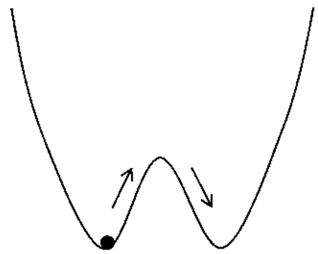
Answer (third part)

The key difficulty here is that, in writing the answer into a memory, we have to be able to write our answer (e.g., a logic one) into the memory *regardless of the current state of the memory*, and we have to make a mechanism that does that. (One might think that one could just measure the current state of the memory, and hence make a contingent mechanism that does different operations depending on the current state of the memory, but that merely postpones the problem. Our contingent mechanism would have to have a one bit memory in it to write down the answer to the measurement, and we would have to write down that answer independent of the current state of that memory, and so on.)

So, imagine that our memory element is in the form of a potential with two minima in it, and we have a ball that sits in one minimum or the other to represent either a logic zero (left minimum) or a logic one (right minimum).



Our proposed "set to logic one" mechanism is then one that simply pushes the ball to the right with sufficient pushing that it will push the ball over the top of the local maximum (the "hill") if it happens to be on the left. (Equivalently, we could temporarily lift the potential of the left well sufficiently that the ball will then roll gently into the right hand well, and then we reset the potential to its original form.) But this will not actually work yet, because the ball will simply then oscillate backwards and forwards between the wells because it now has enough energy to do so. To stop it oscillating, we need to introduce friction, such as immersing the entire apparatus in a viscous fluid, and it is in that addition that we introduce the dissipation to the system. To have the system settle into a specific state independent of its starting state, we need to introduce something irreversible, in this case the damping fluid.

Similarly, in a memory based on voltage stored on a capacitor, applying a voltage pulse through a wire will lead to oscillation from the combination of the capacitance together with the inductance of the wire unless there is resistance in the wire to damp out the oscillation.

A classic reference on the topics discussed in this question is

R. Landauer, "Dissipation and heat generation in the computing process," IBM J. Research and Development **5**, 183 – 191 (1961)

Subsequent discussions include

C. H. Bennett, "The thermodynamics of computation – a review," International Journal of Theoretical Physics **21**, 905 – 940 (1982)

C. H. Bennett, "Notes on Landauer's principle, reversible computation, and Maxwell's Demon," Studies in History and Philosophy of Modern Physics **34**, 501-510 (2003)