1. In Chapter I you discovered that a freely-falling object near the surface of the earth has an especially simple kind of motion. In 7c on page 9 we called it "**___________ acceleration.**" (Copy from RS II.)
   a. If the object is released *from rest*, then its speed-time graph is a ________ line through the _______.
   b. Sketch that speed-time graph in the margin at the right.
   c. Using letters, (not numbers) write an equation describing that graph. **S** = _____ (See page 9 or 13.)
   d. Define each letter in the equation.
   e. In that equation the letters ___ and ___ represent variables, and ___ represents a constant.
   f. Give the numerical value of the constant in SI units. (See #15 on RS I.) ______ ____

2. Someday you will be given a time interval in seconds. You will be asked to calculate how *far* an object will fall during that amount of time, starting from rest. Today we are going to create a *plan* for answering a question like that one. Our plan will resemble an equation:
   a. It will begin with the letter "__", representing "displacement", or distance from the ________.
   b. The right side will involve the constant "__" (mentioned in 1e) and the given variable, "__".
   c. To discover that equation you are going to use the fact that a travelling distance is equivalent to the corresponding _______ under the speed-time graph. (See 4f on page 15 or #2 on RS II.)
   d. Put your pencil at some point to the right of the origin on the time axis of the speed-time graph that you sketched for 1b. That point represents the "certain time" that I am going to give you someday, represented in 2b by the letter "___". *Label* that point accordingly.
   e. Starting at that point, draw a vertical line up to the diagonal graph line. The length of that vertical line segment represents the _______ of the falling object at the given time. We could use a letter to represent that speed, but that would not be consistent with the plan that we made in 2b. Instead, we will use the *formula* for its length that you wrote in 1c: **Speed =** ____.
   f. Shade in the area on the graph which represents the falling distance. What shape is it? _______
   g. In geometry how do we find the area of a figure with that shape? **Area =** ________
   h. In 2b we decided to use the letter ___ to represent the *width* of the shaded region.
   In 2e we decided to use the two-letter formula ____ to represent its *height*.
   i. Using 2a and 2h to rewrite 2g, we obtain the falling-distance equation: ____ = _______
   (Please express it in simplest form, using no letter more than once. *Save a copy* in #6 on RS II.)
   j. Equation 2i describes a graph of __________ vs _____. -Does it agree with 2a and 2b? ___

3. Equation 2i describes a graph which you have already seen, if you finished page 15.
   The equation $\mathbf{y = x^2}$ has a similar shape. We call that kind of curve a "parabola"
   a. Sketch and label that parabolic graph in the margin at the right.
   b. Certain other familiar equations have graphs which resemble this parabolic shape, at least in the first quadrant. *Circle* those equations: $\mathbf{y = mx + b}$ $\mathbf{y = x^3}$ $\mathbf{y = 1/x}$ $\mathbf{y = x^4}$ $\mathbf{y = 1/x^2}$
   c. On the back of this paper (or on another sheet) make sketches of the shapes described by the five equations in that list. (You may use a graphing calculator.) Please show *more than one quadrant* in each sketch, and choose scales to make the heights and widths of the figures roughly equal.
   *We **don't** want a graph that is long and narrow, because that makes its shape hard to see.*
   d. Copy your sketches (with their equations) onto the back of RS II. Label them clearly.

4. Let's create an equation describing a freely-falling object's distance-time graph on page 15:
   a. First notice that the displacement-time graph resembles a "parabola". (**y =** ___)
   b. Because of that resemblance, you guess that displacement ***may*** be ________al to _______ ***squared.***
   c. If so, a graph of displacement vs _________ ________ will be a straight line through the _________.
   d. To test that guess, you must make that graph: Find the falling kilogram's **displacement - time** data table. Make a new column beside the "time" column. Write **"time squared"** in the column heading.
   e. Squaring is multiplication. Therefore if the time values are expressed in "ticks", the units in this new column heading must be "________ ________". (See #1 on RS I.) Write that unit (with a preposition) into the new column heading. Fill in the new column by squaring each number in your "time" column. Using the "displacement" and the "time squared" columns, make a graph of displacement vs time *squared*. *Please use graph paper and follow the instructions on page 7.*
   f. Calculate the slope of that new graph, in range form, with units. Save a copy on the back of RS II.

