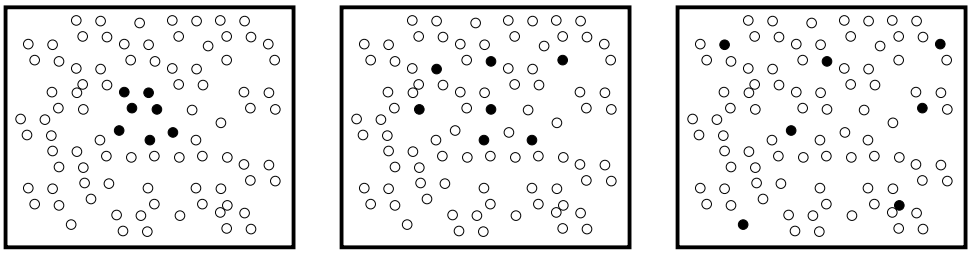
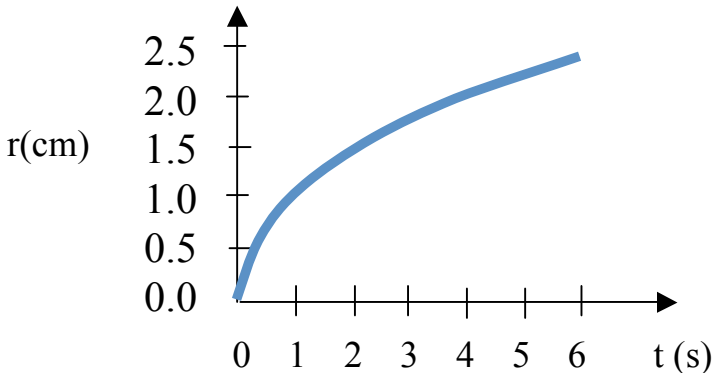
Physics 213 **Problem 5** **Week 3**

Diffusion of Atoms

Some atoms of Argon (atomic weight = 40) are released from a storage tank into a room full of air at T= 300 K, without disturbing the uniform T and pressure. The Ar cloud gradually spreads out by diffusion. (Assume no wind.) After 1s the Ar cloud is spread out with an rms displacement of 1 cm.



1. Sketch how the rms spread (we'll call it "r") changes in time on this plot.



2. What is r after one hour?

   After 3600 seconds, r has increased by a factor of $\sqrt{3600} = 60$, so r = 60 cm.

3. Calculate the diffusion constant from the rms displacement after 1 s.

   $r = (6Dt)^{1/2}$, so $D = r^2/6t = (0.01\ m)^2/(6\times 1\ sec) = 1.7\times 10^{-5}\ m^2/s$

4. Note that we've treated these gas atoms as ideal, i.e., there's nothing attracting them to or repelling them from one another. So, why do they spread out? That is, why do they move outward on average instead of inward or sitting still?

   The argon atoms spread out because the more volume they fill, the more arrangements are possible. The most likely configuration is to have all the gas molecules spread evenly (on average) around the entire room. We're watching the system approach that configuration.