

1. We are familiar with two kinds of potential energy. Their names are both in print on RS VI.
If you mention any other kind of energy on this page, please remember to define it clearly.
 - a. Whenever an object is lifted in a gravitational field, it gains "_____ potential energy".
 - b. Whenever an elastic object is stretched or compressed, it gains "elastic _____ energy".
2. Imagine slowly lifting an object with mass "m" from the floor to an altitude "h":
 - a. Copy (from #12 on RS I OR from #8 on RS III) the formula which predicts the required force: _____
 - b. Using those symbols, create a formula for the *work done on the object*: **Work #1** = _____
 - c. Use the same symbols to write a formula for the work which the object is capable of doing *on you* as it pushes your hand back down to the floor. **Work #2** = _____
 - d. If two vectors both point downward then their product must be _____ tive. *Does 2c agree?* _____
 - e. Work #2 must be _____ tive because the force and the displacement in 2d have _____ signs.
 - f. "Potential energy" is energy that is stored and retrievable but which does not involve motion.
 In 2c we created a formula for gravitational _____ energy in terms of m, h, and the constant "____", which represents _____. *Does this contradict 1a?* _____
 - g. A copy of that formula has been saved in #____ on RS____. Do these formulas give correct units? _____
 - h. If the meanings of the symbols in that equation have also been recorded, check here: _____
 - i. To *test* that equation we would measure _____, _____, _____, and _____.
3. Experiment: Hook a small spring over the end of a stick. Holding the stick vertically, pull the other end of the spring down and release it so that the spring flies upward.
 - a. According to 1b, when you stretch the spring you are giving it _____ energy.
 - b. When the spring has *finished* going upward, virtually all of that energy has been transformed into a _____ tive amount of _____ energy. *Check here _____ when you have re-read #1.*
 - c. Do it several times with different amounts of stretch, *including zero*. Make a data table and a graph of jumping height vs amount of stretch, with one dot for each successful shot, *including repetitions*.
 - d. Record the spring's unstretched length on that graph. *Show your teacher the graph before leaving.*
 - e. This graph must begin _____ the origin. (at, above, below, beside)
 - f. Is the spring's elastic potential energy directly proportional to its amount of stretch? _____
 - * g. If not, use your data to make some other conclusion about the relation between *elastic potential energy* and *amount of stretch*. (Use 3b.) Give evidence in the form of a *linear* graph, as on pages 16R & 17. The slope is not needed. *Write your conclusion as a sentence on the new linear graph.*
 - h. You will need conclusion 3g when you begin page 62. A copy is being saved in #____ on RS ____.
4. Calculating the work required to stretch a spring or a rubber band is not as simple as some people think because the force does not remain constant during the stretching process. We need to invent a special trick to overcome this problem. (Have you already guessed it? _____)
 - a. Sketch a rubber band's tension vs length graph. (Copy it from RS II or from #1 on page 33.)
 - b. Let "x" represent a typical length value intermediate between the unstretched length and the maximum stretched length. Label that point on the L-axis of the graph.
 - c. Let "F(x)" represent the force corresponding to that length. Draw a line on the graph upward from point "x" to the curve and label its length "F(x)".
 - d. Let "dx" represent a *very small change in length*. Suppose the length is increased a tiny bit, changing its value from x to x + dx. Draw a new line similar to 4c to represent the new force.
 - e. Is the new force significantly stronger than the old force? _____ -Are they nearly equal? _____
 - f. The bit of work done in stretching the spring over that small range can be calculated *from F(x) and dx* by using the definition of work: **dW** = _____
 - g. Geometrically, this work represents the _____ of the thin strip above "dx" on the graph.
 - h. **GENERAL CONCLUSION:** The total work done on an elastic device in stretching it from length #1 to length #2 is the _____ under its Tension vs. _____ graph between L₁ and L₂. *Please illustrate.*
5. That conclusion (about how work can be computed from a graph) reminds us of the "new improved definition of impulse" that we invented on page 54. You reviewed it on page 54b and in #12 on RS V.
 - a. "Impulse" is area on a force vs. _____ graph. "Work" is area on a force vs. _____ graph.
 - b. Those two definitions are recorded on RS _____ and RS _____. Will you ever confuse them? _____
 - c. The improved definition of work also reminds us of the process by which Δ displacement can be determined from a speed-time graph. The *name* of that operation is _____ (Copy from RS II.)
