

5.1: Zero of Energy is Arbitrary

The normal definition of a potential energy is somewhat arbitrary. Consider where a potential comes from: It appears when the total energy (potential plus kinetic) is constant. But if something is constant, we can add a number to it, and it is still constant! Thus whether we define the gravitational potential at the surface of the earth to be 0 or 100 J does not matter. Only differences in potential energies play a rôle. It is customary to define the potential “far away”, as $|x| \rightarrow \infty$ to be zero. That is a very workable definition, except in one case: if we take a square well and make it deeper and deeper, the energy of the lowest state decreases with the bottom of the well. As the well depth goes to infinity, the energy of the lowest bound state reaches $-\infty$, and so does the second, third etc. state. It makes much more physical sense to define the bottom of the well to have zero energy, and the potential outside to have value V_0 , which goes to infinity.

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