Physics 45 Winter 2023: Laboratory Eight
Week of January 30 to February 3, 2023

[HW4-8] Modify your diffusion equation code to keep track of the ‘normalization’, that is the sum of the density in all the boxes. What do you observe about the behavior if you run your code? Why is this good or bad? What physical principle is involved?

[HW4-9] Run your diffusion equation code for $D = 0.02, dt = 0.0001, dx = 0.01, N = 1000, N_t = 100000$. Here $N = 1000$ means 1000 boxes (as in lab 7) and $N_t = 100000$ means 100000 time steps. Since $dt = 0.0001$, this number of time steps means $t = N_t * dt = 10$ seconds elapse during the simulation. Make a plot of $\rho[x]$ versus $x$. What is the total time $t$ elapsed? How does your plot compare to the analytic solution presented in class?

Type in the following code, which generates $N$ random numbers and prints them to the screen.

```c
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main()
{
    double R;
    int i,N;
    unsigned int seed;

    printf("Enter number of iterations and seed");
    printf("\n");
    scanf("%i %u",&N,&seed);
    srand(seed);

    for(i=0;i<N;i=i+1)
    {
        R=(double)rand()/RAND_MAX;
        printf("%12.8lf \n",R);
    }
    printf("\n");

}
```

[HW4-9] Run your code for $N = 20$ and $seed = 12345$. Run it again with the same $N$ and $seed$. Run it with $N = 20$ and $seed = 54321$. Comment on what you observe? In what sense are the numbers random? In what sense are they not random?
[HW4-10] Modify your code to compute the first six ‘moments’ of the random numbers. What do you get for $N = 1000000$? What pattern do you observe?

[HW4-11] Write a code which generates random walks. Make plots of position versus ‘time’ for five different walks (different random number seeds) each of length 400 for the case where the probability of moving left equals the probability of moving right. How do the distances from the origin at the end of the walk compare to the rules discussed in class?

Make plots of position versus ‘time’ for five different walks (different random number seeds) each of length 400 for the case where the probability of moving left $p = 0.55$ is higher than the probability $q = 1 - p = 0.45$ of moving right. How do the distances from the origin at the end of the walk compare to the rules discussed in class?

[HW4-13] (extra credit) Prove the result you found in [HW4-10] is correct. That is, derive it ‘by hand’.