

SKILLS NEEDED FOR THE SECOND OCTOBER TEST (1999 L-H)

1. Add, subtract, multiply, or divide algebraic expressions or quantities with units. Add, subtract, multiply, or divide quantities in scientific notation and round off the results properly, as on p. 14.
2. Convert uncertainties TO OR FROM percentage form as in #18 on RS I, as on page 20, and as on the previous tests.
3. Divide or multiply two numbers which both have uncertainties, giving the MLV, GLV, SLV, or absolute uncertainty of the result as in #16 & 17 on RS I.
4. Given the percentage uncertainties of two numbers, calculate the percentage uncertainty of their product or quotient by using #25 on RS II.
5. Estimate the length, area, or volume of any familiar object in range form, using any familiar units.
6. Use the definitions of "speed" and "acceleration" on page 0, 8, 15, and RS I. Use a ticker-tape and a ruler to determine the speed or acceleration of a motion in non-standard units as on pages 8, 9 & 14. Given a ticker-tape record of a motion, sketch the corresponding speed-time graph as on page 8.
7. Use the definition of "frequency" on RS I. Use a ticker frequency to convert a change in speed from cm/tk to cm/sec., or to convert a time interval from ticks into seconds as on pages 12 & 12R. Also determine the time at which the object had such a speed, as on pages 12R and 23.
8. Use the coordinates of two points on a linear graph to calculate its slope with units, as in #9 on RS I or as on pages 6, 7, 9, 12, 18, and the previous test. (You wrote the instructions on the back of RS I.)
9. Copy any equation from RSI or RSII, solve algebraically for an unknown, and use it to calculate the unknown value by plugging in given numbers with units.
10. Identify the graph of any familiar equation, as on page 16-18 and the back of RS II. Create an equation to describe a given set of data, as on pages 16, 18, and 18R. (Use #17 on RSII.)
11. Use the mass conservation law and the familiar relation between weight and mass in #12 on RS I.
12. Use the definition of "gravitational field strength" on page 6 and on RS I. Use the known strength of the earth's gravity that you recorded in SI units on page 6 and on RS I and on the previous skill sheet.
13. Compare the strengths of two gravitational fields by comparing the accelerations of freely-falling objects in those fields.
14. Sketch a speed-time graph to describe any familiar motion, as on pages 17C and 23.
15. Solve routine motion problems by the method in #8 on RS II. (Use the definition of "acceleration" and use #2 on RS II.)
16. Estimate the period of a pendulum with a given length or the length of a pendulum with a given period by using #18 on RSII.
17. Solve routine proportion problems by the five-step method on the back of RS II.
18. Given a description of the relation between two variables in proportion language, and given the percent change in one of the variables, predict the percent change in the other. (Use 17f on RS II as we did on pages 21, 21b, & 22.)

1. A ticker-tape was used to record the motion of an object. The distance between dot zero and dot two was 1.35 cm. The distance from dot 12 to dot 13 was 12.10 cm. Both distances have uncertainties of roughly 0.03 cm. Use skill 6:
 - a. How fast was the object moving when dot #1 was made? (MLV, uncertainty, and units)
 - b. How fast was it moving near the end of the trip, just before the last dot was made?
 - c. At what time (in ticks from the start) did it have that speed?
 - d. Calculate the object's change in speed in *range* form. (skill 1)
 - e. Calculate the object's average acceleration. Give its uncertainty in *percentage* form.
 - f. If the object had uniform acceleration then we can figure out how far it went. What must we multiply its travelling time by to calculate that distance? (MLV and units only)

2. If we knew the frequency of the ticker in #1 then we could convert the results to SI units. Let "A" represent the percentage uncertainty of the acceleration found in 1e. Let "B" represent the percentage uncertainty of the frequency. Show how the uncertainty of the converted acceleration can be calculated from A and B. *Answer with a formula.* (4)

3. Spaceman Spiff finds that a 6-kg rock on airless planet Zorg weighs about 6.6 pounds. What will happen if he drops the rock to the surface of that alien planet? (skill 13)
 - A. It will take more than 9.8 seconds to fall 1.00 meter.
 - B. It will fall 9.8 meters in 1.0 second.
 - C. It will fall more than 19.6 meters in 2.0 seconds.
 - D. It will fall less than 4.9 meters in 1.0 seconds.
 - E. It will take less than two meters to fall a distance of 19.6 sec.

