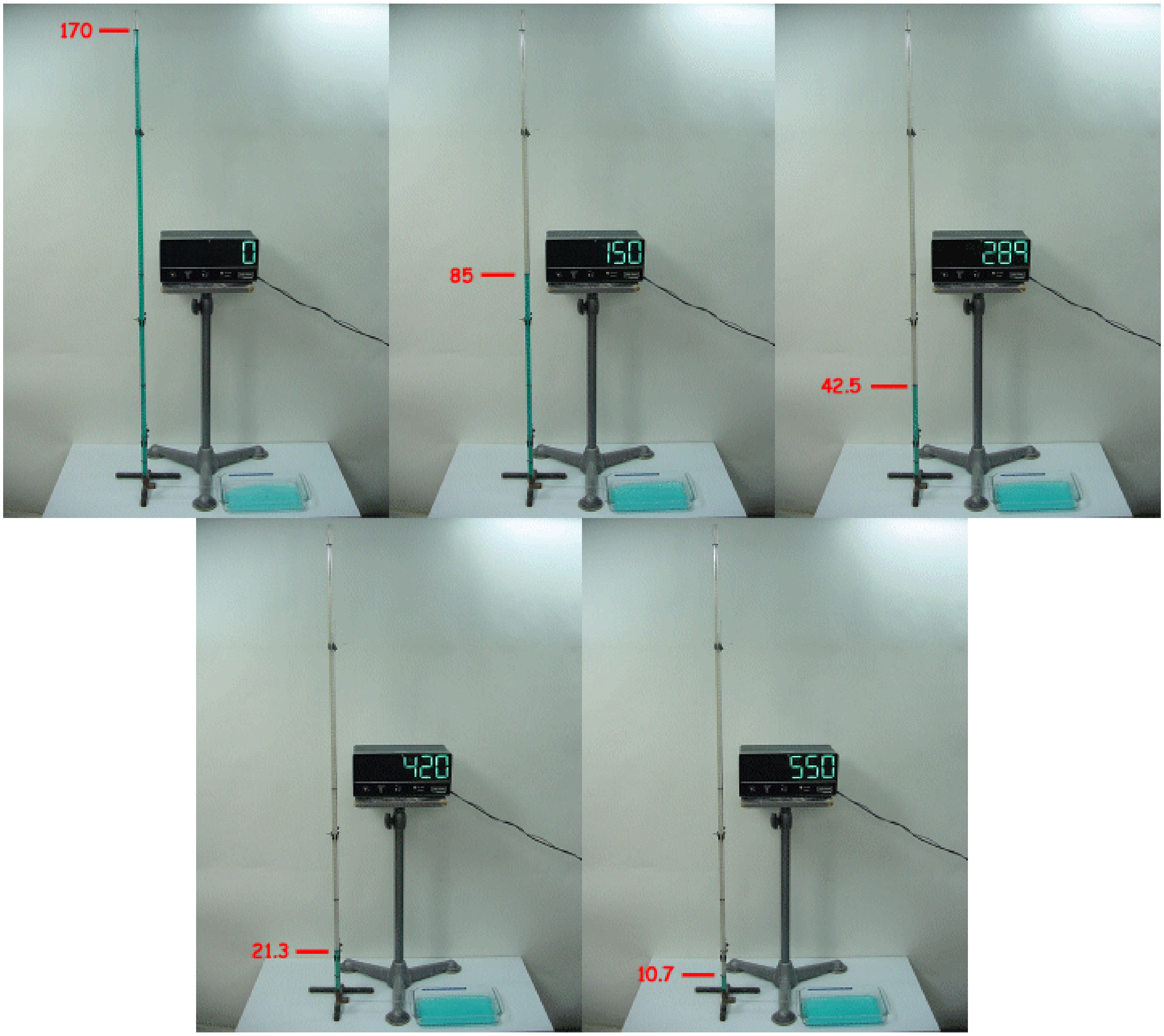
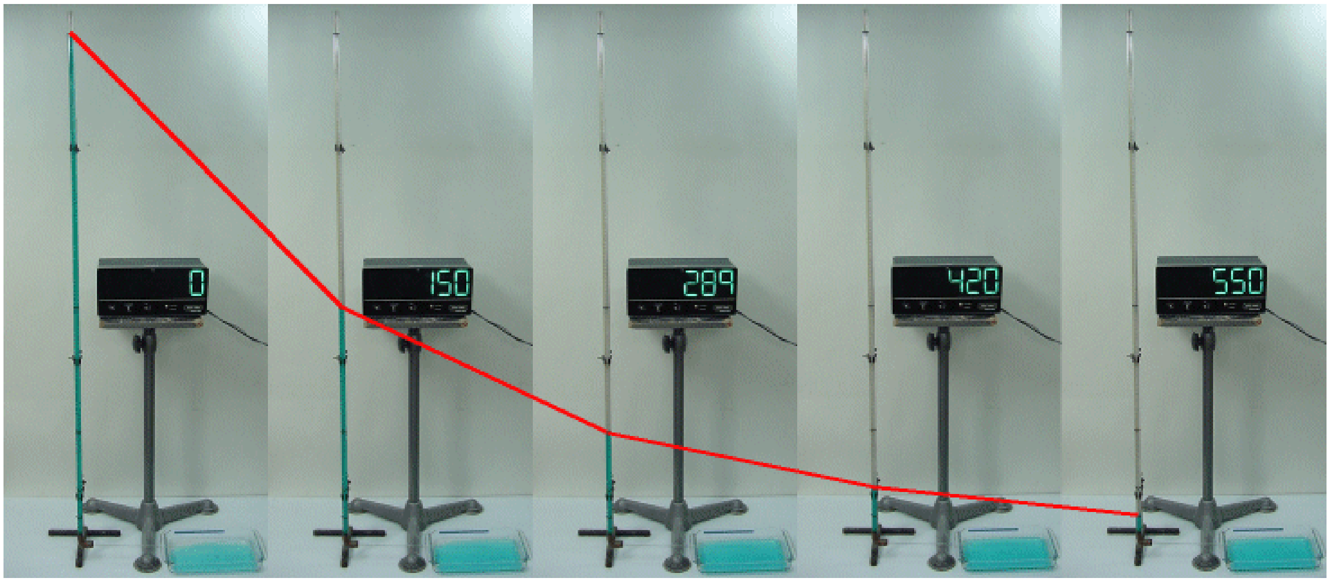
Answer #195

