1. Roll three (6-sided) dice.
   1a. Use inclusion-exclusion to find the probability that \textit{at least one} value of “2” appears.
   1b. Find the probability that \textit{at most one} value of “2” appears.

2. Is it always true that, if and $A$ and $B$ are events (maybe overlapping, maybe disjoint), then $P(A \cup B) \leq P(A) + P(B)$? If “yes,” then give a short and simple reason why this is always true. If “no,” then give a counterexample, i.e., a situation in which $P(A \cup B) > P(A) + P(B)$.

3a. Two red and two blue plates are placed at a circular table for four people, with all arrangements of the plates equally likely. Find the probability that the two red plates are adjacent and the two blue plates are adjacent.

3b. Three red and three blue plates are placed at a circular table for six people, with all arrangements of the plates equally likely. Find the probability that the three red plates are adjacent and the three blue plates are adjacent.

4a. Suppose a drawer has 5 pairs of socks (10 socks total), with each pair having its own unique color. If 3 socks are chosen, what is the probability that none of them match?

4b. Suppose a drawer has 8 pairs of socks (16 socks total), with each pair having its own unique color. If 5 socks are chosen, what is the probability that none of them match?

4c. In general, if a drawer has $s$ pairs of socks ($2s$ socks total), with each pair having its own unique color. If $r$ socks are chosen (with $r \leq s$), what is the probability that none of them match?

5. Six rocks are sitting in a straight line. We paint them, using up to three colors (say, R’s, W’s, and B’s). Suppose all of the $3^6 = 729$ outcomes are equally likely.

5a. Find the probability that exactly 1 color of paint is used.

5b. Find the probability that exactly 2 colors of paint are used.

5c. Find the probability that all 3 colors of paint are used.
   [Hint: Your answers should sum to 1 altogether.]

6a. Simplify the expression $\sum_{j=3}^{\infty} a^j$, where $0 \leq a < 1$.

6b. Simplify the expression $\sum_{j=r}^{\infty} a^j$, where $0 \leq a < 1$, and $r$ is a fixed, positive constant.