Question 2:

Let x be a simulated uniform random number, where, $0 \leq x \leq 1$ and n be the number of uniform random numbers simulated in a given game. For any given game,

Let $\frac{1}{n}$ be the lower bound and $1 - \frac{1}{n}$ be the upper bound for the range determining a "win".

A game would be considered a "win" if all the values of x simulated are within the bounds of $\frac{1}{n} < x < 1 - \frac{1}{n}$. If there exists a simulated number x outside this range, the game is considered a "loss".

A win gives a profit of €10, and a loss gives a profit of €-1 .

Monte Carlo Experiment:

Three individual monte carlo experiments were conducted for differing values of n , where $n = 10$, $n = 100$ and $n = 1000$. For each experiment the $no.\ Simulations$ = 100000. A game was considered a success if the simulated game resulted in a "win", so the no. Successes = no. Wins.

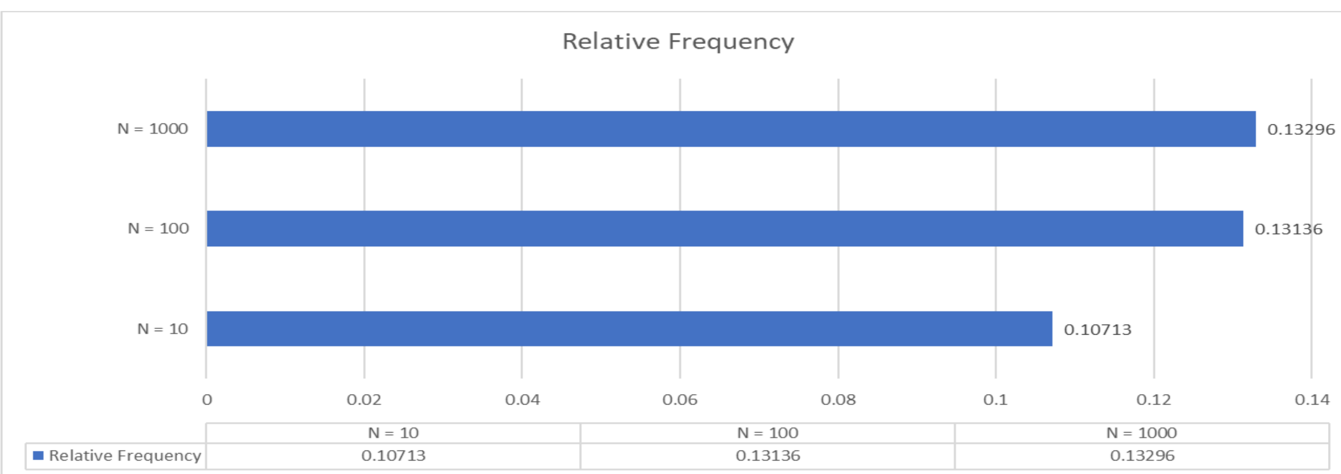
Relative Frequency = $\frac{no.Wins}{no.Simulations}$

