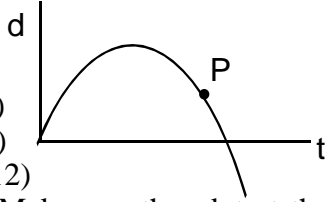


## SKILLS NEEDED FOR THE THIRD OCTOBER TEST (1999, L-H)

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 page 14.
2. Calculate the area of a triangle, trapezoid, rectangle, or circle.
3. Convert changes or uncertainties TO OR FROM percentage form as in #18 on RS I, as on page 20, and as on the previous tests.
4. Add, subtract, divide or multiply two numbers which both have uncertainties. Give the MLV, GLV, SLV, absolute uncertainty, or range of the result, as in #16 on RS I. Use power-of-ten notation when appropriate.
5. Given the percentage uncertainties of two numbers, calculate the percentage uncertainty of their product or quotient by using #25 on RS II.
6. Use the coordinates of two points on a linear graph to calculate its slope with units, as in #7 on RSI or as on pages 6, 7, 9, 12, 18, and the previous test. (You wrote the instructions on the back of RS I.) Decide by visual inspection whether the slope is positive or negative.
7. 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.
8. Solve routine proportion problems by the five-step method on the back of RS II.
9. 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.)
10. Use the definition of "gravitational field strength" on page 6 and on RSI. Use the mass conservation law and the familiar relation between weight and mass in #12 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.
11. Use the definitions of "speed" and "acceleration" on RS I, just as we did on pages 9, 12 and 28.
12. Given a verbal description of an object's motion, sketch the corresponding graph of speed vs time or displacement vs time as we did on pages 15, 15C, 17C, 22, 23, 24, and #10 on RS II. Given a speed-time graph, sketch the corresponding displacement-time graph or vice-versa, as on page 17c.
13. Solve routine motion problems by the method in #13 on RS II. (Use the definition of acceleration and use #2 on RS II.)
14. Draw a line tangent to a given curve at a given point, as on page 29.
15. Solve routine proportion problems by the five-step method on the back of RS II.
16. Sketch a graph to describe any familiar relation that is mentioned on RS I, II, or III.
17. Given a verbal description of a process involving sudden or gradual changes, sketch a graph to describe the process. Identify the sudden and/or gradual changes on such a graph.
18. Compare the masses of two different objects without using gravity, as on page 6R.

1. The motion of a banana falling from a tree on Jungle Planet X is recorded by a video camera. The first part of the recording is lost, but the last part shows that it accelerates from 14.0 m/s to 21.0 m/s while moving 6.30 meters downward.
  - a. Sketch the recorded part of its speed-time graph. (Use skill 12.)
  - b. Using letters only, write an equation relating the given area of that figure to the given speeds and falling time. Solve for the unknown, and *then* write it into the answer space.
  - c. Calculate the unknown falling time. (skill 7)
  - d. Using “ $\Delta t$ ” to represent the falling time and using the other letters that you used in 1b, write a formula to show how you could calculate the banana’s acceleration. (skill 11)
  - e. The mass of the video camera was 2.3 kg. Calculate the gravitational force that it exerts on the Jungle Planet, in SI units. (skill 10)
  
2. A certain spacecraft slows down in an very unusual way: Its speed-time graph is a quarter circle centered at the origin. The radius of the circle is 40 units, so the original speed is 40 m/s and the final speed is 0. That final speed is reached 40 seconds after the start.
  - a. Sketch the speed-time graph in the answer space. (skill 12)
  - b. How far does this craft travel while accelerating? (Use skills 2, 13.)
  - c. At approximately what time did this vehicle have a speed of 24 m/sec?  
*Use a larger, more precise copy of your graph to figure out the answer.* (skills 11, 14)
  - d. Determine the acceleration which the craft must have had 32 sec. after the start. (11)
  - e. Sketch the spacecraft’s displacement-time graph. (skill 12)
  
3. The displacement-time graph for a ball tossed straight up resembles the one sketched at the right, as on page 28.
 
  - a. Draw a line tangent to the curve at point P, using a ruler. (14)
  - b. What sign does the speed have at point “P” on this graph? (6)
  - c. Sketch a velocity-time graph to describe the same motion. (12)  
Make a dot on the time axis corresponding to point “P”. Make another dot at the point where the ball stops going upward. Label those dots “P” and “Q”, respectively.
  - d. Give the numerical value of the slope of the velocity-time graph at point Q, with SI units.
  
