SKILLS NEEDED FOR THE FIRST OCTOBER TEST

1. Add, subtract, multiply, or divide quantities with units, using scientific notation when appropriate.

2. Round off numbers properly (keeping only one bogus digit) as explained on page 14.

3. Use Percentage language:
   a. Increase or decrease a given quantity by a given percentage.
   b. Given the absolute or relative uncertainty of a quantity, express that quantity in range form.
   c. Given a quantity with an absolute uncertainty or given a quantity in range form, calculate its percentage uncertainty as on page 13. (Use #19 on RSI.)

4. Calculate a product or quotient in range form as on pages 4 & 4R. (See #16 on RS I.) Also calculate the MLV and uncertainty of a product by using the shortcut formula discovered on page 14. (You copied it into 16e on RS I.)

5. Use the relation between mass and weight that you recorded in #10 on RSI.

6. Use the known values for the strength of the earth's gravity and the moon's gravity that you recorded in SI units on page 6, on the September Skill Sheet, and on RS I.

7. Use the definitions of "frequency" and "period" (on RS I) as we did on pages 10 - 12.

8. Use the definition of "average speed" (on RS I) as we did on page 15.

9. Given a measured quantity (with it uncertainty expressed in percentage form) and given a counted quantity (with no uncertainty) determine the percent uncertainty of their product or quotient by the shortcut we discovered in #7 on page 11. (See #21 on RS I.)

10. Given a ticker-tape record of a motion, sketch the corresponding speed-time graph as on page 8.

11. Use a ticker-tape and a ruler to determine the initial speed of a motion, the final speed, the change in speed, the average speed, and the acceleration in non-standard units as on pages 8 and 9.

12. Use the coordinates of two points on a linear graph to calculate its slope as on pages 6, 7, 9, 12, and 12R. (You recorded the instructions on the back of RS I.)

13. Use a ticker frequency to convert a change in speed from cm/tk to m/sec or to convert a time interval from ticks into seconds as on pages 12 & 12R.

14. Use the definition of "acceleration" on RS I as we did on pages 9, 12 and 12R.

15. Given the acceleration of a freely-falling object on a strange planet, decide whether that planet's gravity is stronger than the earth's. (Use #13 on RS I.)

16. Solve simple proportion problems as on p. 5, 10, 19, and 20 by using #5 on RSI and #17 on RS II.)

17. Use the plan on page 16 (#22 on RS II) to predict how far an object will fall in a given amount of time or to predict the amount of time for an object to fall a given distance, starting from rest.

18. Given a complete verbal description of an object's motion, sketch the graph of displacement vs time or speed vs time as we did on pages 15-17. Also use such information to determine the object's displacement at any given time and its average speed as we did on page 15.

19. Sketch a graph of speed vs time OR displacement vs time OR displacement vs time *squared* to describe the motion of a freely-falling object, as on pages 9, 12, 13, 15, and 16.

20. Use the pendulum equation recorded in #18 on RS II. You will need the value of the proportionality constant, which you recorded on the graph stapled onto page 18.

21. Given a description of a motion, sketch its displacement-time graph or speed-time graph as on page 15.

First October Test (1999 L-H) **name**____________________

Credit will be given only for answers and units legibly written **IN** the answer spaces.
Credit will be given for correct **units**, even if numerical answers are wrong or missing.
NO credit will be given for numerical answers requiring units if units are missing.
No credit will be given for numerical answers not rounded off properly.

1. Give the MLV of each quantity below, rounded off properly. Keep only one bogus digit. (Use skill 2.)
   a. "8.21564 ± 0.036 m^3"
   b. "3.4567 x 10^3 kg ± 5%"

2. In #1 you were given the mass and volume of a certain spacecraft on the moon.
   a. Calculate its weight (on the moon) in *range* form. (Use skills 5, 6, & 7.)
   b. Divide its mass by its volume to calculate its density. Using scientific notation, give the MLV, units, and percent uncertainty of the quotient. Round off properly.

