1. Mr. Wetherbee weighs 180.00 lb: (a) How heavy will he be if his weight increases by 1.20 lb? ____ ____
   b. How heavy will he be if his weight increases *by a factor of* 1.20? ____ ___ (See RS I.)
   c. How heavy will he be if his weight increases by 1.20 *percent?* ____ ____
   d. "Increasing something by 1.20%" means multiplying it by ____, as in 1-3 on page 10R.
   e. "Decreasing something by 2%" means *dividing* it by _____ or *multiplying* it by ______.

2. Suppose y is directly proportional to x. Then x and y must both be ___________ *(variables, constants)* and changing the value of x must cause y to change, as described in 7f on RS I. (That's a clue!)
   a. How must the percentage change in y compare with the percentage change in x? _____ (one word)
   b. If the radius of a circle is decreased by two percent, its circumference must __crease by ___%

3. There must be an equation which describes how a circle's area depends on its diameter. That equation must contain a symbol representing the diameter, a symbol representing the area, and a constant.
   a. Is it possible for that constant to have units? ____ (If so, consider the consequences.)
   b. If the diameter is measured in meters, then the area must be in _______ meters.
   c. The symbol representing diameter must have an exponent. The units in the equation cannot balance unless that exponent is __. Therefore the area must be proportional to ______ _______.
   d. Sketch the graph of **area vs diameter** which was described above in 3c. -Is it linear? ____ -Does it go through the origin?___ -Do those answers contradict 3c? __
   e. If the diameter of a circle is increased by 1% then its area increases by __%. (Use #3 on page 20.)

4. The **"frequency"** of a repeating motion is the ***reciprocal of its period.*** (Recorded on RS ___)
   a. If a pendulum's *period* is 0.50 seconds per swing then its *frequency* is 2.0 ______s per ______.
   b. If the period in 4a is increased by 0.7%, then the new period is ____ ____.
   c. The new ***frequency*** in 4b is _________ ______. (Please do *not* round off yet.)
   d. To find the "change" in frequency, we subtract: (______ ___) - (______ ___) = ______ ___
   e. That change can be converted into percentage language: **100(_____) ÷ (____) = ____%** (Please keep ***no more than one*** bogus digit here.)
   f. Did the frequency increase, or did it decrease? _________ --Do we call that a positive change, or is it a negative change? _________ -Do 4d and 4e agree with this answer? ____

5. In #4 we saw that whenever the denominator (bottom part) of a fraction is *increased* by some small percentage, the value of the fraction is ___creased by _____ ______ percentage.
   a. For example, increasing the period of a pendulum by 0.7% caused its frequency to __crease by ___%.
   b. Increasing the denominator of a fraction by 2% will __crease the value of the fraction by ___%.
   c. For example, if the original fraction is **65/200** and we increase the denominator by 2%, then the new fraction will be **65/____**. *Use page 10R. Do not round off before the last step in 5e.*
   d. In decimal form, the original fraction in 5c was **0.325** and the new fraction is __________.
   e. The fractional change in this example is **[(______) - 0.325] ÷ (0.325) = ______** = ____%
   f. The ____tive sign in the answer to 5e shows that the fraction ___creased. Did that happen in #4 too?

6. Increasing the *numerator* (top part) of a fraction by X% always causes the value of the fraction to ___crease by ___%. For example, if the original fraction is **200/537** and we increase the numerator by 3%, then the new fraction will be **(____)/537**. ***Show*** how the percentage change is calculated. Don't round off until the last step!

7. Suppose "A" is increased by x% and "B" is increased by y%. According to #5 & #6, the quotient A/B will increase by approximately ____% **if** both x and y are _____. (large, small, rational, irrational) -If A is increased by x% and B is ***decreased*** by y% then A/B will __crease by ____%.

8. Suppose "A" has a small relative uncertainty of 2% and "B" has a small relative uncertainty of 3%.
   a. The MLV of their quotient will be A/B. The GLV of their quotient will be roughly _____% greater.
   b. The SLV of their quotient will be roughly ______% *smaller* than the MLV.
   * c. Show how the results from 8a and 8b can be used to estimate the uncertainty of the quotient.
   d. Apparently the percentage uncertainty of their quotient can be estimated by ____ing the percentage uncertainties of A and B. This important discovery is being saved for future use in #___ on RS II.