4. An object hangs from a vertical string. One second after noon the string breaks for no apparent reason (The string tension suddenly became zero.) The object falls to the floor.
  - a. Describe those events by sketching and labeling graphs of *tension vs time*, *speed vs time*, *displacement vs time*, *acceleration vs time*, and *total force on the object vs time*. (Use the bottom margin of this paper.) Label the string-breaking time ( $T_b$ ) and the impact time ( $T_i$ ) on the time axis of each of the five graphs, and let each one show what was happening just before and just after those times, as well as between them. (skill 17)
  - b. Find two graphs in that set which show *sudden* changes. Label those events with the letter “SC”. Also find two graphs which show a variable changing *gradually*, and label those regions with a “GC” for “gradual change”. (17)
  
5. A rope with a diameter of half an inch is strong enough to lift  $10^3$  pounds.  
A thicker rope is needed to lift  $10^5$  pounds.
  - a. Sketch a graph of rope strength vs thickness. (skill 16)
  - b. If the new rope is made of the same material, how thick must it be? (skill 15)
  
6. A standard slingshot is used to to shoot two pellets straight downward. The slingshot is always pulled back exactly the same distance, but it always gives pellet "A" a greater velocity than pellet "B". Which conclusion is correct? (skill 18)
  - A. The slingshot must have exerted more force on A than on B.
  - B. Gravity must have pulled harder on A than on B.
  - C. The mass of B must be greater than the mass of A.
  - D. The force of the slingshot was more than the force of the pellets.
  - E. The force of A was greater than the mass of B.

ANSWER SPACE!

1a) \_\_\_\_\_

1b) \_\_\_\_\_

1c) \_\_\_\_\_

1d) \_\_\_\_\_

1e) \_\_\_\_\_

2a) \_\_\_\_\_

2b) \_\_\_\_\_

2c) \_\_\_\_\_

2d) \_\_\_\_\_

2e) \_\_\_\_\_

3a) *on diagram*

3b) \_\_\_\_\_

3c) \_\_\_\_\_

3d) \_\_\_\_\_

4a) *use margin*

5a) \_\_\_\_\_

5b) \_\_\_\_\_

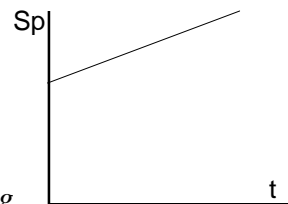
6) \_\_\_\_\_

### Solutions to the Third October Test (L-H, 1999)

1. A falling banana accelerates from 14.0 m/s to 21.0 m/s while moving 6.30 m down.

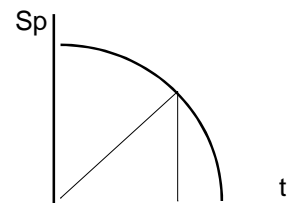
- Sketch the recorded part of its speed-time graph. (Use skill 12.)
- Write an equation relating the given area of that figure to the given speeds and falling time and solve for the unknown. *The area of the trapezoid represents the given falling distance:  $D = \Delta t(S_2 + S_1)/2$ . Solving for " $\Delta t$ ",  $\Delta t = 2D/(S_2 + S_1)$*
- Calculate the unknown falling time. *Using 1b,  $T = 2 \times 6.30 \text{ m} / (21.0 + 14.0 \text{ m/s}) = 0.72 \text{ s}$*
- Show how you could calculate the banana's acceleration. *By definition,  $a = (S_2 - S_1)/\Delta t$*
- The mass of the video camera was 2.3 kg. Calculate the gravitational force that it exerts on the planet. *The gravitational attraction (force) between the camera and the planet is given by  $w = mg$ . The gravitational field strength "g" is equal to the acceleration of the falling object, found in 1d.*

$$w = (2.3 \text{ kg})(21 - 14 \text{ m/s})/0.72 \text{ s} = 22.3 \text{ N}$$



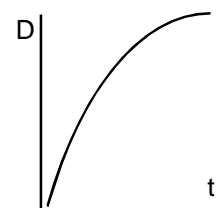
2. A certain speed-time graph is a quarter circle centered at the origin. The radius of the circle is 40 units, so the original speed is 40 m/s and the final speed is 0. That final speed is reached 40 seconds after the start.

- Sketch the speed-time graph. (skill 12)
- How far does this craft travel while accelerating? (Use skills 2, 13.)  
*Distance = area under the graph =  $\pi r^2/4 = 3.14 \times (40 \text{ m/s})(40 \text{ s})/4 = 1250 \text{ m}$*
- At approximately what time did this vehicle have a speed of 24 m/sec?  
*That speed is 3/5 of the initial speed. Drawing a straight line from the origin to that point on the curve and another straight down from that point gives us a 3-4-5 triangle. The base of the triangle is then 4/5 of the hypotenuse.  $(4/5) \times 40 \text{ sec} = 32 \text{ sec}$  after the start.*



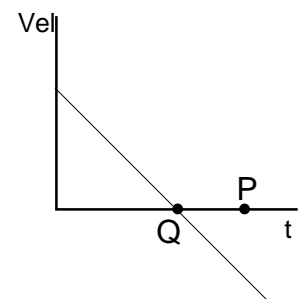
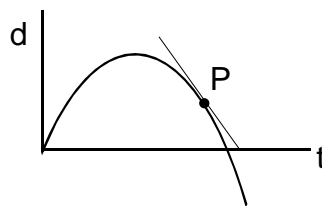
- Determine the acceleration which the craft must have had 32 sec. after the start. (11)  
*Starting at the 32-second point on the time axis, draw a vertical line up to the curve. Another straight line from the intersection point completes a right triangle like the one in 2c. The slope of its hypotenuse is  $24/40 = 0.60$ . But we want the slope of a line tangent to the curve at that intersection point. Since the tangent line must be perpendicular to the radius line, its slope must be the negative reciprocal of that quantity, or roughly  $-1.7 \text{ m/s}^2$ . The answers to 2c & 2d could also be obtained with acceptable accuracy without resorting to geometrical tricks by drawing and measuring.*

