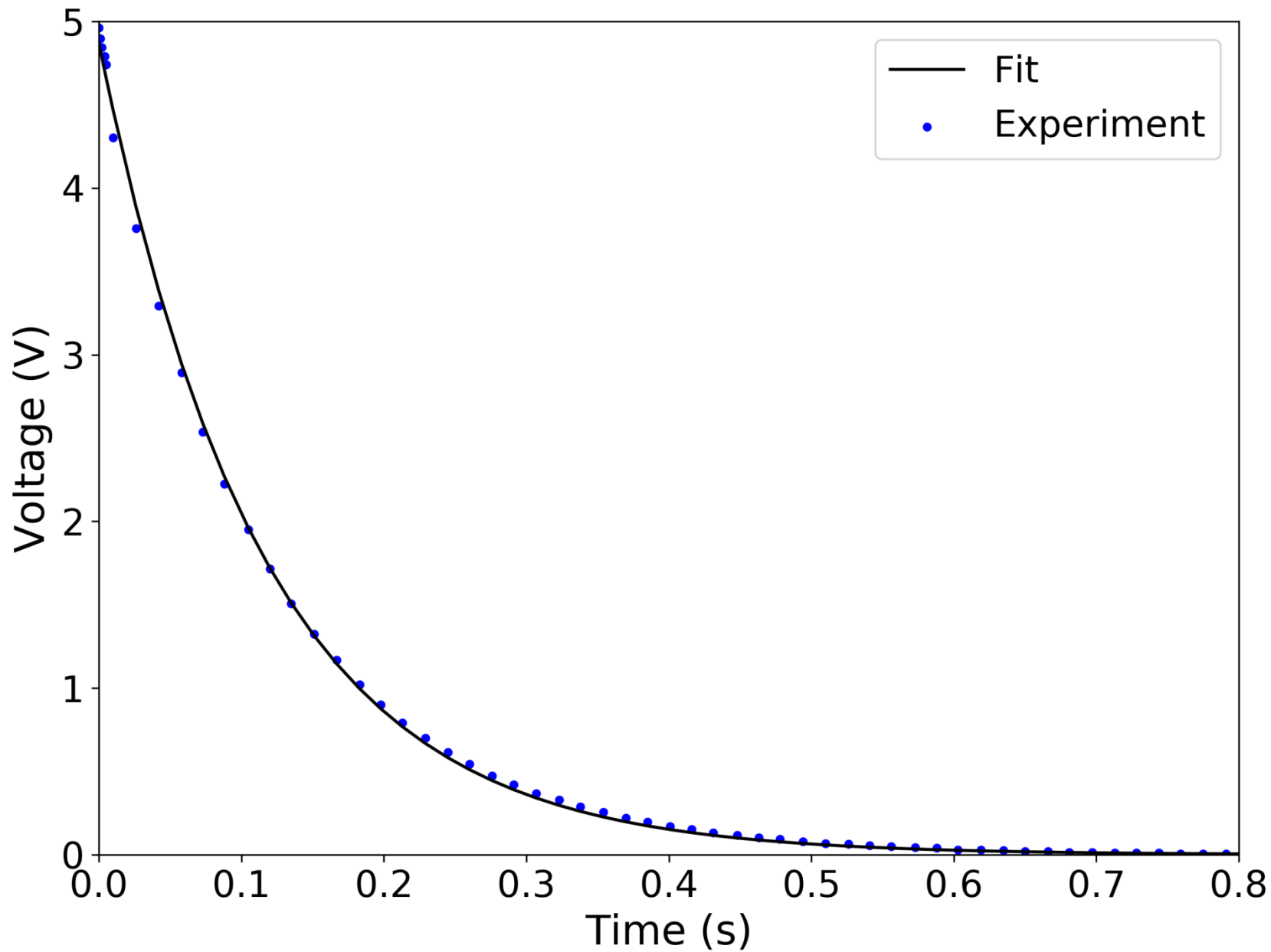


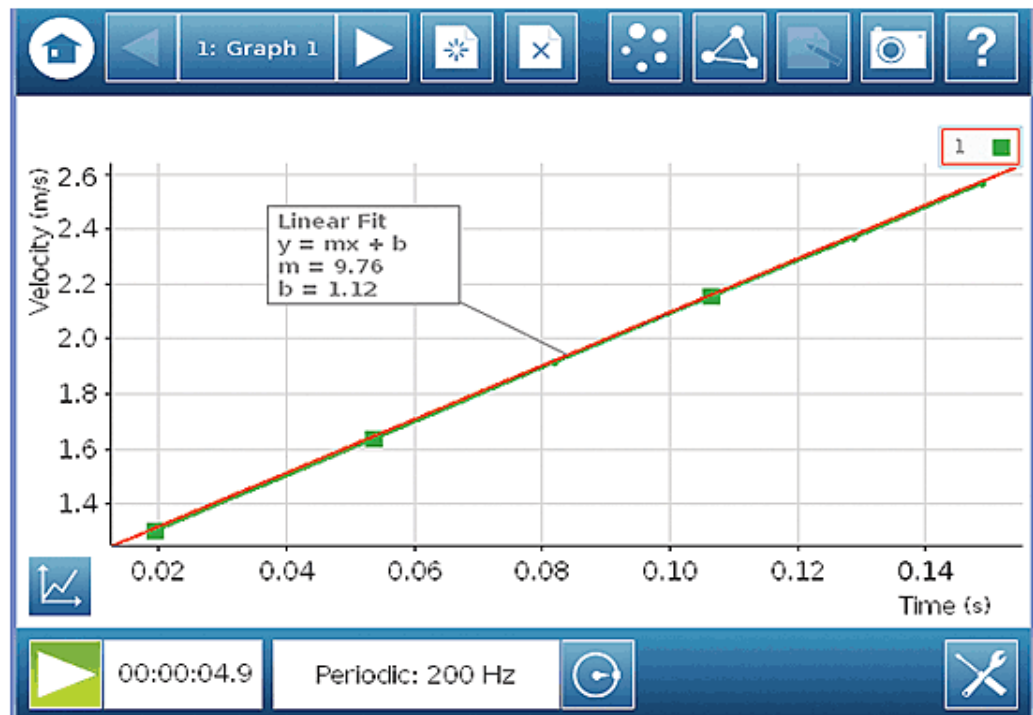
