Question 1

```python
import numpy as np

population = 100000
disease_prob = 0.001
true_positive_rate = 0.99
false_positive_rate = 0.05

disease = np.random.choice([1, 0], size=population, p=[disease_prob, 1 - disease_prob])

test_results = []
for person in disease:
    if person == 1:
        result = np.random.choice([1, 0], p=[true_positive_rate, 1 - true_positive_rate])
    else:
        result = np.random.choice([1, 0], p=[false_positive_rate, 1 - false_positive_rate])
    test_results.append(result)

test_results = np.array(test_results)

num_disease = np.sum(disease)
num_positive = np.sum(test_results)
true_positives = np.sum((disease == 1) & (test_results == 1))

p_disease_given_positive = true_positives / num_positive


print("Number of people with disease:", num_disease)
print("Number of people tested positive:", num_positive)
print("Number of true positives:", true_positives)
print("Estimated P(Disease | Positive Test):", p_disease_given_positive)
```

output:-

```
Number of people with disease: 96
Number of people tested positive: 5150
Number of true positives: 96
Estimated P(Disease | Positive Test): 0.018640776699029128
```

Question 2

```python
import numpy as np
import matplotlib.pyplot as plt
from collections import Counter

trials = 1000
winnings = []

for _ in range(trials):
    tosses = np.random.choice(['H', 'T'], size=2)
    heads = np.sum(tosses == 'H')
    winnings.append(10 * heads)

joint_counts = Counter([(w // 10, w) for w in winnings])
joint_prob = {k: v / trials for k, v in joint_counts.items()}


E_Y = np.mean(winnings)
Var_Y = np.var(winnings)

values, counts = np.unique(winnings, return_counts=True)
plt.bar(values, counts / trials)
plt.xlabel("Winnings (Y)")
plt.ylabel("Probability")
plt.title("PMF of Y (Coin Toss Game)")
plt.show()

print("Joint Probability Distribution (X, Y):", joint_prob)
print("Expected Value E(Y):", E_Y)
print("Variance Var(Y):", Var_Y)
```
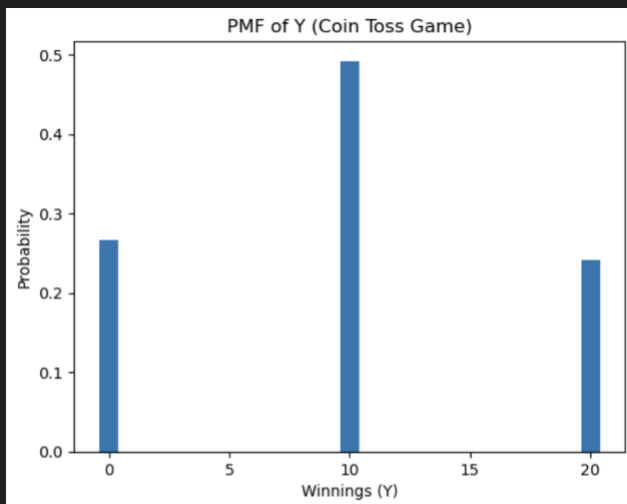
output:-