- Sketch the spacecraft's displacement-time graph. *The graph must begin at the origin because the craft is at the starting point when the trip begins. It must have a steep positive slope at the start because the speed is great at that time. Then it must level off because the speed becomes zero at  $t = 40 \text{ sec}$ .*



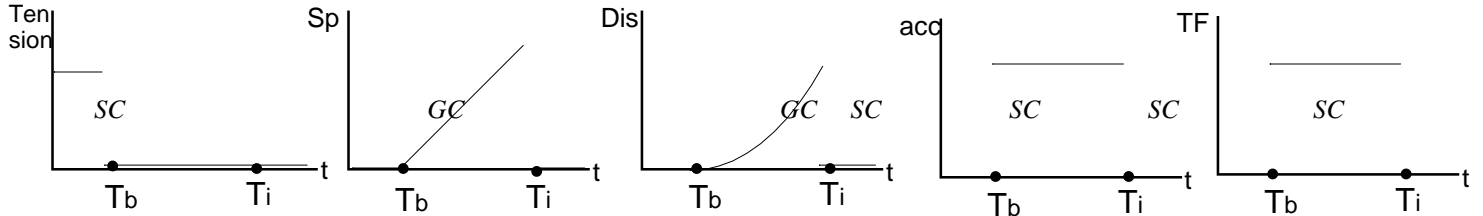
3. The displacement-time graph for a ball tossed straight up resembles the one sketched at the right, as on page 28.

- Draw a line tangent to the curve at point P, using a ruler.
- What sign does the speed have at point "P" on this graph?  
*The speed is the slope of the tangent line, which is **negative**.*
- Sketch a velocity-time graph to describe the same motion. Make a dot on the time axis corresponding to point "P". Make another dot at the point where the ball stops going upward. Label those dots "P" and "Q", respectively.
- Give the numerical value of the slope of the velocity-time graph at point Q.  
*The slope of a v-t graph is called "acceleration". This acceleration is caused by the earth's gravity, so it is  $-9.8 \text{ m/s}^2$ .*



### Solutions to the Third October Test (continued)

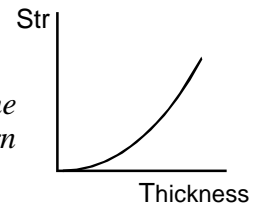
4. An object hangs from a vertical string. One second after noon the string breaks, and the object falls.
- a. Describe those events by sketching and labeling graphs of *tension vs time*, *speed vs time*, *displacement vs time*, *acceleration vs time*, and *total force on the object vs time*. Label the string-breaking time ( $T_b$ ) and the impact time ( $T_i$ ) on the time axis of each of the five graphs, and let each one show what was happening just before and just after those times, as well as between them. (skill 17)



- b. Find two graphs in that set which show *sudden* changes. Label those events with the letter “SC”. Also find two graphs which show a variable changing *gradually*, and label those regions with a “GC” for “gradual change”. (17)

5. A rope with a diameter of half an inch is strong enough to lift  $10^3$  pounds.  
A thicker rope is needed to lift  $10^5$  pounds.

- a. Sketch a graph of rope strength vs thickness. *Rope strength is proportional to the number of fibers in the rope, which is proportional to its cross-sectional area, which in turn is proportional to the square of the radius or diameter.* (skill 16)



- b. If the new rope is made of the same material, how thick must it be? (skill 15)  $(S_2/S_1) = (T_2/T_1)^2$ , so  

$$T_2 = T_1(S_2/S_1)^{1/2} = (0.5 \text{ in})(10^5/10^3)^{1/2} = \mathbf{5 \text{ inches.}}$$

6. A standard slingshot is used to shoot two pellets straight downward. The slingshot is always pulled back exactly the same distance, but it always gives pellet "A" a greater velocity than pellet "B". Which conclusion is correct? (skill 18)

- A. The slingshot must have exerted more force on A than on B.

*This can't be correct. The force is always the same if the rubber band is always stretched the same amount.*

- B. Gravity must have pulled harder on A than on B.

*This could be true only if A had more mass than B.*

*But that would make it harder to accelerate A, so A would leave the slingshot with the smaller speed.*

- C. The mass of B must be greater than the mass of A.

*This could be correct, since a greater mass will have less acceleration when the propelling forces are equal.*

- D. The force of the slingshot was more than the force of the pellets.

*This is meaningless. Force is not a property of an object.*

*Force can only be exerted on one object by another.*

- E. The force of A was greater than the mass of B.

*Also meaningless.*