4. Estimate the volume of the big rock in this room in cubic meters without leaving your seat. Express your answer in the form of a *range*. To be very safe, make your SLV about one third of the correct value and give a GLV that is about three times the correct value. You will get full credit if the correct answer is within your estimated range and if the upper and lower ends of that range differ by no more than a factor of ten. There will be a penalty if either number is off by more than a factor of 100. (skill 5)

5. On page 18 we discovered that the gravitational force exerted on an object by a planet is proportional to the reciprocal of the square of the distance between the object and the planet. Which statement below agrees with that fact? (Use skill 18.)
 - A. Decreasing the distance by 1% causes the force to increase by 1%.
 - B. Increasing the distance by 2% causes the force to decrease by 1%.
 - C. Increasing the distance by 1% causes the force to decrease by 2%.
 - D. Decreasing the distance by 2% causes the force to decrease by 1%.
 - E. Increasing the distance by 1% causes the force to increase by 1%.

6. Some curved graphs are sketched in the answer spaces. Each graph can be described with an equation like $y = kx^n$, but the exponent "n" has a different value for each graph. We cannot determine the numerical values of those exponents precisely from these imperfect sketches. What *can* we conclude about the exponents? In the space beside each graph, write the capital letter corresponding to the best choice. (Use skill 10.)
 - A. The exponent is equal to 1.
 - B. The exponent is greater than 1.
 - C. The exponent is negative.
 - D. The exponent is between 0 and 1.
 - E. The exponent is equal to zero.

7. A block of wood sliding on a level surface has an initial velocity of 1.85 m/sec. It slides 1.64 meter before coming to rest. (We are describing only the *coasting* part of the trip.)
 - a. Sketch the block's velocity-time graph for that part of the trip. Do *not* include the part where the block was propelled by hand. (skill 14)
 - b. Calculate the amount of time it took to stop sliding. (skill 15)
 - c. Calculate the slope of that graph. Do not convert units, but get the *sign* right. (15)
 - d. How far does it move during the first half of that sliding time? (Skill 15)

1a)

1b)

1c)

1d)

1e)

1f)

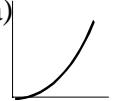
2)

3) (Choose one.)

4)

5)

6a)



6b)



6c)



7a)

7b)

7c)

7d)

Solutions to the Second October Test (1999)

1. The distance between dot zero and dot two was 1.35 cm. The distance from dot 12 to dot 13 was 12.10 cm. Both distances have uncertainties of roughly 0.03 cm. Use skill 6:
 - a. How fast was the object moving when dot #1 was made? (MLV, uncertainty, and units)
 $Initial\ Speed = \Delta dist / \Delta time = (1.35 \pm 0.03\ cm) / 2\ tk = \mathbf{0.675 \pm 0.015\ cm/tk}$
 - b. How fast was it moving near the end of the trip, just before the last dot was made?
 $Final\ Speed = \Delta dist / \Delta time = (12.10 \pm 0.03\ cm) / 1\ tk = \mathbf{12.10 \pm 0.03\ cm/tk}$
 - c. At what time (in ticks from the start) did it have that speed? *The average speed during the last interval is probably equal to the instantaneous speed at some time near the middle of that interval, or at 12.5 ticks.*
 - d. Calculate the object's change in speed in range form. (skill 1) $SLV\ of\ \Delta Sp = 12.07 - 0.69 = 11.38\ cm/tk$.
 $GLV\ of\ \Delta Sp = 12.13 - 0.66 = 11.64\ cm/tk$. Answer: $\Delta Sp = \mathbf{between\ 11.38\ and\ 11.64\ cm/tk}$
 - e. Calculate the object's average acceleration. Give its uncertainty in percentage form.
 $Acc. = \Delta Sp / \Delta t = (11.42 \pm 0.045\ cm/tk) / (12.5 - 1\ tk) = (11.42\ cm/tk \pm 0.4\ %) / (11.5\ tk) = \mathbf{0.993\ cm/tk^2 \pm 0.4\ %}$
 - f. What must we multiply its travelling time by to calculate how far it went? (MLV and units only)
 $Traveling\ Dist = Travel\ Time \times Average\ Speed$.
 $Avg\ Sp = (initial\ sp + final\ sp) / 2 = (0.675 + 12.10\ cm/tk) / 2 = \mathbf{6.39\ cm/tk}$