1. In #18 on RS II you recorded the relation between a simple pendulum's period and its length.
   a. Describe that relation in *proportion* language: "**P is proportional to _____**"
   b. Using 17d on RS II, translate 1a into *ratio* language: $\mathbf{P_2/P_1 =}$ ____
   c. Suppose we increase the length of a pendulum by 2.0%. Using #24 on RS II, the numerical value of the length ratio is $\mathbf{L_2/L_1 =}$ ____. (A ratio is a *quotent*. Write *one* number in the blank.)
   d. Plug that numerical value into equation 1b and calculate the period ratio: $\mathbf{P_2/P_1 =}$ _____ =
   e. Translate that result back into percentage language, rounding off properly:
   "If a pendulum’s length is increased by 2.0% then its period __creases by about __%."

* 2. How is a sphere's volume affected if its radius is increased by 1.0 %? The volume *units* are a clue, as explained in 4b on p. 19. The final sentence of your explanation must be similar (in form) to 1e.

3. Let's look for a pattern in our recent discoveries:
   a. In #2 on page 21 we found that a two-percent decrease in diameter causes a ___-percent __crease in the circumference of a circle because circumference is proportional to the ___ power of ______.
   b. In #3 on page 21 we found that a one-percent increase in the diameter of a circle caused its area to increase by ___% because area is proportional to the ___ power of diameter.
   c. In #4 on page 21 a 0.7-percent increase in period caused a ___-percent ___crease in frequency because frequency is equal to period to the ___ power.
   d. In #2 on this page the percentage increase in volume was __ times the percentage increase in radius because volume is proportional to the ____ power of radius. *That’s a clue for #7.*
   e. In #1 the exponent was ___. The percent change in period was ___ times the ____ ____ __ ____.
   f. Do the units balance in 3e? ___ If not, why haven’t you corrected your mistake?

4. Conclusion: **If A is proportional to B^n then the percentage change in A is always approximately ___ times the percentage change in B.** (Recorded in part __ of #__ on RSII.)
   -Do all of the examples in #3 illustrate this rule? ___ If not, please explain.

5. Is the general rule in #4 exact when n is not equal to 1? ___ -Is it only an approximation? _____
   -The rule work best when the percentages are ________ (large or small?)

6. According to #20 on RS II, the volume of a gas sample is proportional to the ___ power of its pressure if the gas temperature is kept constant. If we increase the pressure of such a gas sample by 2% then its volume must ___crease by ___%. Does this contradict #4? ___

7. On p. 19 we found that the weight of a bowling ball is proportional to the ___ power of its diameter. Does #2 agree? ___ -Does 3d agree also? ___ Suppose a new bowling ball has a diameter just 0.5% greater than the old one: According to #4, the new ball will be ___% heavier than the old one.

8. In #6 on RS II you recorded a relation between free-falling distance and falling time:
   "D is proportional to ______ *if* the initial speed is zero."
   a. To increase the falling distance by 4%, you must ___crease the falling time by about ___%
   b. If the falling distance uncertainty is 4% then the time uncertainty must be about ___%.
   c. If you decrease the falling **time** by 4%, you will ___crease the falling **distance** by about __%.

9. The strength of a rope is proportional to the number of fibers in it.
   Imagine a set of ropes with different thicknesses, all made with the same kind of fibers.
   a. How must the rope strength depend on its cross-sectional area? ____ (Use proportion language.)
   b. According to 9a and 3b, strength must be proportional to the _____ power of thickness.
   c. To make such a rope 10% stronger you must make it roughly __% thicker. Does #4 agree?__

10. Bonus Question: The neat trick that you learned in #4 works best when the percentage changes are small. Is there any limit to the accuracy that can be achieved with this new relation if the changes are super-small? _____ If so, describe the limitation clearly by calculating the smallest error possible.