1. It's easy to create an equation describing a linear graph. It's especially easy if the line begins at the origin. For practice, use the descriptions in the examples below to create equations:
   a. If the title of a graph is "**Y vs X**" and its slope is 3, the equation must be **Y =** _____.
   b. If the title is "**Distance vs Time**" and the slope is represented by "V", then **d =** _____.
   (This equation describes motion with a constant ____________.)
   c. Suppose the title is "**Tension vs Amount of Stretch**" (**T vs. X**) and the slope ("K") is 2.5 newton/cm. *Using those letters,* **T =** ____ -Does #11 on RS I agree? ___ Do the units balance?

2. On page 16 you made a graph of "Displacement vs. Time Squared", or "D vs. t^2."
   a. From the shape of that graph we conclude that _____________ is *proportional* to ______ ________.
   b. You found that the slope ("K") was *roughly* _____ cm/tick^2. (Naturally, you saved a copy.)
   c. Using the given letters, the equation describing that linear graph must be: **D =** ______.
   d. In #10 on page 9 and also on RS I you recorded the acceleration of the falling object as measured *with a ticker*: **a =** _____ _____. (Give the numerical value of its MLV, with units.)
   e. The textbook says that acceleration is about ____ ____ in SI units. (Recorded in # __ on RS I)
   f. The "K" value in 2b is roughly ____ times the acceleration in 2d.
   g. Use that fact to replace the "K" in equation 2c with an expression involving "a": **D =** _____.
   h. Does 2g agree with #6 on RS II?____ -The constant "K" in 2c is about _____ cm/tick^2.
   i. Using SI units with #6 on RS II & 2ef above, the slope of the linear graph in 2b must be ______ ___.

3. On page 15 you sketched a speed-time graph describing the motion of a car with constant speed. (It was a horizontal line.) By "integration" you transformed it into a displacement-time graph which was a _______ line through the _______. Please *illustrate* that transformation with small labeled sketches.

4. On page 9 you made a speed-time graph describing the motion of a freely-falling object. It was a ________ line through the origin. On page 15 you transformed it (by integration) into a displacement-time graph with a ________ shape. Please illustrate *that* transformation with clearly-labeled sketches.

5. Drop a rock from a window. Time its fall with a stopwatch. Use the plan in #2 on page 16 to calculate how high the window is. (The plan is reviewed above and is recorded in #6 on RS II.) *Show how you get your answer. Explain your uncertainty estimate. Do not keep more than one bogus digit.*

6. A major-league ballplayer can throw a baseball straight up to a height of 30 meters and catch it when it returns. Use the steps below to determine its total flight time, assuming that gravity is the only significant force acting on it after release:
   a. Solve the distance equation (from 2g or 5) algebraically for "t": **t =** ______
   b. Insert the given height (_____m) and the known acceleration value (___ ____). Then do the indicated arithmetic to discover how much time it spends falling back down: **t =** ______ ____
   c. Using your personal experience, make a decision about the amount of time the ball spends going *upward*: (Is it more time, less time, or the same as the amount of time found in 6b?) ____
   d. The total amount of time in the air must be roughly _____ ____

7. Suppose you are investigating the relationship between two variables called "A" and "B". You find that the graph of B vs. A *resembles* the graph of $y = x^3$. Which conclusion is best? _____
   (a) "B is equal to A cubed."
   (b) "A is equal to B cubed."
   (c) "B is proportional to A cubed."
   (d) "A is proportional to B cubed."
   (e) "B *may* be proportional to A cubed."
   (f) "A *may* be proportional to B cubed."

8. Suppose "A" is in *kilograms* in #7, and "B" is in *inches*. Which of the six choices above can be ruled out immediately because of those clues? *If #7 contradicts #8 you will earn credit for neither answer.*

9. What graph would you make to find out if the guess that you made in #7 is correct? Give its title and show (with a sketch) what you would expect it to look like. Remember to label the axes. (See # 2.)