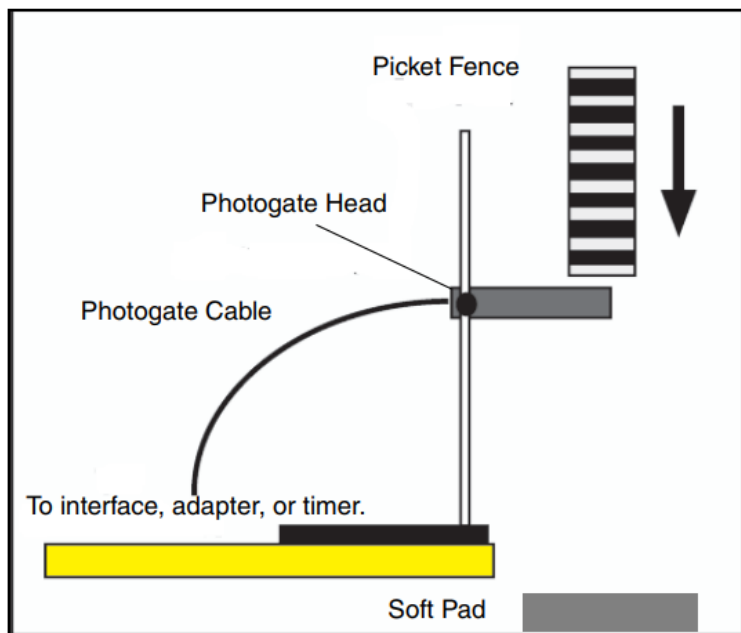
[www.advlab.org](http://www.advlab.org)



