

## Expt. 4 Rubric

Note: Always credit the work of others (i.e. write your lab partner's name at the top of your report)

**Note: If you used Excel to do any of your calculations, print out the spreadsheet and neatly cut and paste it into your report. All data and calculations must have labels.**

**Introduction:** Statement of the problem (What is the goal of this experiment? What are we ultimately trying to measure, calculate, and describe? Why is this worth doing? Write a brief summary of procedure. Include all major equations used in your calculations.  
**(Minus 1 point for not doing this part)**

**Measurements** and associated uncertainties or Standard Deviations for:

- $m$ : Mass of the coat hanger
- $m_1$ : Mass of circular capacitor plate with rubber stop
- $m_2$ : Mass of circular counterweight plate.
- $l$ : Moment arm length of the coat hanger (Not simply the length of the coat hanger wire)
- $R$ : Radius of the circular capacitor plate
- $d$ : Distance between the capacitor plates (i.e. thickness of the rubber stopper)
- $T$ : Period measurements of the torsional pendulum
- $\theta$ : Angle measurements for the 5 different voltage settings

### **Calculations/Error Analysis:**

$\kappa$  and its uncertainty

$V_{\text{calc}}$  using the angle data at each voltage setting and calculate the uncertainty for each of these

### **Graph** of $V_{\text{calc}}$ vs. $V_{\text{expected}}$

(Graphs of course need descriptive titles; axis labels with units; a legend or labeling for multiple data series or fitting lines.)

Before plotting  $V_{\text{calc}}$  vs.  $V_{\text{expected}}$ , what kind of

relationship do you expect between  $V_{\text{calc}}$  and  $V_{\text{expected}}$ . Call this your "expected distribution". Be explicit (i.e. Where should the curve intersect the axes? What shape should the curve have? Etc...)

Plot  $V_{\text{calc}}$  vs.  $V_{\text{expected}}$ . Also plot vertical error bars.

What kind of relationship do you see between  $V_{\text{calc}}$  and  $V_{\text{expected}}$ ?

Using the **type** of curve of your "expected distribution," do a least-squares fit by hand (show your work) using the method described in the experimental guidelines. (Do not just use Excel to determine the best fit curve.) Then plot and label your least-squares fit curve on your graph of  $V_{\text{calc}}$  vs.  $V_{\text{expected}}$ .

### **Conclusion/Discussion:**

Calculate  $\chi^2$  (Chi-squared) and the reduced chi-squared. Determine the probability of acquiring a reduced chi-square larger than the value you calculated. What does this tell you about the agreement between your data and the **type** of curve you fit to your data? Should you reject your least-squares fit curve? If so, at what significance level do you reject your least-squares fit curve?

If you had discrepant results, discuss the sources of error and try to trace what is the most significant contribution to the error in your results. Explain why you believe this is the most significant source of error.

**Note:** Even if you didn't have to reject your least-squares fit curve, consider whether your least-squares fit curve is discrepant from the "expected distribution."

NOTE: "Human error" conveys no useful information.