2. Let "A" represent the percentage uncertainty of the acceleration found in 1e. Let "B" represent the percentage uncertainty of the frequency. Show how the uncertainty of the converted acceleration can be calculated from A and B. *As we found on page 12, converting an acceleration to SI requires us to multiply twice by the ticker frequency; once to convert the ΔSp from cm/tk to cm/sec and again to convert the $1/\Delta t$ from 1/tk to 1/s. Whenever we multiply numbers we must add their percentage uncertainties. The uncertainty of the converted acceleration is then $A + B + B = A + 2B$.*

3. Spiff finds that a 6-kg rock on airless planet Zorg weighs about 6.6 pounds. What will happen if he drops the rock to the surface of that alien planet? (skill 13) *We know that a 6-kg rock on earth weighs more than 6.6 pd. ($6\ kg \times 2.2\ pd/kg = 13.2\ pd$) Therefore the gravity on Zorg is about half as strong as on earth. We also know that falling distance is $at^2/2$, so on earth an object falls 4.9 m in one second and 19.6 m in 2 sec. On Zorg it won't fall so far because the gravity is weaker. The answer is D. (It falls less than 4.9 m in 1.0 s.)*

4. Estimate the volume of the big rock in this room as a range, in cubic meters. *If the rock were made of clay, we could squeeze it down to a box shape roughly 0.2 m by 0.2m by 0.3m. Its volume would then be $0.2 \times 0.2 \times 0.3 =$ roughly $0.01\ m^3$. To be very safe, we make the SLV about one third of that value and the GLV about three times that value: The volume is **probably between 0.003 and $0.03\ m^3$** .*

5. The gravitational force exerted on an object by a planet is proportional to the reciprocal of the square of the distance between the object and the planet. Which statement agrees? *According to skill 18, the percentage change in force is twice the percentage change in distance and has the opposite sign, because the exponent is -2. Therefore choice C is correct. **Increasing the distance by 1% causes the force to decrease by 2%.***

6. Each graph can be described with an equation like $y = kx^n$, but the exponent "n" has a different value for each graph. What can we conclude about the exponents?
*The first graph resembles $y = x^2$ or $y = x^3$, so the answer for 6a is **B (The exponent is greater than 1.)**
 The second graph resembles $y = x^{-1}$ or $y = x^{-2}$, so the answer for 6b is **C (The exponent is negative.)**
 The third graph resembles $y = x^{1/2}$, so the answer for 6c is **D (The exponent is between 0 and 1.)***

7. A block of wood sliding on a level surface has an initial velocity of 1.85 m/sec. It slides 1.64 meter before coming to rest.
 - a. Sketch the block's velocity-time graph for the coasting part of the trip.
 Do not include the part where the block was propelled by hand. (skill 14)
 - b. Calculate the amount of time it took to stop sliding. (skill 15)
 $D = VT/2$, so $T = 2D/V = 2 \times 1.64\ m / 1.85\ m/s = \mathbf{1.77\ sec}$.
 - c. Calculate the slope of that graph. Do not convert units, but get the sign right.
 $A = -V/T = - (1.85\ m/s) / (1.77\ s) = \mathbf{-1.04\ m/s^2}$
 - d. How far does it move during the first half of that sliding time? (Skill 15)
The area under the speed-time graph can be divided into four identical triangles. The first half of the stopping time includes three of them. $(1.64\ m)(3/4) = \mathbf{1.23\ m}$

