1. Select a cylindrical object like a soup can. Give it a short, quick push across a level surface and watch it slide to a stop. Practice making it coast more than half a meter. Sketch a force vs time graph.

2. Imagine recording the motion of that object, *starting from rest*: Sketch a *possible* speed-time graph describing the object's motion. Label the "pushing" and "coasting" sections on your sketched graph and mark the boundary between them. Use the hints and clues below:
   a. Do you expect everyone to push exactly the same way during the first part of the trip?____
   b. The coasting part of the trip begins at the moment when you release the object. Did you continue pushing after release? _____ -Did you *stop* pushing on the object at the moment of release? ____
   c. After release the object's speed gradually ___creases, as on p. 0. What causes that change? ______
   d. Does that force affect everybody's sliding objects in pretty much the same way? ____
   e. Do you expect the coasting parts of all the speed-time graphs to have similar shapes? ____
   f. Do you already know what that shape must be? ____ If so, *describe* it and *explain* how you know.

3. Sketch a ticker-tape with 10 to 20 dots on it showing the pattern that you expect to see in #2. Number the dots, beginning with dot number zero, as you did on pages 8 & 15.
   a. Displacement is *not* the same thing as speed. (See RS II.) To determine the object's displacement at the time when dot *five* was made, you would measure the distance from dot number __ to dot ___.
   b. The *time* when the object had that displacement was " ___ ticks after the start".
   c. Use the dots in 3a to sketch a rough graph of displacement vs time. (Use pages 15R & 17.)
   d. Mark and label the point on the *time* axis representing the time when you stopped pushing.
   e. Label the pushing and coasting distances as *segments* on the D axis of your graph.

4. Suppose you measured the "change in displacement" from dot 5 to dot 7 on your tape:
   a. To calculate how fast the object was moving during that part of the trip you could _________ that change in displacement by the duration of that short ______ _______, which was ___ ticks.
   b. The process in 4a is equivalent to calculating the _____ of a segment on the displacement-time graph (length, slope, area) because speed is the ______ of a ____________-time graph. (See #3 on RS II.)
   c. The *time* when the object's speed was equal to the one in 4a was roughly ___ ticks after the start.
   d. We do not know the exact shape of the graph in #2, but we do know that the speed __creased from ___cm/tick during the first part of the trip, when the object was pushed by hand. Do #2 & 3 agree?__
   e. We also know that during the *second* part of the trip (when the object was coasting) its speed gradually __creased to a final value of __cm/tick. (See #1.) Does graph in #2 agree with 4e? ___

5. After your answers to 2 - 4 have been checked, you may record the motion of the sliding object and find out what the speed-time graph really looks like. The object must coast at least half a meter *after* you stop pushing it, and it must coast to a stop *before* the recording process ends.
   a. When a satisfactory speed-time graph has been produced, sketch it carefully. Then hit ENTER.
   b. Using the cursor, obtain the coordinates of a point near the beginning of the coasting part, and another near the end. *Record them clearly, with units. Ask for help if necessary.*
   c. ***Show*** how the slope of the coasting part is calculated from those coordinates. Don't forget the units.
   d. Instruct the computer to calculate the slope of that part of your graph. See if you get the same result.

6. Decide if the displacement-time graph that you sketched in 3c needs to be modified. Make whatever corrections seem necessary. Then instruct the computer to plot the real displacement-time graph describing the motion of your object. (Use ESC to remove the cursor, hit F2, F4, ENTER.)

7. Copy the computer version of the displacement-time graph carefully. Compare it with your sketch. Describe any difference that you see and explain them clearly. Label the points corresponding to the ones in 5b. Obtain the coordinates of those points by using the cursor and record them beside your sketched graph, as you did in #5. Don't forget the units. Don't contradict #5.

8. Subtract the two recorded time values to determine a skidding time. Then show how the two speeds recorded in #5 and the skidding time are used to calculate the skidding distance. (Use #2 on RS II.)

9. Show how the skidding distance is calculated from the two "D" values recorded by the sketch in #7. Compare it with the one calculated in #8. If they don't agree, find out why and explain.