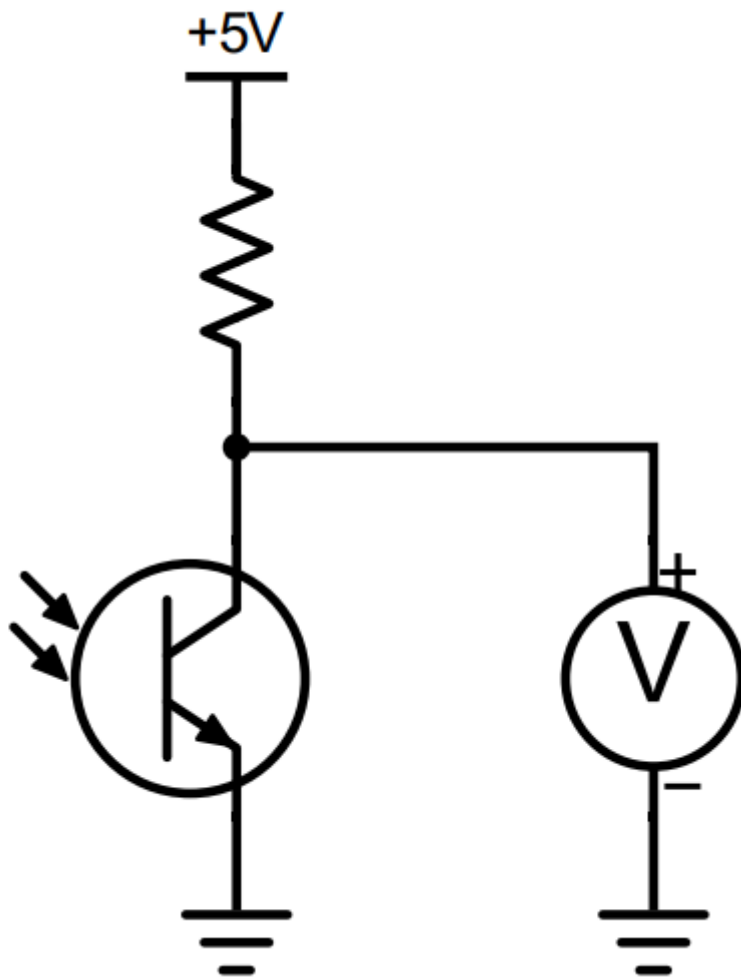
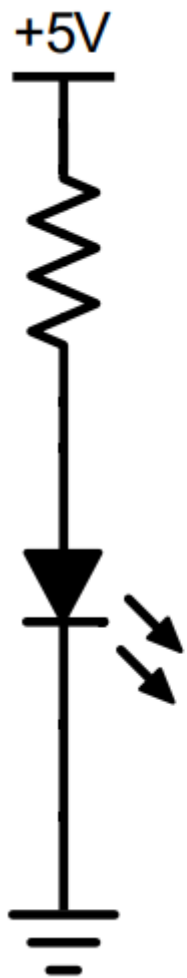