PMF of Y (Coin Toss Game)

```
Joint Probability Distribution (X, Y): {(np.int64(2), np.int64(20)): 0.241, (np.int64(0), np.int64(0)): 0.267, (np.int64(1), np.int64(10)): 0.492}
Expected Value E(Y): 9.74
Variance Var(Y): 50.732400000000005
```
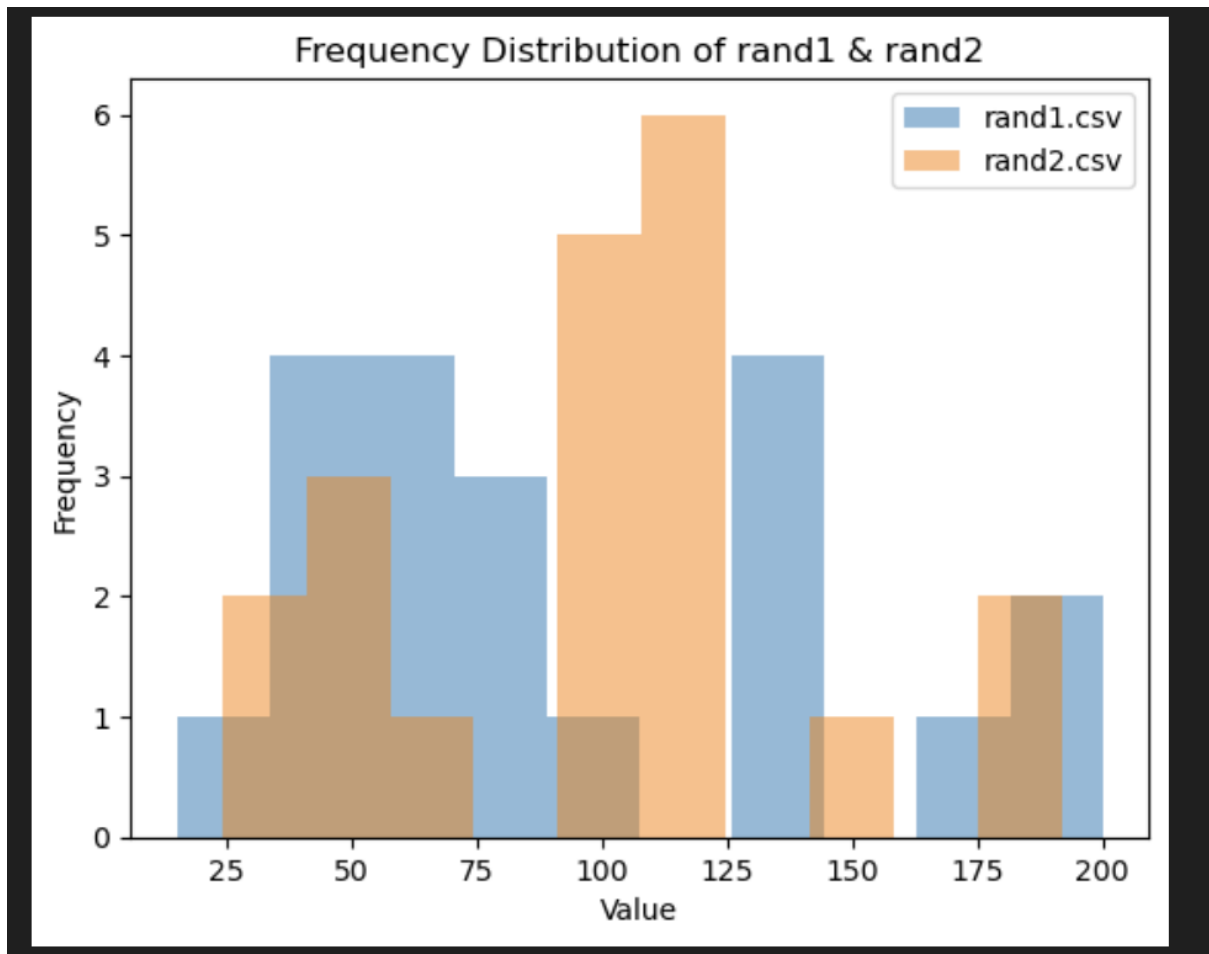
Expert level 1

```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

rand1 = np.random.randint(10, 201, 20)
rand2 = np.random.randint(10, 201, 20)

pd.DataFrame(rand1, columns=["Numbers"]).to_csv("rand1.csv", index=False)
pd.DataFrame(rand2, columns=["Numbers"]).to_csv("rand2.csv", index=False)

plt.hist(rand1, bins=10, alpha=0.5, label='rand1.csv')
plt.hist(rand2, bins=10, alpha=0.5, label='rand2.csv')
plt.xlabel("Value")
plt.ylabel("Frequency")
plt.legend()
plt.title("Frequency Distribution of rand1 & rand2")
plt.show()
```

output:-

Frequency Distribution of rand1 & rand2

Expert level 2

```python
import random
from collections import defaultdict

sentences = [
"We love the world and the things in it.",
"We love the way cheetah runs.",
"We have a man of honor.",
"We should be rich.",
"We are teenagers so we will be rebellion.",
"We are iconoclast and fighter.",
"We believe in education.",
"We love everything.",
"We watch a movie every day.",
"We hate pollution.",
"We love the work of god.",
"We love the beauty of this world.",
"We adore the way people try solve hard things.",
```

```python
"You are nothing but a blade of grass.",
"We will unleash a lot of prophecies and will bring down hordes of legions unto this earth to destroy you.",
"We love doing things in a peculiar way.",
"We love and hate probability. It is so stupid and fun at the same time.",
"We love the way software programs work.",
"We love your room."
]

model = defaultdict(list)
for sentence in sentences:
    words = sentence.split()
    for i in range(len(words) - 1):
        model[words[i]].append(words[i+1])

def generate_sentence(start_word, length=10):
    word = start_word
    result = [word]
    for _ in range(length - 1):
        if word not in model:
            break
        word = random.choice(model[word])
        result.append(word)
    return " ".join(result)

print(generate_sentence("We", 12))
print(generate_sentence("You", 12))
```

Output:-

```
We love and hate probability. It is so stupid and fun at
You are teenagers so we will be rebellion.
```

END OF ASSIGNMENT...