1. Sketch a speed-time graph describing the motion of an object coasting to a stop on a level surface.
   a. Is the *coasting* part of the graph a straight line? ____ -Is it a curved line? ____
   b. If the object is coasting *away* from the sonic ranger then the slope of the graph is _____tive.
   c. Did that slope change during the time when the object was coasting? ___ -Does 1a agree?__
   d. What *name* did we give to the slope of a speed-time graph? (Copy from RS I.) _______________

2. On page 0 most people said that a force called "_________" causes the object's speed to decrease when it is coasting on a level surface. With what instrument would you *measure* such a force? _______ _____
   a. Imagine repeating the coasting experiment on smooth ice instead of smooth counter-tops: Will the object slow down more quickly? ___ -more gradually? ___ -at exactly the same rate? ____
   b. Illustrate your answer to 2a by sketching and labeling the coasting parts of two speed-time graphs.

3. Imagine a hockey puck coasting on a large frozen puddle in a parking lot. It is moving pretty quickly when it reaches the edge of the ice, so it slides some distance on the dry pavement before stopping. In the space at the right sketch a speed-time graph describing its motion. Label the point where it crosses the boundary between the low-friction region and the high-friction region.

4. Whenever the friction force on a coasting object is small, the speed-time graph has a _____ negative slope. (great, small) Whenever the friction force is great, the ________ of the _______-______ graph is _______. *Do 2 & 3 agree?* __ In 1d that slope was called the object's "__________tion".

5. In # 1 you sketched the speed-time graph which you made for the coasting experiment on page 23: If the object is coasting away from a sonic ranger on a uniform level surface (as in #1) then its speed-time graph is a ________ line _______ the origin with _________ slope. (Straight or curved? -Above, through, or below the origin? -Positive, negative, or zero slope?)
   a. Did the acceleration of the coasting object change as it slowed down, as in #3? ____
   b. Does 5a agree with 1a and 1c? ___ In #2 we said that acceleration was caused by ________ .
   c. We must conclude that the friction force _____________________ when the coasting speed decreases. (increases, decreases, remains unchanged) -Does 5c contradict 5a? ___
   d. In other words, friction __________ depend on sliding speed. (does, does not)
   e. A copy of this conclusion is being saved in #___ on RS __.

6. Now let's create an equation describing that graph. Let "__" represent the object's initial speed, let "__" represent its speed at any later time, let "__" represent that time, and let "___" represent the acceleration.
   a. Please write the correct *sign* in front of that acceleration symbol to make it agree with 1b and #4.
   b. Algebra students are taught to describe a linear graph with the equation **"y = mx + b"**.
   c. We just decided to use the letter ___ instead of "y", to use ___ instead of "x", ___ instead of "m", and ___ instead of "b". (Don't forget the *sign* mentioned in 5a!)
   d. Write the revised equation here, placing the negative term *last*: __ = _____ - _____

7. Example: Imagine a car being driven at 56 mph, or 25 m/s. The driver sees a stuffed animal in the road and slams on the brakes. While the car is skidding its acceleration is -7.8 m/sec^2.
   a. Sketch the car's speed-time graph and write its equation as you did in 5 & 6d.
   b. Show how that equation is used to determine the speed of the car after 2.0 seconds of skidding.
   c. Mark the 2-second point on the time axis of your sketched graph. Then use #2 on RS II to figure out *how far* the car skids during those 2 seconds. *Remember to show how your results are obtained.*
   d. Make a dotted line on your graph to describe the motion of an identical car which was moving at only 40 mph when the brakes were applied. (This car also skids for more than two seconds.)
   * e. Are the two skidding distances equal during the first 2 sec. of skidding? (Explain, using #2 on RS II.)

8. Imagine sitting on the waxed and polished roof of a car which suddenly accelerates forward.
   a. Will you accelerate with the car, or will you be left behind? __________
   To find out, yank a sheet of paper from under a small object on a smooth, level surface.
   b. If you are left behind, you hit the ground and slide in the _____ward direction.

9. You don't cause potatoes to grow by "making them get bigger", nor do you cause an object to accelerate by "making it go faster". To cause an object to accelerate you must ______ the object.