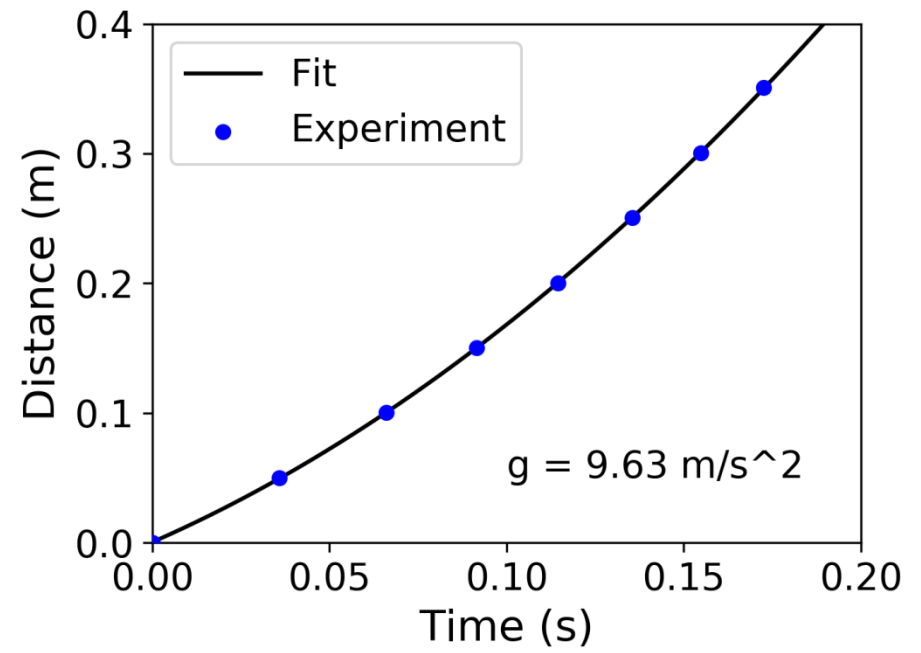
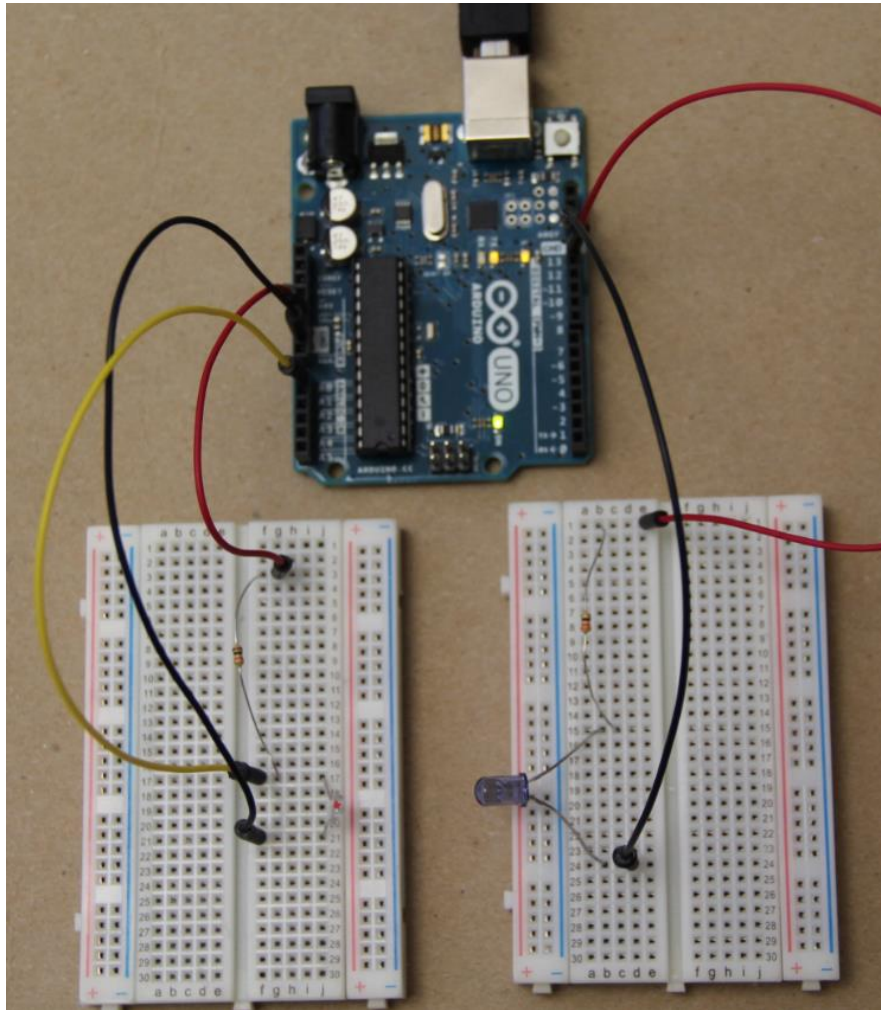
# Extra Slides





