SMS 303: Diffusion, homework # 1

Obtain the worksheet with the data from the activity from the class's web site at:

http://misclab.umeoce.maine.edu/boss/classes/SMS_303/SMS303.htm

I **expect** you to remember how to do **good** graphs. If you don't, go back to your SMS204 notes.

Homework **part a** (40pts) – one dimensional random walk:

1. Plot the student concentration (# of student at each position) as function of time for t=0,4,8,12,16 turns. x-axis could be the position.
2. How did the mean student position change as function of time (plot it)?
3. How did the standard deviation around the mean change as function of time (plot it)? What units does it have?
4. Assuming a time-step of 30sec and a step-length of 25cm, estimate from dimensional analysis the diffusion coefficient of the students in the corridor ($[D]=L^2/T$, where [] means dimensions off, D- the diffusion coefficient, L is distance and T-time).

Homework **part b** (40pts) – biased one dimensional random walk:

1. Plot the student concentration as function of time for t=0,4,8,12,16 turns.
2. How did the mean position changed as function of time? Plots it as function of time.
3. How did the standard deviation around the mean change as function of time (plot it)? What units does it have?
4. Assuming a time-step of 20sec and a step-length of 30cm, estimate from dimensional analysis the diffusion coefficient of the students in the corridor ($[D]=L^2/T$). How does the mean drift ($[U]=L/T$, U-speed) compare to what you may derive from dimensions alone?

Part c : Using dimensional analysis answer the following questions:

1. Assuming molecular diffusion alone, and a thermal diffusion coefficient of $D=(8.43 - 0.101\times T)\times 10^{-3}$ cm^2/s with T=20°C, approximately how deep will a large atmospheric temperature change be felt after one month? (10pts)

2. A bacterium (1μm in size) swims at a speed of about 25 body-lengths a second. Every two seconds, on average, it tumbles and starts off swimming at another random direction (hence it mean-free-path is 50μm). Compute the time scale it will take a tiny bacterium drop released within a flat Petri dish to diffuse 2mm away from its release position (10pts).