1. Reaction Errors: As you know, some time is required for any human to respond to an unforseen event. This delay is called "reaction time". A good way to study reaction time is to hold a meter stick vertically so that its lower end hangs between your partner's thumb and fingers. Place the back of a chair under the catcher's wrist so that it cannot move downward, and instruct him or her to catch the meter stick immediately when you let it go. If you release the meter stick *without warning* you will find that it usually falls some distance before it is caught. The distance that it falls is a measure of your partner's reaction time. Record a lot of those falling distances. Each student must make a histogram of his or her own results. Use your histogram to answer the following questions:
   - * a. Is your reaction time always the same, or does it have random variations? -Does 5a on p. 2 agree?
   - * b. Determine the MLV and uncertainty of the distance that the stick falls during your reaction time.

2. Try giving a steady, rhythmic countdown so that your partner knows when to expect the release.
   Does that reduce your partner's reaction time? ____

3. Try releasing and catching the stick simultaneously by yourself.
   Does the stick fall as far as it did in #1? _____ -Does it fall as far as it did in #2? ____

4. Another way to investigate human reaction time is to ask a group of people to clap simultaneously when given a cue. (A similar problem is faced by the conductor of a band.) Try it and listen to the results.
   Do results of the clapping experiments agree with your earlier conclusions? ___ *If not, please explain.*

5. Now let’s think about reaction errors you can make when using a stopwatch:
   a. What is the smallest fraction of a second you can measure? _____ (Copy from #5 on RS I.)
   b. What is the smallest fraction of a pendulum swing that you can easily count? ______
   c. A fraction of a ______ is easier to measure than a fraction of a ______. (second, swing)
   d. Does 5c contradict 5a & b? ____ * *If so, please explain why you chose not to correct your error.*
   e. Which is better: (1) telling another person to start and stop the clock while you watch the pendulum, or (2) letting the observer start and stop the clock personally? _____
   f. Suppose it is impossible for one person to work the clock while observing the pendulum:
   What is the *second-best* method described above for minimizing reaction error? ______

6. To divide a *sum* by a *number* you use the "distributive law": **(X + Y) ÷ 5 = X/5 + ____.**
   The same rule is used when you divide a *measured quantity* like "15.5 ± 0.2 sec" by a *counted* number like "5 swings": **(15.5 ± 0.2 sec) ÷ (5 swings) = 3.1 ± _____ sec per _____**

7. The distributive law does *not* work when you divide a *counted* number *BY* a *measured* quantity, like (5 swings) ÷ (15.5 ± 0.2 seconds). If the divisor has an uncertainty, you must use the old reliable "range" method. Just think of the quotient as a fraction with an adjustable divisor:
   a. Calculate the *GREATEST* possible value of the quotient by using the ______est value of the given divisor: **GLV of quotient = (5 swings) ÷ (_____ ____) = ______ ____ per____**
   b. Calculate the SLV of the quotient by dividing the *numerator* by the __LV of the *divisor*:
   SLV of quotient = (5 sw.) ÷ (_____ ___) = ______ _____ per ___
   c. Calculate the MLV of the quotient by dividing the _______ by the ___LV of the ______:
   MLV of quotient = (____ ___) ÷ (_____ ___) = _____ _____ per ____
   d. If you did not round off too much, you may have noticed that the MLV of this quotient is not exactly midway between its SLV and its GLV. If that discrepancy is great enough to worry about, then leave the quotient in range form and don't bother with the MLV. If the discrepancy is small enough to ignore, then the uncertainty of the quotient is simply the half-width of its range, exactly as on page 3:
   UNC of quotient = (GLV - SLV) ÷ 2 = (_____ - _____) ÷ (_____) = ±______ _______

8. Here are three ways to measure the period of a pendulum: **Method 1:** Measure the amount of time needed to swing back and forth once. **Method 2:** Measure the amount of time required for five complete swings and then divide that number of seconds by the number of swings, as you did in #6. **Method 3:** Count the number of swings completed in five seconds and then divide. (Naturally, you must make sure that the amplitude does not change significantly when using methods 2 & 3.)
   a. We can easily minimize the pendulum’s natural loss of amplitude during a series of swings by starting it with a very ______ amplitude. *Write an adjective into the blank.*
   b. Which method is the best? ___ -How can you modify that method to make it *much more precise?*