The answer is (d): about half of the remaining water will be gone after an additional 150 seconds. In fact, after additional time intervals of about 150 seconds, the amount of water in the vertical tube is reduced by half, as seen in the sequence of photographs below.



Well, actually it is not quite that simple, but is approximately correct: the first half life is 150 sec, the second 140 sec, the third 130 seconds, and the fourth 130 seconds. So the average half-life for this experiment is about 140 seconds.

This is an example of exponential decay, as can be seen in the composite of these photographs shown below. Note that the curve joining each of the water surface positions is a lot like an exponential decay graph.



This is a water model of the decay of a radioactive material, in which after each "half-life" unit of time one half of the nuclei decay. Thus, if there is one unit of material (radioactive nuclei or water in the tube) at time t=0, then after one unit of time 1/2 of the material is left, after 2 units of time 1/2 of 1/2, or 1/4 of the material is left, after 3 time units 1/8 of the material is left, after 4 units of time 1/16 of the material is left, and so on.

It turns out that the mathematics for both of these cases is very nearly identical: the only assumption that must be made is that, in the case of the water tube, the rate at which the water flows out is proportional to the amount in the tube (which is proportional to the pressure), or in the case of radioactive nuclei, the number of decays is proportional to the number of radioactive nuclei in the sample at any given time. This basic assumption leads to the process of exponential decay and the concept of half-life.

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