

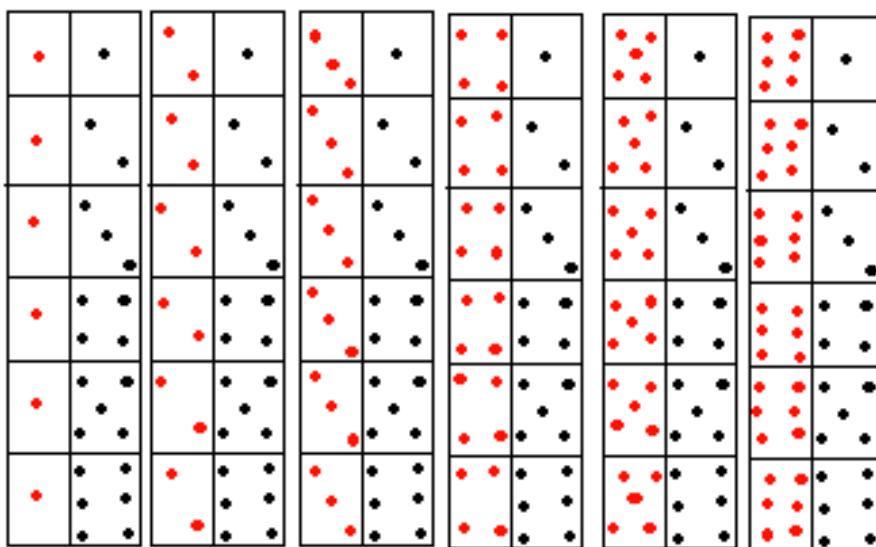
Module 2A Questions:

1. A fair coin is tossed six times, and the results are recorded in the order that they appear. Which of the following outcomes is most likely to occur and why?

H=heads; T=tails

- a) HHHTTT
- b) HTHTHT
- c) HTTHTT
- d) 1 and 2 are equally likely
- e) 1,2 and 3 are all equally likely

2. Event A = Black die is 1, Event B = Red die is 1



A. $P(A \text{ OR } B) = ?$

- a. 6/36
- b. 12/36
- c. 11/36
- d. 1/36

B. $P(A \text{ AND } B) = ?$

- a. 6/36
- b. 12/36
- c. 11/36
- d. 1/36

C. $P(\text{NOT } A) = ?$

- a. 1/36
- b. 35/36
- c. 6/36
- d. 30/36

3. A man went to Monte Carlo to try and make his fortune. Whilst he was there, he had an opportunity to bet on the outcome of rolling dice. He was offered the same odds for each of the following outcomes (in each case the dice are rolled simultaneously):

- i. At least 1 six with 6 dice.
- ii. At least 2 sixes with 12 dice.
- iii. At least 3 sixes with 18 dice.

The man decided that these were all the same so he could choose one at random and bet on that. This is also called the Chevalier de Mere ‘paradox’. Was he right? Give your answer and explanation (in your own words). Note: to answer iii, you will need to use the binomial coefficient (we will cover this in 3A). I included this so you can see how probability connects to what we will focus on next and because you have been given the answer (you only must indicate by explaining the solution yourself that you truly understand the answer).

4. **(optional question, only for interested individuals!)** Here is the question that you can imagine represents migration between two originally isolated populations which, as you will recall from your biology courses, is one of the forces that shapes genetic variation (stolen from <https://nrich.maths.org/1970>)
 1. There are 5 yellow balls in bag One. One ball is transferred to bag Two which contains an unknown number of green balls.
 2. Bag Two is then shaken and a ball is selected at random and transferred to bag One without seeing its colour.
 3. Bag One is then shaken and a ball is selected at random and transferred to bag Two without seeing its colour.
 4. Finally, a ball is chosen at random from bag Two.

If I tell you before you carry out this process that there is a $3/5$ chance you will end up with a green ball at the end, can you work out how many green balls are in bag Two at the start? **Draw a probability diagram (showing your solution) and explain the logic of your answer in your own words.**

Hint: You are following the state space of each of the two bags in this question. They start out as the following representation: $(5,0)(0,n)$, as there are 5 yellow balls in bag 1 initially, and 0 yellow balls in bag 2, as well as an unknown number of green balls in bag 2.

Note: There will be a bit of algebraic rearrangement involved in the solution – just do your best! You can find the answer to this question online, too. If you can successfully answer this question, even with online support, you have a solid understanding of conditional probability!