

19. (a) Since the nuclear force has a short range, any nucleon interacts only with its nearest neighbors, not with more distant nucleons in the nucleus. Let N be the number of neighbors that interact with any nucleon. It is independent of the number A of nucleons in the nucleus. The number of interactions in a nucleus is approximately NA , so the energy associated with the strong nuclear force is proportional to NA and, therefore, proportional to A itself.
- (b) Each proton in a nucleus interacts electrically with every other proton. The number of pairs of protons is $Z(Z - 1)/2$, where Z is the number of protons. The Coulomb energy is, therefore, proportional to $Z(Z - 1)$.
- (c) As A increases, Z increases at a slightly slower rate but Z^2 increases at a faster rate than A and the energy associated with Coulomb interactions increases faster than the energy associated with strong nuclear interactions.