Pendulum Lab Report

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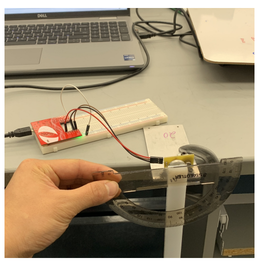
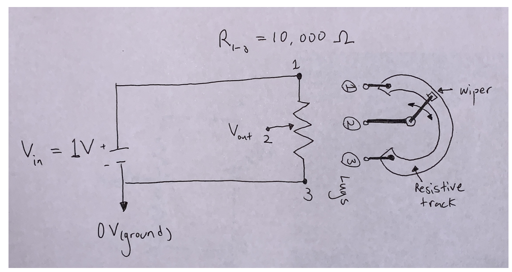
1 Circuit Image and Schematic



(a) Circuit with the pendulum attached



(b) Hand-drawn circuit schematic

Figure 1: Circuit image and hand-drawn schematic

2 Experimental Methods

To obtain angle of the pendulum as a function of time through the voltage readings of the potentiometer attached to the shaft, the angle data had to be calibrated with voltage data; using angle of the resting position as 0°, voltage at angle 0° and both negative and positive 20°, 40°, 60°, 80°, and 90° were measured to cover the entire range of the pendulum swing that would begin from 90°. Then, using this data, a linear line of best fit was added to the scatter plot (Fig. 3) using MATLAB.

OScope was then used to record the voltage data while the pendulum swung from a perpendicular position from its resting position for a total of 30 seconds. The exported CSV file was imported to MATLAB to transform the voltage data into angle data using the calibration curve above. According the Ohm's law, the voltage recorded had to be linearly proportional to the resistance in the series circuit. Also, the varying resistance during the swing was directly dependent on the angle of the pendulum since the pendulum was attached to the shaft of the potentiometer. Thus, the transfer function from the voltage to the angle matched the expectations for it to be linear. The transformed data was then plotted against time to show the change in angle as a function of time.

3 Results

```
% inputting calibration data
voltage_cali =
    [212; 232; 300; 370; 432; 505; 573; 630; 680; 737; 769];
angle_cali =
    [-90; -80; -60; -40; -20; 0; 20; 40; 60; 80; 90];

% creating a trendline
p = polyfit(voltage_cali, angle_cali, 1);
px = [min(voltage_cali) max(voltage_cali)];
py = polyval(p, px);

clf
scatter(voltage_cali, angle_cali, "filled")
hold on
plot(px, py, 'LineWidth', 2);
title("Angle vs Voltage")
xlabel("Voltage (mV)")
ylabel("Angle (°)"); hold off
legend('Calibration points', sprintf('y=%f*x+%f',p(1), p(2)));
```

