Lab1

Kieran Cosgrove

Import libraries

In [1]:
```
import numpy as np
import matplotlib.pyplot as plt
from sklearn.linear_model import LinearRegression
```

Question 1

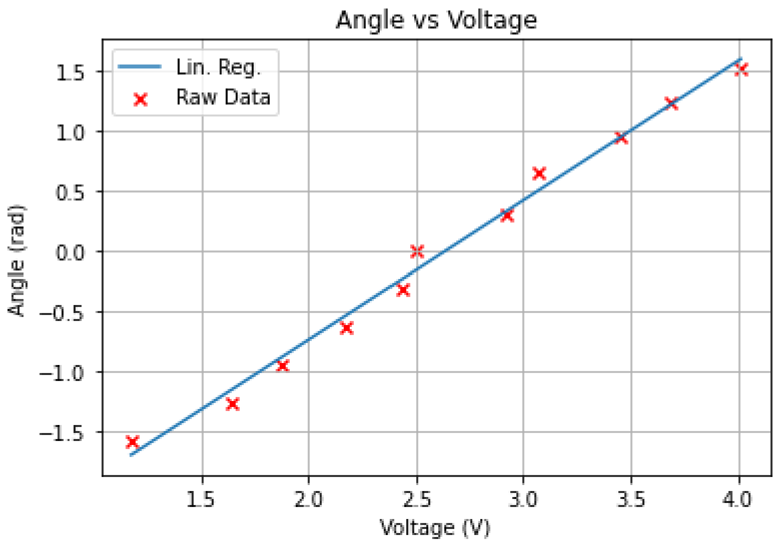
Model linear regression between angle (radians) and voltages (volts); get fit variables

In [2]:
```
angles = np.array([-1.57, -1.26, -0.94, -0.63, -0.31, 0., 0.31, 0.65, 0.96, 1.23,
voltages = np.array([1.176, 1.648, 1.874, 2.175, 2.438, 2.503, 2.925, 3.067, 3.45

fit = LinearRegression().fit(voltages, angles)
r_squared = fit.score(voltages, angles)

print("Rsquared: {0} (%)\nSlope: {1} (V/rad)\nIntercept: {2} (rad)".format(r_squa
```

```
Rsquared: 0.9906097430823074 (%)
Slope: [[1.15858052]] (V/rad)
Intercept: [-3.05344161] (rad)
```

Plot fit

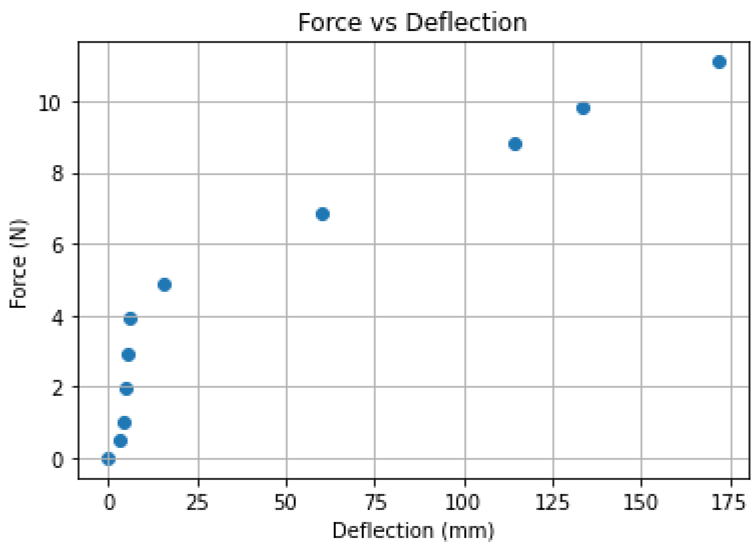
In [3]:
```
plt.scatter(voltages,angles, c="r", marker='x')
plt.plot(voltages,fit.coef_*voltages + fit.intercept_)
plt.xlabel('Voltage (V)')
plt.ylabel('Angle (rad)')
plt.legend(['Lin. Reg.','Raw Data'])
plt.title('Angle vs Voltage')
plt.grid()
```



Question 2

Initial data & conversion; plot data

In [4]:
```
Mass     = np.array([0,50,100,200,300,400,500,700,900,1000,1133]).reshape(-1, 1)
L_bungee = np.array([8.75,8.875,8.925,8.95,8.975,9,9.375,11.125,13.25,14,15.5]).r

L_mm = L_bungee * 25.4
Force  = Mass / 1000 * 9.81 # N
DeltaL = L_mm - L_mm[0]

plt.scatter(DeltaL, Force)
plt.title("Force vs Deflection")
plt.xlabel("Deflection (mm)")
plt.ylabel("Force (N)")
plt.grid()
```



Based on this graph and the Physics of Bungee Jumping article, I would suggest a piecewise solution. The data seems to follow two linear trends put together, splitting at approximately 4 N

Below is the fits for these two linear models

In [5]:
```
def filter(a_list, cutoff, above_bool):
    new_list = []
    for x in a_list:
        if above_bool and x > cutoff or not above_bool and x < cutoff:
            new_list.append(x)
    return new_list

# fit for < 4 N
force_1 = filter(Force, 4.5, False)
defl_1 = DeltaL[:len(force_1)]


fit2 = LinearRegression().fit(defl_1, force_1)
r_squared2 = fit2.score(defl_1, force_1)
print("Fit1\nRsquared: {0} (%)\nSlope: {1} (N/mm)\nIntercept: {2} (mm)".format(r_

# fit for > 4 N
defl_2 = DeltaL[len(force_1)-1:]
force_2 = Force[len(force_1)-1:]

fit3 = LinearRegression().fit(defl_2, force_2)
r_squared3 = fit3.score(defl_2, force_2)
print("\nFit2\nRsquared: {0} (%)\nSlope: {1} (N/mm)\nIntercept: {2} (mm)".format(
```

```
Fit1
Rsquared: 0.7560466050622758 (%)
Slope: [[0.57196009]] (N/mm)
Intercept: [-0.64401527] (mm)

Fit2
Rsquared: 0.9922245154862659 (%)
Slope: [[0.04228297]] (N/mm)
Intercept: [4.03974643] (mm)
```

Plot fits & raw data

In [6]:
```
plt.scatter(DeltaL, Force, c="r", marker='x')
plt.plot(defl_1,fit2.coef_*defl_1 + fit2.intercept_)
plt.plot(defl_2,fit3.coef_*defl_2 + fit3.intercept_)
plt.xlabel('Deflection (mm)')
plt.ylabel('Force (N)')
plt.legend(['Fit1','Fit2','Raw Data'])
plt.title('Force vs Deflection')
plt.grid()
```