3. After falling for a certain amount of time a freely-falling rock on an airless planet reaches a speed of 4.592 m/sec.
   a. What speed will it reach if we decrease that falling time by 3%? (skill 16)
   b. Calculate the ratio of the new falling distance to the original one. (sk. 16, 17, & 18)

4. A speed-time graph describing the motion of a freely-falling object on Planet X is a straight line through the origin. The last data point is at 24 ticks, 8.53 cm/tick. All of the speeds on this graph have uncertainties of ± 0.02 cm/tick. The ticker frequency is 56 ± 3 ticks per second. Use skills 8, 10, 11, & 13 to:
   a. Convert the given falling time to seconds. Express it in RANGE form. (Skill 13)
   b. Convert the corresponding change in speed to meters per sec. Give its MLV and unc.
   c. Express the acceleration in SI units, using range form. (skill 14)
   d. How does the gravity on Planet X compare with the gravity here on earth? (stronger, weaker, same) (skill 15)
   e. Give the MLV and *percentage* uncertainty of the falling distance. (sk. 4, 17, 18)

5. A rock is dropped from a bridge into the Connecticut River.
   a. Sketch the rock's displacement vs time graph. (skill 19)
   b. Sketch the rock's displacement vs **time squared** graph. (skill 19)
   c. Give the slope of that graph (5b) in SI units. (Use skills 18 & 19.)
   d. The rock fell for 1.36 seconds. How far did it fall? (Use skill 17.)

6. A child on a rope swing takes 3.1 seconds to swing out over a river and then back to the starting point. (He almost got his feet wet, but then decided not to let go.)
   a. How high is the tree branch that the rope is tied to? *Answer in range form.* (sk. 20)
   b. Calculate the frequency of another swing with a rope only 2/3 as long. (16, 20)

7. A, B, and C are data points on a certain linear graph of spring **Tension vs Length.** Here are their coordinates: A = (10,5), B = (12,15), C = (18,45). The force values (5, 15, and 45 N) have uncertainties of ± 0.5 newton. The lengths (10, 12, and 18 cm.) have uncertainties of ± 0.1 cm. Using any pair of those points, we can easily find the slope of the graph. Use skills 12 & 4 to:
   a. Calculate the MLV, uncertainty, and units of the slope by using points A and C.
   b. Calculate the *uncertainty* of the slope that could be obtained with points A and B.
   c. How long was this spring before it was stretched? (MLV and units only)

8. A car goes westward at 25 mph from noon until 1 PM. For the next half-hour it continues at 55 mph. Then it goes west at 35 mph for two hours.
   a. Sketch its displacement-time graph in the margin below. (skill 21)
   b. Sketch its speed-time graph in the margin below. (skill 21)
   c. Calculate its average speed for the entire trip. (skill 8)

ANSWER SPACES

1a) ____________

1b) ____________

2a) Between
and ____________

2b) ____________

3a) ____________

3b) ____________

4a) ____________

4b) ____________

4c) ____________

4d) ____________

4e) ____________

5a) ____________

5b) ____________

5c) ____________

5d) ____________

6a) ____________

6b) ____________

7a) ____________

7b) ____________

7c) ____________

8c) ____________

First October Test (1999 L-H) Solutions

a. 8.21564 ± 0.036 m^3 *The 3rd digit could be almost anything, so the 4th is worthless:* ***8.21 m^3***

b. 3.4567×10^3 kg $\pm$ 5% *Five percent of 3.4 is 0.17, so the 2nd digit is partly significant:* ***3.45 kg***

2a. Calculate its weight (on the moon) in *range* form. *GLV = (3.4567 kg)(1.05)(9.8/6 N/kg) = 5.928 N*
SLV = (3.4567 kg)(0.95)(9.8/6 N/kg) = 5.364 N *Answer:* ***Between 5.36 and 5.92 N***

b. *MLV of density = (3.4567 kg)/(8.2156 m^3) = 0.421 kg/m^3. Relative unc of vol. = ± 0.036/8.215 = ± 0.43%*
Rel. unc. of quotient = 5% + 0.4% = ± 5.4 % *Answer:* ***0.421 kg/m^3 ± 5.4 %***

3 a. What speed will it reach if we decrease its falling time by 3%? *Falling speed is proportional to falling time, the speed will also decrease by 3%.* *(0.97)(4.592 m/s) =* ***4.454 m/s***

b. Calculate the ratio of the new falling distance to the original one. *Falling distance is proportional to falling time squared, so the distance ratio is the square of the time ratio:* $D_2/D_1 = 0.97^2 =$ ***0.94***

4. A speed-time graph describing the motion of a freely-falling object on Planet X is a straight line through the origin. The last data point is at 24 ticks, 8.53 cm/tick. All of the speeds on this graph have uncertainties of ± 0.02 cm/tick. The ticker frequency is 56 ± 3 ticks per second.

a. Convert the given falling time to seconds, in RANGE form. ***Between 0.407 and 0.453 sec***
GLV of falling time = (24 tk)/(56 -3 tk/sec) = 0.453 sec; SLV = (24 tk)/(56 + 3 tk/s) = 0.407 sec.