Images from pasco.com







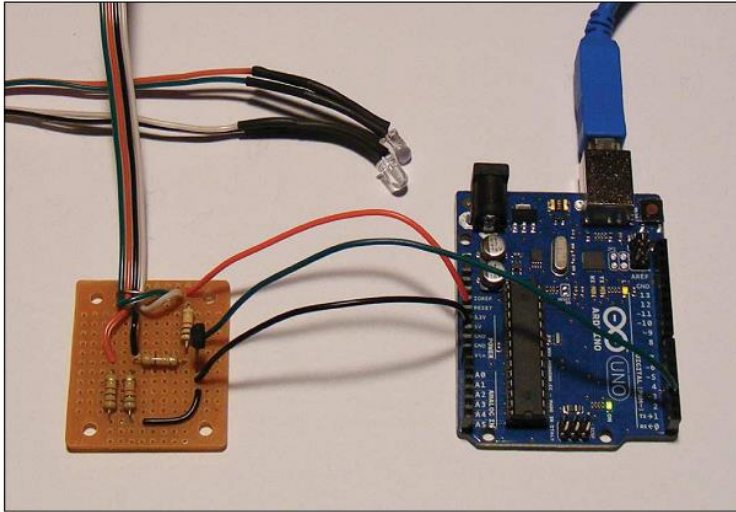


Fig. 3. The photogate circuit and the Arduino board.

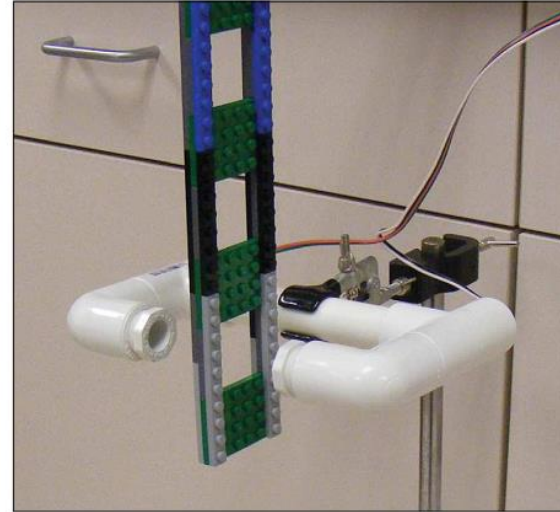


Fig. 4. The "picket fence" was made with Lego bricks.

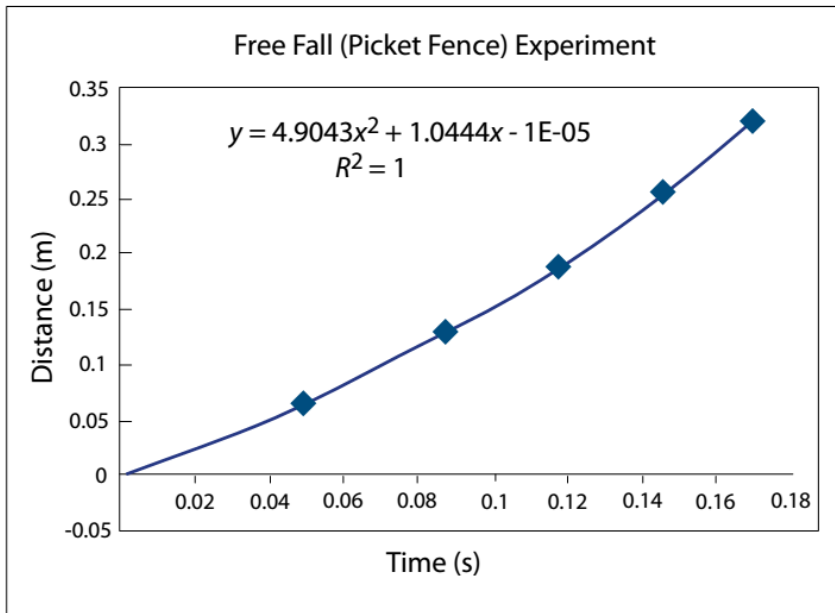


Fig. 6. The graph of distance vs time for an object in free fall.

