Part 1: Artillery

A.

```
Required elevation to hit target: 20.0

Time step variation: 0.1
average       = 5074.340152243897
average_error = 74.34015224389714

Time step variation: 0.001
average       = 4991.177355304181
average_error = -8.82264469581878
```

1. **Using a function I found the ideal elevation to be 20 degrees**

2. **A smaller timestep results in a significant decrease in average_error**

B.

```
Elevation variation: 0.5
average_error = 87.88789762995475
average       = 5087.887897629955
CEP = 0.528

Initial velocity variation: 6.5
average_error = -1.851495369530312
average       = 4998.14850463047
CEP = 0.521
```

1. **Maximum variation in elevation was 0.5 units, anything more resulted in CEP < 0.5**

1. **Maximum Initial velocity variation was 6.5**

C.

```
X velocity variation: 4.5
average       = 4990.411882647515
average_error = -9.588117352484915
CEP = 0.502

Y velocity variation: 1.6
average       = 5002.148266651987
average_error = 2.148266651986887
CEP = 0.515
```

1. **Maximum variation in velocity(x) was 4.5 units, anything more resulted in CEP < 0.5**

2. **Maximum variation in velocity(y) was 1.6 units**

D.

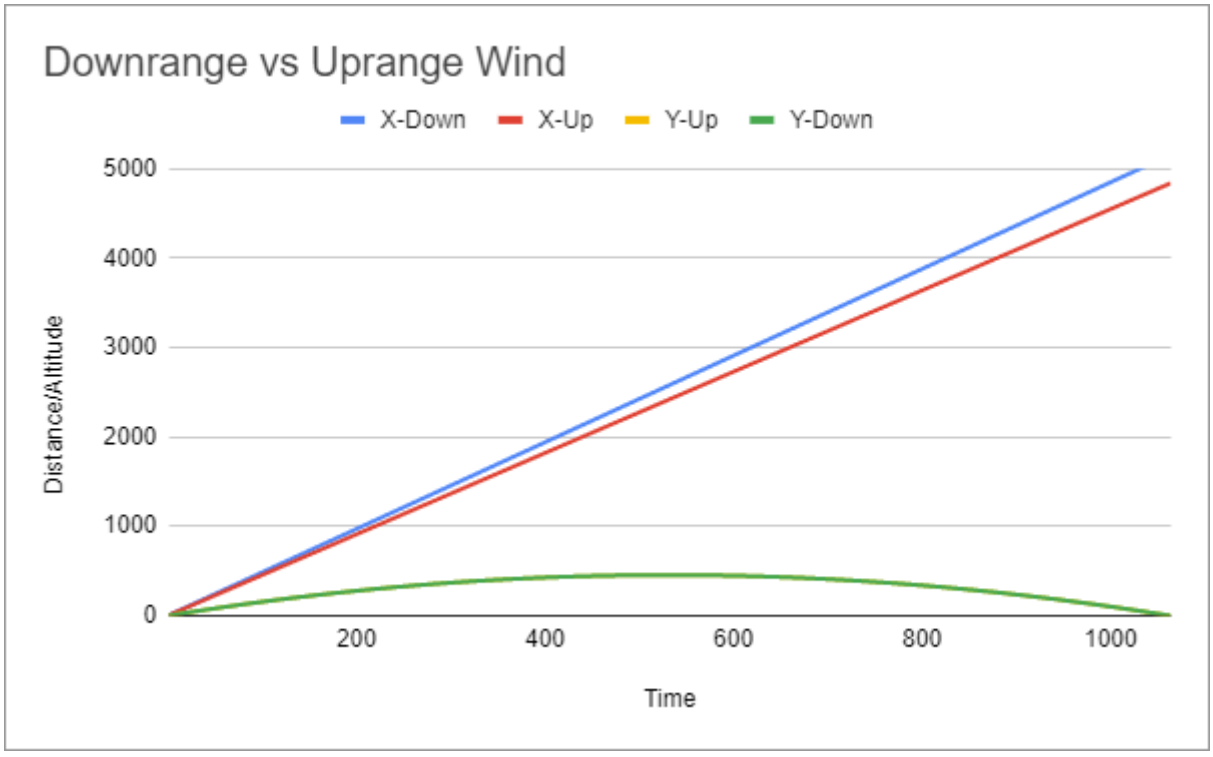
```
Deterministic solution:
average       = 7767.56799133401
average_error = 2767.56799133401

Nondeterministic solution:
average       = 7742.283650607882
average_error = 2742.283650607882
```

1. **Deterministic solution had avg error = 2767.**
2. **Nondeterministic solution had avg error = 2742 however it slightly varied depending on the seed.**

