1

a. Distance, with miles (on phone - gps error, not walking straight line)
   Weight lbs (scale not calibrated perfectly, not staying perfectly still)
   Volume, fl oz (levels on water bottle not accurate, spilling some)

b. With 1 minute, I'd expect a variation of ± 1 second

   Room temperature ± 2 degrees

   1 cup of water ± a teaspoon

2

a.)

```
>> x = normrnd(50, 0.01, [10 1])

x =

   50.0054
   50.0183
   49.9774
   50.0086
   50.0032
   49.9869
   49.9957
   50.0034
   50.0358
   50.0277

>> mean(x)

ans =

   50.0062
```

This result is about what I expected but it is further away from 50 than I thought it would be. I was thinking it would be very close to 50, it might be if I generated more numbers

b.) after generating 100 numbers

```
   50.0084
   49.9911
   50.0010
   49.9946
   50.0030
   49.9940
   50.0049
   50.0074
   50.0171
   49.9981

>> mean(x)

ans =

   50.0008
```

This is more what I expected for the other simulation, it is very close to 50 but not exactly 50

After 1000

```
   49.9920
   49.9873
   49.9985

>> mean(x)

ans =

   49.9996
```

This one is even closer to 50 and keeps in line with my hypothesis. The more and more numbers generated the more the average will get closer to the actual generated average

3.

a. location: red lot 65 UMASS Amherst. Polaris is found in the night sky directly north. It is shown in the program as directly above the northern point

b. the angle between Polaris and the horizon was derived from an estimate of 10 degrees per fist, it was about 4 fists to the north star. This means the angle was about 40 degrees which is 40 degrees latitude

4

a. the maximum phase shift is .2/343 = 0.00058 seconds when one microphone is .2 meters closer to the source than the other microphone.

b. $.2/3.0 * 10^8 = 6.66 * 10^{-10}$ seconds is the amount of time for electromagnetic waves to travel .2 meters

c. beamforming is easier to implement because the differences in time between 2 distances is really small, so there is not much variation in signal propagation time

5.

a. A = 4.24 km

b = 5.38 km

c = 4.12 km

b. since each radio signal travels at the speed of light, it will depend on distance to the beacon to find out which order the signal will arrive. In order, they will arrive in C, A, B

a. 1.411 *10^-5 seconds

b. 1.795 *10^-5 seconds

c. 1.374 * 10^-5 seconds

c. If x moves to the right, it would alter its distance to each beacon, this altering the time. I would expect distances to become longer for a and c but shorter for b, based on this assumption, I believe it should change to CBA

6.

If the technology was there to be able to have an accuracy of a few inches indoors all over the earth, you could use the GPS to do many things. One easy way to utilize this would be for robots to be able to navigate buildings easily, either for cleaning robots inside domestic buildings or robots inside of warehouses. Another thing you could do with such a system is to have an app like google maps or something but for the inside of buildings, say you were lost inside a big building like the ILC, you could use this GPS to show you exactly where to go to. Another useful application would be finding lost things like a phone, if it could tell you exactly where your phone was it wouldn’t be so stressful to loose it.