Dungeon Master's Dice

Exercise 1

All dice are assumed to be fair throughout!

1. Complete the table showing the scores obtained by throwing two six-sided dice.

	⚀	⚁	⚂	⚃	⚄	⚅
⚀						
⚁						
⚂						
⚃						
⚄						
⚅						

2. Count the number of times each score occurs and divide by 36 to find the probability. Check that your answers add up to 1.

Result	2	3	4	5	6	7	8	9	10	11	12
Probability											

3. Use your results to determine the probability of each possible score obtained on throwing three six-sided dice. Check that your answers add up to 1.

Result	3	4	5	6	7	8	9	10
Probability								

Result	11	12	13	14	15	16	17	18
Probability								

Hint: think about throwing two dice, and then one more.

Exercise 2

All dice are assumed to be fair throughout!

In what follows, we will refer to n j-sided dice as nDj (Dungeons & Dragons notation!). The questions are concerned with using one or more $D6$ to simulate other types of dice.

1. Is it possible to simulate a $D12$ by throwing two identical $D6$ together? That is, can we divide all possible combinations into twelve groups, each with probability $1/12$? If it is possible, make a table showing which combinations on $2D6$ correspond to which scores on a $D12$. Otherwise, explain why it is not possible.

2. Is it possible to simulate a $D12$ using two $D6$ of different colours? If it is possible, make a table showing which permutations on $2D6$ correspond to which scores on a $D12$. Otherwise, explain why it is not possible.

3. Is it possible to simulate a $D8$ using the score obtained by rolling $3D6$? If it is possible, make a table that shows which scores on $3D6$ correspond to which scores on a $D8$. Otherwise, use your table to show the best way to group the scores (i.e. eight groups with probability as close to $1/8$ as possible).

4. Is it possible to simulate a $D8$ by throwing three different coloured $D6$? Don't try to make a table for this case. If it's possible, describe how you would do it; otherwise explain why it's impossible.

5. Is it possible to simulate a $D8$ by throwing three identical $D6$ together? (Hard) Again, don't try to make a table for this case. If it's possible, describe how you would do it; otherwise explain why it's impossible.

6. Explain why simulating a $D20$ using $D6$ is never possible, regardless of the number of dice used and their colour.

7. Can you think of an extra 'trick' that would allow you to simulate a $D20$ using multiple $D6$? Can you see a potential problem with this?

   Hint: think about simulating a $D4$ using a single $D6$. Then use a similar idea to simulate a $D20$ using $2D6$.

Exercise 3

Play the three card game ten times. Record the player's action, and the outcome in the table below.

stick and win	stick and lose	switch and win	switch and lose

Exercise 4

1. Find the probability of the Lotto jackpot (i.e. ●●●●●●).

2. Find the probability of ●●●●●●. How many different arrangements have five matches? What is the probability of five matches?

3. Find the probability of ●●●●●●. How many different arrangements have four matches? What is the probability of four matches?

4. After the six balls have been drawn, the *bonus* ball is drawn from the remaining balls. Matching this increases player's prize if they already have five matches from the main draw. Find the probability of this occurring.

5. The prizes for most combinations in Lotto vary, depending on the number of players, and the number of winners. Only the prize for three matches is fixed. Approximate figures are shown in the table below.

Match	Prize
three balls	£25
four balls	£100
five balls	£1,000
five balls + bonus	£50,000
jackpot	£1,000,000+

Given that playing the game costs £2, what do you think about the odds and prizes?