Basic Probability Rules **Workshop**

An **event** is a subset of the possible outcomes in a probability model. We use capital letters like A or E to represent events, and $P(E)$ is short-hand for the phrase *"the probability that event E happens"*. Here are three important probability rules about events.

Complementary Events $P(A \text{ does not happen}) = 1 - P(A)$.

Addition Rule $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$.

Multiplication Rule $P(A \text{ and } B) = P(A)P(B)$ if A and B are **independent** events.

Two events A and B are **independent** if the probability of A happening doesn't depend at all on whether B happens or not.

1. For each of the following pairs of events, decide whether they are independent or not.
   (a) It rains a week from today *and* the baseball game that day is canceled.

   (b) It rains a week from today *and* your friend wins the lottery.

   (c) A random person was a cheerleader in high school *and* they are female.

2. Bob is taking a multiple choice test. Each question has five options. For the last two questions, Bob has no clue which answer is correct, so he guesses.
   (a) What is the probability that Bob gets both questions wrong?

   (b) What is the probability that Bob gets both questions right?

   (c) What is the probability that Bob gets one question wrong and one question right?

3. A doctor tells you that you need knee surgery. The knee surgery has some risks. There is an 11% chance the surgery will fail to fix the problem. There is also a 4% chance that you will get an infection. Finally there is a 2% chance that both problems will occur.
   (a) Find the probability that at least one of these bad outcomes occurs.

   (b) What is the probability that the knee surgery is successful without any complications?

   (c) Let A be the event that the surgery fails and let B be the event that you get an infection. One way to tell that these two bad outcomes are not independent is to check the multiplication rule. According to the multiplication rule, what should $P(A \text{ and } B)$ be?

   (d) Is the actual value of $P(A \text{ and } B)$ higher or lower than it would be if A and B were independent?

4. Only 7.2% of Americans have type O-negative blood. What is the probability that a random pair of people both have type O-negative blood?

5. Alice and her identical twin sister go to donate blood. Neither knows their blood type. What is the probability that both have type O-negative blood? Hint: blood type is genetic, so identical twins will have the same blood type.