C. Galeriu  
 Phys. Teach. **51**, 156 (2013)

P. J. O'Connor and L. R. O'Connor,  
 Phys. Teach. **12**, 423 (1974)

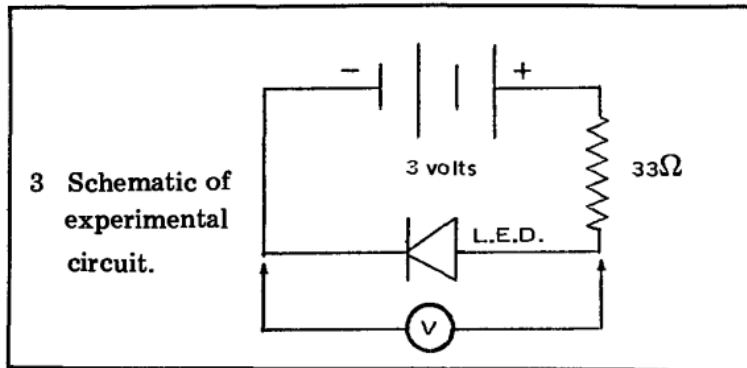


TABLE I

Monsanto catalog number	$\lambda$ from catalog	V measured	h calculated (joule-seconds)
(infrared) ME-4	9100 A	1.35 v.	$6.57 \times 10^{-34}$
(red) MV-10B	6700 A	1.7 v.	$6.07 \times 10^{-34}$
(amber) MV-1	6100 A	2.0 v.	$6.5 \times 10^{-34}$
(green) MV-2	5600 A	2.3 v.	$6.87 \times 10^{-34}$
Average $h = 6.51 \times 10^{-34}$			

F. Zhou and T. Cloninger,  
 Phys. Teach. **46**, 413 (2008)

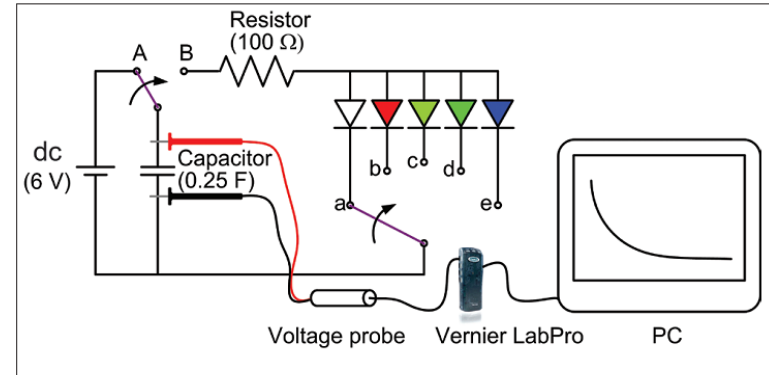


Fig. 1. Experimental setup.

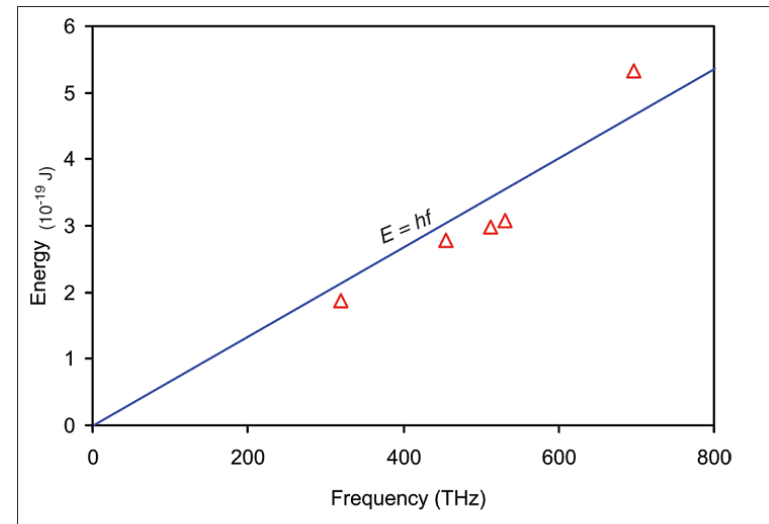


Fig. 3. Graph of photon energy  $E = eV_0$  vs frequency ( $f = c/\lambda$ ) for the five LEDs from which  $h$  is determined from the slope.