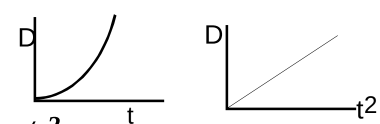
b. Convert the corresponding change in speed to meters per sec. Give its MLV and unc.
MLV of speed = (8.53 cm/tk)(56 tk/sec) = 478 cm/sec; GLV = (8.55)(59) = 504 cm/s
SLV = (8.51)(53) = 451 cm/s; Unc = (504 - 451)/2 = 26 cm/s *Answer:* ***4.78 ± 0.26 m/s***

c. *GLV of acc. = (5.04 m/s)/(0.407 s) = 12.4 m/s^2; SLV = (4.51 m/s)/(0.453 s) = 9.96 m/s^2*
The acceleration of the object is ***between 9.9 and 12.4 m/s^2***

d. How does the gravity on Planet X compare with the gravity here on earth? ***Stronger. (9.9 > 9.8)***

e. *Falling* distance *= area of triangular speed-time graph:*
Height of triangle = 8.53 ± 0.02 cm/tick = 8.53 cm/tick ± 0.023%; *Width = 24 ticks;*
Area of triangle = (8.53 cm/tick ± 0*.023%)(24 ticks)/2 =* ***102.3 cm ± 0.023%***

5. A rock is dropped from a bridge into the Connecticut River.



a. Sketch the rock's displacement vs time graph. (skill 18)

b. Sketch the rock's displacement vs **time squared** graph.

c. *Since* $D = (a/2)t^2$*, the slope in 5b must be* $D/t^2 = a/2 = 9.8/2$ $m/s^2 =$ ***4.9 m/s^2***

d. The rock fell for 1.36 seconds. How far did it fall? $D = at^2/2 = (4.9\ m/s^2)(1.36\ s)^2 =$ ***9.06 m***

6. A child on a rope swing takes 3.1 seconds to swing out over a river and then back.

a. How high is the tree branch? $P = k(L)^{1/2}$ *, so* $L = (P/k)^2 = (3.1/2)^2 =$ ***roughly 2.4 m***

b. Another swing is made with a rope only 2/3 as long. Calculate its frequency.
P_2/P_1 *= Sqr Root of* (L_2/L_1)*, and freq = 1/P, so New Freq =* $(3/2)^{1/2}/3.1$ *s =* ***0.395 sw/sec***

7. A, B, and C are data points on a certain linear graph of spring **Tension vs Length**: A = (10,5), B = (12,15), C = (18,45). The force values (5, 15, and 45 N) have uncertainties of ± 0.5 newton. The lengths (10, 12, and 18 cm.) have uncertainties of ± 0.1 cm.

a. Using A and C, *MLV of slope = "k" = ΔT/ΔL = (45 - 5 N)/(18 - 10 cm) = (40 N)/(8 cm) =* ***5.0 N/cm***.
Unc of ΔT = (2)(± 0.5 N)/(40 N) = ± 2.5%; Unc of ΔL = (2)(± 0.1 cm)/(8 cm) = ± 2.5%.
Uncertainty of slope = ± (*2.5% + 2.5%) =* ± ***5%.***

b. Calculate the *uncertainty* of the slope that could be obtained with points A and B.
Unc of ΔT = (2)(± 0.5 N)/(15 - 5 N) = ± 10%; Unc of ΔL = (2)(± 0.1 cm)/(12 - 10 cm) = ± 10%
Uncertainty of slope = ± (*10% + 10%) =* ± ***20%. (Notice that using points that are four times closer together on the graph results in four times as much uncertainty in the slope.)***

c. How long was this spring before it was stretched? *y = mx + b becomes* $T = k(L - L_o)$*, or* $L_o = L - T/k$.
Plugging in values for point A, L_o *= 10 cm - 5N/(5 N/cm) =* ***9.0 cm***

8. A car goes westward at 25 mph from noon until 1 PM. For the next half-hour it continues at 55 mph. Then it goes west at 35 mph for two hours. a. Sketch its displacement-time graph.

b. Sketch its speed-time graph in the margin below. (skill 21)

c. Calculate its average speed for the entire trip. (skill 21)
Avg Sp = Travel Dist./Travel Time
= (25x1 + 55x0.5 + 35x2 mi)/(1 + 0.5 + 2 hr)
= 122.5 mi/3.5 hr = ***35 mph***