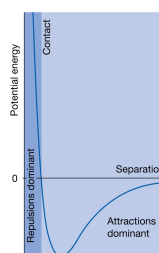


Assignment 1: Due 16 Aug 2024 before class (11:40 hrs.)

1. Estimation is an important aspect of modeling in sciences. Do the following exercises to test your ability to estimate quantities (brief explanation is needed for each) :

- If the hall H-105 was filled with the paranthas/parotas that you eat in the mess, what would be the total number of paranthas/parotas required? Answer as 10^n ($n=?$).
- If the paranthas/parotas in (a) were replaced by molecules of benzene, what would be the total number of molecules required?
- Use internet or library resources to estimate the number of atoms in the universe.
- If a thin conducting cable (say, copper or aluminum, used for fittings in homes) was laid from the classroom to the main gate on the regular path that you use for walking, and typical current (as in wires in home fittings) made to flow through it, what would be the time taken by an individual electron to go from one to the other end on average? Assume each atom in the cable to contribute one electron for conduction.
- If the electron in the ground state of hydrogen atom were to go around the hydrogen nucleus following Bohr model, approximately how many rounds will it make in the time estimated in the question above (c).

2. The energy of interaction of two entities is as shown in the diagram. What are good estimates for the scales (minimum and maximum magnitudes with appropriate units) involved if the entities are (a) atoms (b) molecules (c) subatomic particles? (d) stars and planets (no repulsion in this case, but the plot looks similar)



- Show using SI units that the quantity $\alpha = \frac{1}{4\pi\epsilon_0} \cdot \frac{e^2}{\hbar c} = \frac{1}{137}$, a dimensionless constant. (ϵ_0 =electrical permittivity of vacuum, e =charge of an electron, m =mass of an electron, \hbar =Planck's constant, c =speed of light)
 - In scientific calculations, often units are chosen with characteristics of the system in mind. For instance, in molecular physics, a system of units called atomic units is often used. Find out the units of length, time, mass and energy in this system. From the value of α defined in (a), obtain the speed of light in atomic units. How do we express it in words? For distances between planets and stars close to us, a unit called the astronomical unit of length is used. What is it?
- The logistic map $x_{t+1} = rx_t(1 - x_t)$ is usually studied for the growth parameter, r , in the range $0 \leq r \leq 4$. Why? Write a small code for the logistic map and compare the results graphically for $r = 3.5$, and 3.84 for any arbitrary initial condition and for iterations $t = 100$ to $t = 120$. Take another case with $r = 3.7$ and and plot the results for $t = 100$ to $t = 180$.