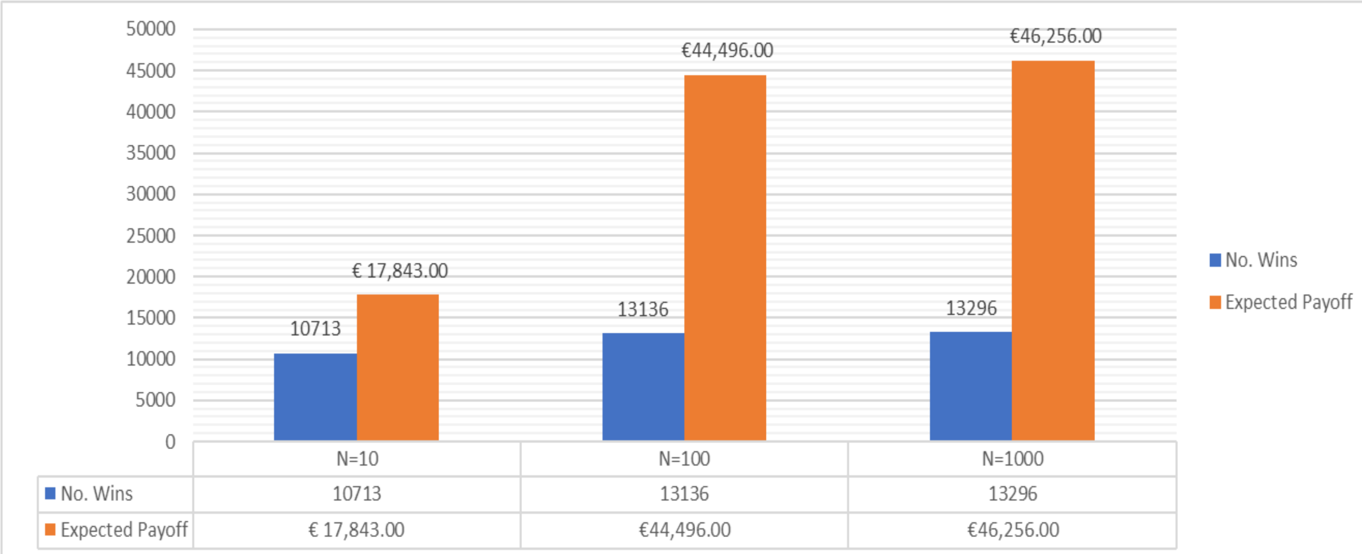
No. Losses = $No.Simulations - No.Wins$

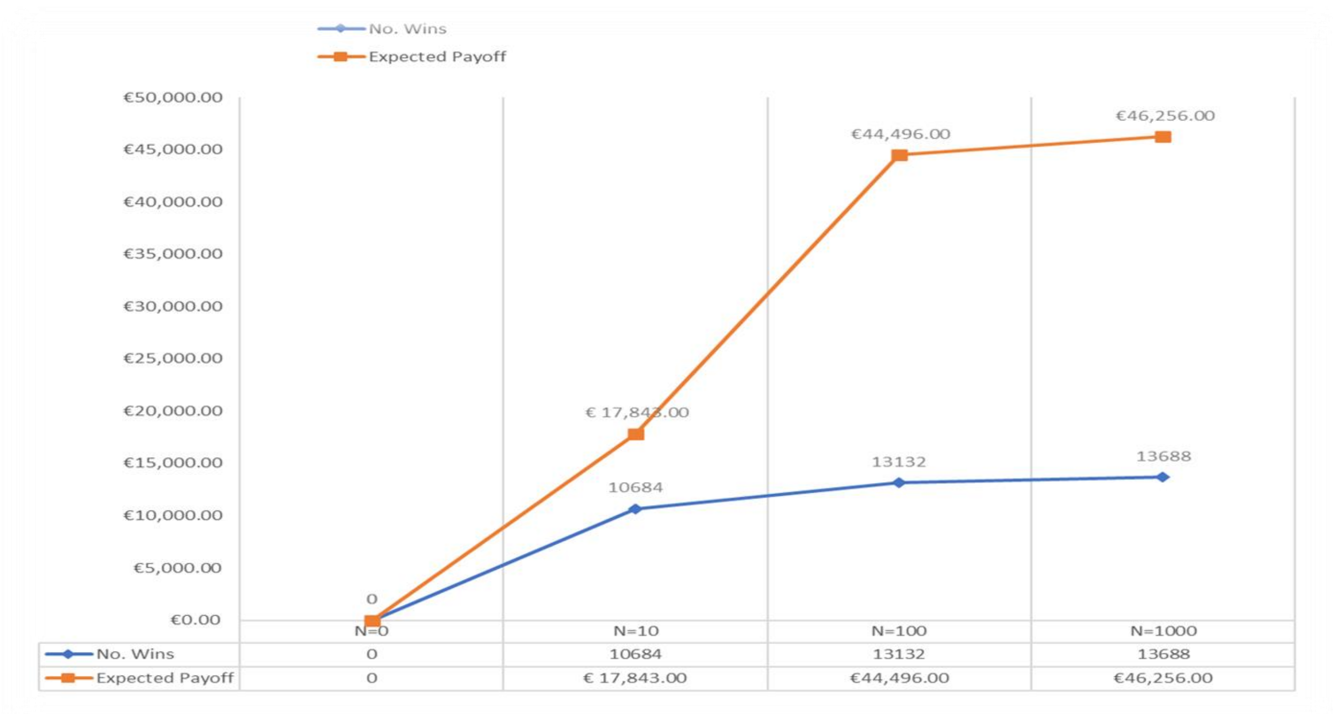
Expected Net Payoff (After 100000 games) = $(No.Wins \times €10) - (No.Losses \times €1)$