E.

```
Wind going with projectile:
average       = 5158.764742581081
average_error = 158.764742581081

Wind going against projectile:
average       = 4839.564742580988
average_error = -160.43525741901158
```

1. **Downrange wind (with projectiles) resulted in the artillery overshooting.**
2. **Uprange wind (against projectiles) resulted in the artillery undershooting by a near equal amount.**



Part 2: Bomber

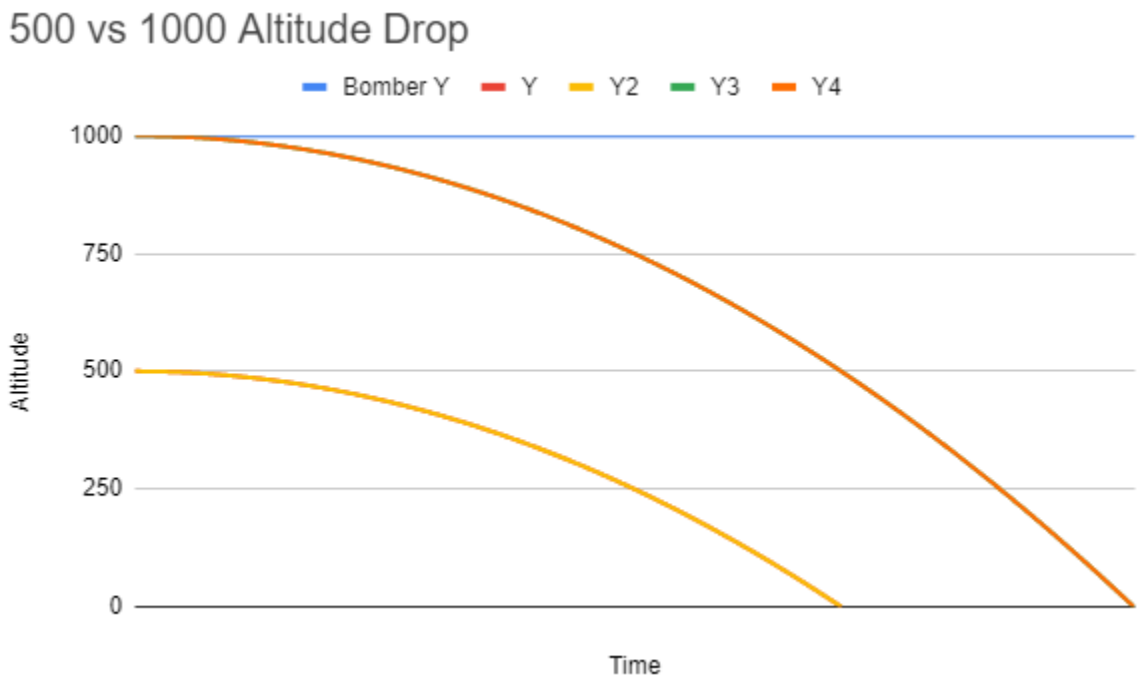
A.

```
Altitude 500, Speed 300:
average       = 1674.0
average_error = -3326.0

Altitude 500, Speed 600:
average       = 3348.0
average_error = -1652.0

Altitude 1000, Speed 300:
average       = 2367.0
average_error = -2633.0

Altitude 1000, Speed 600:
average       = 4734.0
average_error = -266.0
```

1. **General observations: Appears to act as expected. The first test tells us that an altitude of 500 and speed of 300 is far too little to hit the target.**

2. **Doubling the speed appears to reduce the error significantly more than doubling the altitude**

3. **Looking at the graph it appears starting velocity doesnt affect the y values when dropped**



B.

```
Velocity variation 22:
average       = 3973.258821880754
average_error = 28.258821880754112
CEP = 0.5

Altitude variation 65:
average       = 4046.5
average_error = 101.5
CEP = 0.5
```

1. **A velocity variation of 22 resulted in a CEP of <u>exactly</u> 0.5**

2. **An altitude variation of 65 also resulted in a CEP of <u>exactly</u> 0.5**

C.

```
X velocity variation 4:
average       = 3922.363194621915
average_error = -22.636805378084773
CEP = 0.5

Y velocity variation 2:
average       = 4005.0
average_error = 60.0
CEP = 0.5
```

3. **Maximum variation in velocity(x) was 4 resulting in CEP = 0.5**

4. **Maximum variation in velocity(y) was 2 resulting in CEP = 0.5**

D.

```
Deterministic solution:
average       = 3888.0
average_error = -1112.0

Nondeterministic solution:
average       = 3891.5051030346276
average_error = -1108.4948969653724
```

Similar to Part 1D, it appears the nondeterministic solution has less average_error than the deterministic solution but also varies with seed. What is interesting is that the nondeterministic solutions for both questions appear to have SLIGHTLY less average error for the majority of seeds tested.