Problem 1 (10 points)

John has a coin that he flips twice. The universal set for this is
\[ S = \{H, T\} \times \{H, T\} = \{(H, H), (H, T), (T, H), (T, T)\} \]
Write the sets for

(a) A: first coin toss is H,
(b) B: at least one T is observed in two coin tosses,
(c) C: two tosses have different results.

Problem 2 (15 points)
Suppose we have the following information:

1. There is a 60 percent chance that it will rain today.
2. There is a 50 percent chance that it will rain tomorrow.
3. There is a 30 percent chance that it does not rain either day.

Find the following probabilities:

a. The probability that it will rain today or tomorrow.
b. The probability that it will rain today and tomorrow.
c. The probability that it will rain today but not tomorrow.
d. The probability that it either will rain today or tomorrow, but not both.
In class we solved (a), (b) and (c). Remember the solutions were as stated below. Find the solution to part (d).

a. The probability that it will rain today or tomorrow: this is $P(A \cup B)$. The answer is $P(A \cup B) = 0.7$.

b. The probability that it will rain today and tomorrow: this is $P(A \cap B)$. The answer is $P(A \cap B) = 0.4$.

c. The probability that it will rain today but not tomorrow: this is $P(A \cap B^c)$ which is equal to 0.2. It is calculated by

$$P(A \cap B^c) = P(A - B)$$
$$= P(A) - P(A \cap B)$$
$$= 0.6 - 0.4$$
$$= 0.2$$

d. Find the probability that it either will rain today or tomorrow, but not both.
Problem 3 (15 points)

Early in the morning a student reaches into a drawer containing six (6) blue socks and three (3) black socks. Two socks are randomly pulled out of the drawer. What is the probability that the student has selected a matching pair of socks?

Problem 4 (10 points)

Two people proofread a term paper. One person (proofreader A) finds 50 errors and the other person (proofreader B) finds 30 errors. When comparing the errors only 20 errors are common between both proofreaders. We will assume that all errors are equally likely (you probably realize that is not actually true, but it simplifies this problem). This assumption is equivalent to assuming independence between the two proofreaders. Given these assumptions and information, how many errors does the term paper likely have?
Problem 5 (10 points)

When two dice are rolled, find the probability of getting a greater number on the first die than on the second, given that the sum should of the two dice equals 8.
**Problem 6** (10 points)

Detectives in Austin, TX, put together a description of a robbery suspect involving the usual parameters like weight, height, color of hair, etc. Austin is a city with a population of about one million.

A person is picked up fitting this description and goes to trial based solely upon this description. The prosecutor tells the jury that one person in ten thousand in Austin fits this description, thus, it is highly unlikely (“beyond a reasonable doubt”) that an innocent person would fit the description. Therefore, it is highly unlikely that the defendant is innocent. All these statements are correct.

If you were on the jury, would you be inclined to vote “guilty” or “not guilty”? Given what you know about probability, justify your vote?

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**Problem 7** (15 points)

A game show host offers you the choice of three doors. Behind one door is the grand prize (it might be a car or a boat, etc.) and behind the other two doors are goats (but maybe you like goats). The host (who knows what is behind the doors) announces after you select a door (without opening it), he will open one of the non-selected doors and reveals the promised goat. He then offers you the chance to change your choice to the other unopened door. To maximize the probability of winning the grand prize, should you switch your door selection? Or does it even matter?
Problem 8 (15 points)

A friend tells you she will stop by your house sometime from 1:00 p.m. until before 2:00 p.m. However, she cannot be more specific because her schedule is quite hectic. Being very dependable you are certain she will stop by your house in that time interval. You assume her arrival will be random, but certainly within the 1:00 p.m. to 2:00 p.m. interval. (In the jargon of probability speak the arrival time is “uniformly distributed.”) Let $T$ be the arrival time within the interval.

(a) What is the sample space $T$?
(b) What is the probability of $P(1:30$ p.m.$)$? Explain your reasoning.
(c) What is the probability of $T \in [1:00$ p.m., $1:30$ p.m.$)$?