Lab 1: Uncertainty and Experimental Design

1. Read the following scenario and then consider the issues and questions posed below.

   Suppose a person in the state of California who is suspected of driving while under the influence of alcohol (DUI) has blood withdrawn for the purposes of doing a blood alcohol content (BAC) test. Five people independently run the BAC test from the portions of the same original sample and acquire the following results: as a trained assistant, you get a reading of 0.097% BAC, while a nurse gets 0.072%, a resident intern gets 0.0729%, a laboratory technician obtains a reading of 0.064%, and the head MD (doctor) gets 0.152%. Now you are presented with the full set of measurements.

CALIFORNIA VEHICLE CODE (CVC)
Section 23152

(a) It is unlawful for a person who is under the influence of any alcoholic beverage to drive a vehicle.

(b) It is unlawful for a person who has 0.08 percent or more, by weight, of alcohol in his or her blood to drive a vehicle. For purposes of this article and Section 34501.16, percent, by weight, of alcohol in a person?s blood is based upon grams of alcohol per 100 milliliters of blood or grams of alcohol per 210 liters of breath.

Section 23153

(a) It is unlawful for a person, while under the influence of any alcoholic beverage, to drive a vehicle and concurrently do any act forbidden by law, or neglect any duty imposed by law in driving the vehicle, which act or neglect proximately causes bodily injury to any person other than the driver.

(b) It is unlawful for a person, while having 0.08 percent or more, by weight, of alcohol in his or her blood to drive a vehicle and concurrently do any act forbidden by law, or neglect any duty imposed by law in driving the vehicle, which act or neglect proximately causes bodily injury to any person other than the driver.

   (a) Looking at all the data, what would be best to report for the BAC? Explain your procedures and your thinking to arrive at your answer.

   (b) Give several reasons why five trained individuals might come up with different readings.

(c) Should the individual be presumed to be under the influence of alcohol under the Vehicle Code for the State of California? Explain why or why not.

2. In the front of the room is a pendulum which consists of a mass hanging from the end of a string. The length of the pendulum is the distance from the support to the center of the hanging mass. Measure in centimeters and estimate to the nearest millimeter.

   (a) Write down your measured value for the length of the pendulum and describe the exact procedure you used to make the measurement. Also write your measurement on the whiteboard in the table started by your instructor.

   (b) Does every group get exactly the same result for the length of the pendulum that you measured? List at least three reasons why your results may differ from the results gotten by other groups.

3. By now, all of your classmates should have written their measurements for the length of the pendulum on the whiteboard. Copy these results into the table below and find the mean values of each column to be placed at the bottom.

Length of pendulum (cm)	Deviation from mean	Squared deviation from the mean

4. The *period* of a pendulum is defined as the time it takes for the pendulum to make one complete swing, i.e. from when you release it, through its swing to the other side, and back to its starting point.

   (a) What are some factors that you believe will affect the period of a pendulum?

   (b) For each of the factors you mentioned in the previous question, write a *hypothesis* stating how you think that factor will affect the period. For example, you could say: as (*factor you mentioned*) increases, the period of the pendulum will increase/decrease.

5. Your challenge is to construct a pendulum with a period that will be assigned to you by your instructor. You can construct the pendulum by tying at least 5 paperclips to the end of a piece of string to make a pendulum bob. You may use your cell phone to measure the period by timing how long it takes the pendulum to swing back and forth 10 times and dividing that number by 10. Do not lift the pendulum very high before letting it go, as it is easier to get more consistent results by only raising it a relatively small amount before releasing it.

   (a) When you believe your pendulum has the right period, write a description of how you constructed it.

   (b) Experiment with the different factors you thought would affect the period by changing them and timing the period again. For each factor, was your prediction correct?