 - d. According to #4, this new definition of "work" is necessary only if the _____ is not _____.

1. To put your data into the calculator: Hit the STAT key, then ENTER to get into “edit” mode, so that you can see a data table. (If you need to clear old data out of the “L1” column, move the cursor to the column heading, hit CLEAR, then ENTER. Do the same for the L2 column if necessary.)
 - a. Type your *amounts of stretch* into the L1 column.
 - b. Put the corresponding *jumping heights* into the L2 column of the data table.
2. To prevent old equations from being graphed on-screen: Hit the Y = key. If you see any equations listed on the screen with their “equal” signs highlighted then you must remove them with the CLEAR key *or* switch them off (so their graphs won’t be displayed) by putting the cursor on the = sign and hitting ENTER. (An equation’s graph will be displayed only if the = sign is highlighted.)
3. To select the type of graph you wish to display:
 - a. Hit 2ND, STATPLOT, ENTER.
 - b. Select “ON”, and hit ENTER to switch on “plot #1” so it will be displayed.
 - c. Select either the first or second type of graph, hit ENTER again.
 - d. Select L1 for the X-LIST, so that the spring’s *amount of stretch* will be on the *horizontal* axis.
 - e. Select L2 for the Y-LIST, so that the spring’s *jumping height* will be on the *vertical* axis.
4. To choose appropriate scales for your graph:
 - a. Hit the ZOOM key, and select choice 9 (zoom stat) to scale the graph automatically. Then ENTER.
 - b. Then hit the WINDOW key. Change the XMIN and YMIN values to zero, so the origin will be visible on your graph. To see your graph displayed on the screen, hit the GRAPH key.
5. You should be familiar with a simple equation which has a similar graph.
Let’s draw the graph of that equation onto the screen to see how well it fits your data points:
 - a. Hit the Y= key. Enter the equation that you had in mind. Then hit the GRAPH key.
 - b. Hit the Y= key again and alter your equation in some way. (Try to make it fit a little better.)
 - c. When you get tired of this game, copy your best-fitting equation onto paper.
Then delete it from the “Y=” screen or switch it off, as in #2 above.
6. If you suspect that the jumping height may be proportional to the amount of stretch with some exponent and you want to find out if you guessed that exponent correctly, then you need to make a new graph of height vs. stretch *with that exponent*, hoping to see a _____ line through the _____.
 - a. First you need a new column on your data table: Hit STAT, select EDIT, and hit ENTER as in 1a.
The amounts of stretch are still recorded in the ___ column.
 - b. We want to put the _____s of those amounts into the L3 column. To do so, move the cursor to the L3 column heading. You will see “L3 = ” at the bottom of the screen. Finish that equation by inserting the symbol L1 with the exponent that you had in mind. Hit 2ND, then hit the “1” key to make the L1. Then hit the exponent key, which is labelled with a carat. (It’s below the CLEAR key.) Then enter the exponent that you wanted to try. (If it’s a fraction then use decimal form.) Then hit ENTER.
7. To see the new graph of jumping height vs stretch *with the chosen exponent*:
 - a. Hit the 2ND key, and then the Y= key to go to the STATPLOT screen, as in 3a.
 - b. Hit ENTER to get the PLOT 1 screen. Select OFF, so we won’t see the L2 vs L1 graph again.
 - c. Repeat step 7a, select PLOT 2, Turn Plot2 ON by highlighting that word and hitting ENTER.
 - d. Select L3 for the X-LIST, and L2 for the Y-LIST. (Hit ENTER after each choice.) That tells the calculator to plot L2 vs. L3, or _____ vs. _____.
 - e. Hit the GRAPH key to see the graph. Hit WINDOW and adjust the X-MAX value, then GRAPH.
8. If the pattern appears to be linear, we can draw two reasonably good straight lines on the graph:
 - a. Hit Y=. Enter a linear equation with a numerical coefficient.
 - b. Hit GRAPH to see how well it fits your data. Hit Y= again. Adjust the value of your constant.
 - d. By trial and error make two straight lines from the origin so that *most* data points are between them.
 - e. Write a conclusion describing how GPE depends on the amount of stretch.
9. If your calculator has the program called A12PLOT, try running it. Select the type of equation called “power”. See how well the result agrees with the conclusion that you wrote in 8e. Also try putting the x^2 values into L1 and running the program again. This time select “linear”.