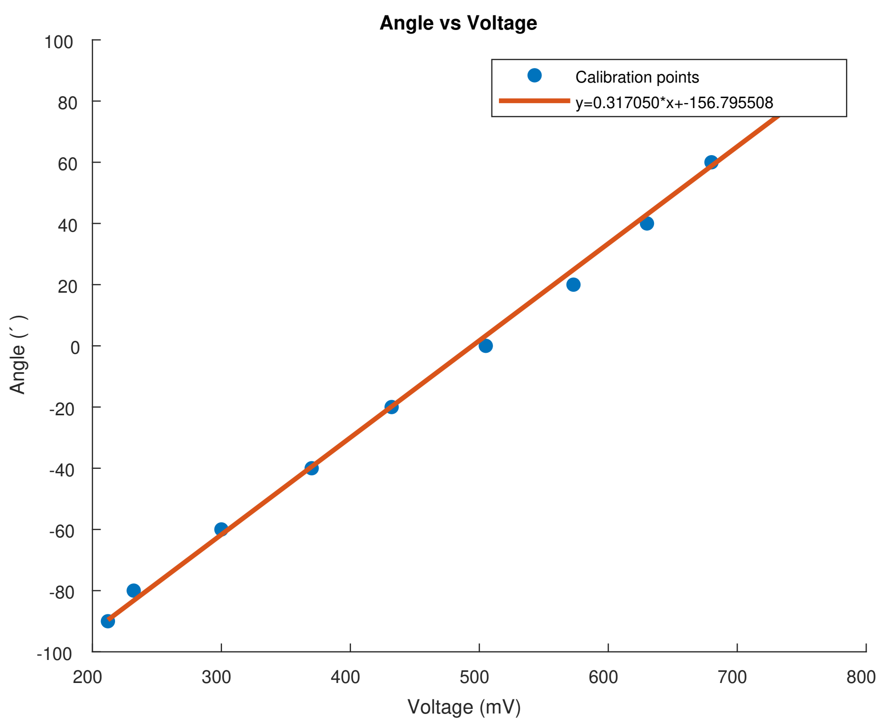


Figure 2: Voltage vs angle for the pendulum. A 1 kiloohm potentiometer was used as an angular position sensor in a voltage divider circuit with 1 V DC input.

```
% calculating the angle data from the trendline
exp_data = readmatrix('pendulum_voltage.csv');
voltage_exp = exp_data(:,2) * 1000; % convert from V to mV
time_exp = exp_data(:,1) + 15;

angle_exp = polyval(p, voltage_exp);

plot(time_exp, angle_exp); hold on
axis([0 30 -90 90])
title("Angle vs Time")
xlabel("Time (sec)")
ylabel("Angle (°)"); hold off
```

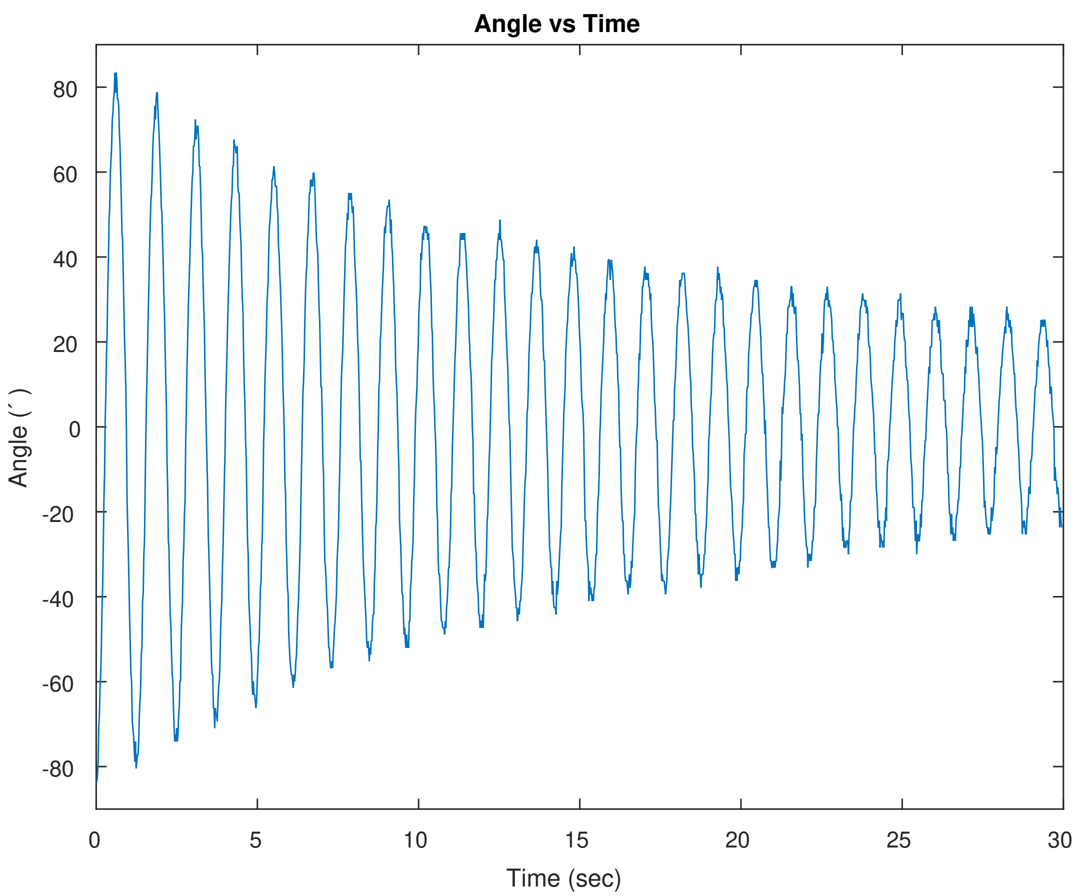


Figure 3: Angle vs time for the pendulum. The calibration curve from Fig. 2 was used to convert voltage values to their corresponding angle.