SKILLS YOU WILL NEED FOR THE FIRST HONORS PHYSICS QUIZ

1. Convert a given uncertainty into percentage form:

   3.45 ± 0.07 cm = **3.45 cm ± 2%**

2. Convert a length or a mass from one familiar unit to another.

   3.45 ± 0.04 cm = **(3.45 ± 0.04) x 10^{-2} meter.**

   2.340 ± 30 grams = **2.340 ± 0.030 kg.**

3. Given a number in "range" form OR in "MLV ± UNC" form, decide how many of its digits are significant.
   For example: if a number is "between 2345.6 and 2365.9" then its MLV really has only *three* significant digits because we know that its third digit is probably 4, 5, or 6 but we have no idea what its fourth or fifth digits are.

4. Given the uncertainty of a measuring method, decide how far off we should expect its results to be from the true value of the thing being measured.

5. Match up familiar names and units. For example, a "Celsius degree" is a unit of *temperature*, not distance. A distance can be measured in *feet or meters*, but not in kilograms.

6. Decide whether a given push on a moving object will cause the speed of the object to increase or decrease. Decide whether changing a swinging pendulum in a given way will cause its period to increase or decrease.

7. Use known clues to estimate an unknown quantity in power-of-ten form as we did on page 2b.

Honors Physics Quiz I **name: _____**

1. Convert the uncertainties of these numbers into percentage form.
   Remember that uncertainties are just rough estimates.
   a. 300 ± 7 gram = 300 gram ± ____%
   b. 175 ± 2 centimeters = ____ ___ ± ___%

2. Rewrite 1a using kilograms instead of grams. (One kg = 1000 grams.)
   Remember to use scientific notation whenever it is appropriate.

   _____ ± 0.007 kg = _____ ____ ± _____%

3. Rewrite 1b using meters instead of centimeters. (One meter = 100 cm.)

4. When a certain quantity is measured carefully several times we find that its value is "between 3.594758 and 3.593827 m^2".
   a. Could it be the circumference of a circle? Explain your answer briefly.

   b. How precise was that measuring method?
      Answer in percentage language and *show* how that percentage is calculated.

   c. How many significant digits do the measurements have?
      Include nearly significant digits in your count, but do not include pure fiction.

5. When another quantity is measured carefully we find that its value is 8.7316482 kg ± 0.05%.
   a. What kind of quantity must it be? _____
      (circumference, area, mass, weight, temperature, or what?)

   b. Give the MLV and absolute uncertainty of that measurement, with proper roundoff.

   c. Show how that uncertainty was calculated.

6. Two children are swinging side-by side on playground swings. The two swings have equal lengths and the children have equal masses. Suppose they decide to reach out and hold hands while swinging: Does that cause the period of their motion to change? *Please explain.*

7. The two children together in #6 form a single object (pendulum bob) with double mass. The experiment in #6 tells us that the period of a pendulum _____ depend on the mass of its bob. (must, cannot) We must conclude that increasing the mass of a pendulum bob will cause the period to _____. (increase, decrease, remain unchanged)

8. How much water is there in all of the oceans of the earth? Please *estimate* the amount, in cubic meters. Use powers of ten, and use range form. *Explain your estimate* in the space below or on the back of this paper. Please *do not* include insignificant (bogus) digits. Delete them at every step of your estimation. Draw a box around your final answer. It must be in range form, with units.

Solutions to First Honors Physics Quiz

1a. ± 7/300 = **± 0.023 = ± 2.3%** b. ± 2/175 = ± 0.011 = **± 1.1%**

2. 0.300 ± 0.007 kg = **0.300 kg ± 2.3%**, because 0.007/0.300 = .023

Notice that power-of-ten notation would be longer and more cumbersome than decimal notation here, so decimal notation IS the scientific way to write the numbers in this example.

3. 0.02/1.75 = 0.011, so 1.75 ± 0.02 m = **1.75 m ± 1.1%**

4. A certain quantity is "between 3.594758 and 3.593827 m^2".

a. Could it be the circumference of a circle?

No, because circumference is a length. Square meters are not units of length.

b. How precise was that measuring method?

The uncertainty of this area can be estimated by subtracting the smallest likely value (SLV) from the greatest likely value (GLV) and then dividing by 2:
(3.594758 m^2 - 3.593827 m^2)/2 = 0.00046 m^2
To convert that "absolute uncertainty" into percentage language we divide it by the MLV, or Most Likely Value. Since uncertainties are never very precise, we do not need to keep a lot of digits in this calculation: ± 0.00046/3.594 = ± 0.00013 = **± 0.013%**

c. How many significant digits do the measurements have?

*The given SLV and GLV share the same first three digits and their 4th digits almost agree. Therefore this measuring method apparently gives results with **four** significant digits.*

5. When another quantity is measured carefully we find that its value is 8.7316482 kg ± 0.05%.

a. What kind of quantity must it be? *The unit (kg) tells us that this is a **mass** measurement.*

b. Give the MLV and absolute uncertainty of that measurement, with proper roundoff.

The MLV is given, but with some bogus digits. To convert the given percentage uncertainty into absolute form, we multiply it by the MLV: (± 0.0005)(8.73 kg) = ± 0.00043 kg *That absolute uncertainty tells us that the fifth digit could be almost anything. Therefore the given mass value has only four significant digits. Keeping the fifth digit is harmless and will certainly avoid roundoff errors, but keeping more than five digits is silly.*
Final answer: **8.7316 kg ± 0.00043 kg**

6. Two children are swinging side-by side on playground swings. The two swings have equal lengths and the children have equal masses. Suppose they decide to reach out and hold hands while swinging: Does that cause the period of their motion to change? *No. Their motions are determined only by the forces exerted on the children by the ropes and by the earth's gravity.*

7. The experiment in #6 tells us that the period of a pendulum *cannot* depend on the mass of its bob. Increasing the mass of a pendulum bob will cause the period to ***remain unchanged.***

8. How much water is there in all of the oceans of the earth?

Water volume = area x average depth.
Area = roughly a few times diameter squared. (For a cube it would be 6 D^2; for a sphere it must be less.) As discussed on page 2b, the earth's diameter is about 8000 miles x 1600 meter/mile = about 10^7 m^2, so its ocean area is probably between 2 x 10^{14} and 5 x 10^{14} m^2.
Average depth of ocean = probably between 1 and 5 km = between 10^3 and 5 x 10^3 m.
SLV of volume = (2 x 10^{14} m^2)(10^3 m) = 2 x 10^{17} m^3.
GLV of volume = (5 x 10^{14} m^2)(5 x 10^3 m) = 25 x 10^{17} m^3.
*Final answer = **"probably between 2 x 10^{17} and 2 x 10^{18} m^3".***