1

A drunkard's walk. A drunkard begins walking aimlessly, starting at a lamp post. At each step, the drunkard forgets where he or she is, and takes one step at random, either north, east, south, or west, with probability 25%. How far will the drunkard be from the lamp post after N steps?

Write a program that simulates the motion of a random walker for N steps. Your program should ask the user for an input which should be an integer number (examples: 1, 10, 100...) and should work for values of steps from 1 to a large number. Your program should print an error message if an invalid number (negative) is entered.

After each step, print the location of the random walker, treating the lamp post as the origin (0, 0). When the walker concludes print the square of the final *squared* distance from the origin ($x^2 + y^2$).

Example printouts could look like:

```
N = 10
(0, -1)
(0, 0)
(0, 1)
(0, 2)
(-1, 2)
(-2, 2)
(-2, 1)
(-1, 1)
(-2, 1)
(-3, 1)
distance = 10
```

```
N = 15
(0, 1)
(-1, 1)
(-1, 2)
(0, 2)
(1, 2)
(1, 3)
(0, 3)
(-1, 3)
(-2, 3)
(-3, 3)
(-3, 2)
(-4, 2)
(-4, 1)
(-3, 1)
(-3, 0)
distance = 9
```

2

Duplicate and modify your program to now take two prompts:

The first is still N – the number of steps the walker will take.

The second is T – the number of trials, or the number of times you will measure the walker's distance.

Your modified program should print out the average distance walked in N steps across the T trials.

```
N=100 T=10000                    N=400 T=2000
mean sq. dist = 101.446          mean sq. dist = 383.12

N=100 T=10000                    N=800 T=5000
mean sq. dist = 99.1674          mean sq. dist = 811.8264

N=200 T=1000                     N=1600 T=100000
mean sq. dist = 195.75           mean sq. dist = 1600.131
```

Note: these are examples! Your code will not produce these exact results but should only have a single line of output that says

```
mean sq. distance = ________
```

As N increases, we expect the random walker to end up further and further away from the origin. But how much further? Use your program to formulate a hypothesis as to how the mean squared distance grows as a function of N. Use a variety of values for T (as shown above) for testing the program, but for this analysis, use T = 100,000 trials to get a sufficiently accurate estimate.

Submit two separate pieces of code labeled:
`152_assignment3_1.java` (or `.pde`)
`152_assignment3_2.java` (or `.pde`)

Each program must include (in a comment) your name, the date, and the course information. They may contain other comments.