Results:

Table1:	N = 10	N = 100	N = 1000
Frequency (no. Wins)	10713	13136	13296
Relative Frequency	0.10713	0.13136	0.13296
Expected Payout	€17,843.00	€44,496.00	€46,256.00







Conclusion:

After simulating 100000 games for each proposed value of n , I have determined that Expected Net Payoff grows exponentially as the value of n increases, this growth with n begins to plateau for $n = 100$ but nonetheless increases with n . To answer the question, for the proposed values I have found that $n = 1000$ has the highest Expected Net Payoff.

Question 4

Using R, a simulated deck of cards with x values of 1 to 100 was shuffled using the "sample()" function, a vector of values 1 to 100 was used to represent the shuffled deck. Let i be a counter used in a for loop going from 1 to 100, if $i = i^{th}$ card in the deck then it was considered a "hit".

Interquartile Range = Quartile 3 – Quartile 1

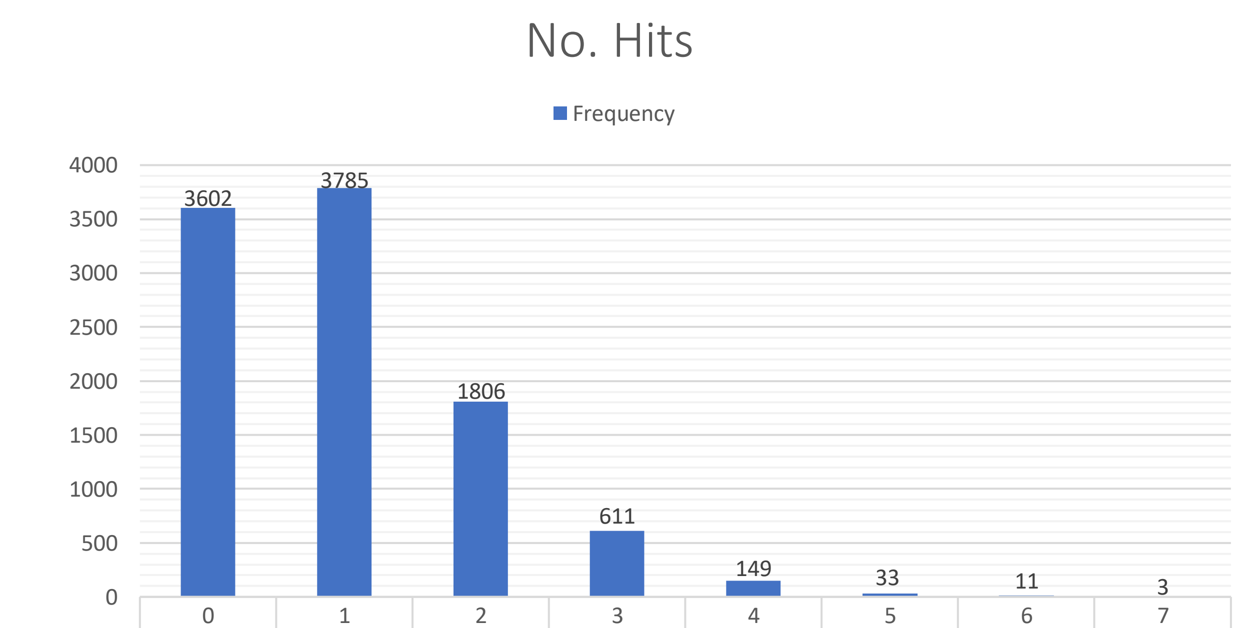
Monte Carlo Experiment:

Let the results of the Monte Carlo Experiment be represented as a frequency table, with the score of the table being x. (no. Hits in a game) and f being the frequency of a specific value of x. The built-in R statistical functions were used to obtain the Standard Deviation, Variance and Quartile-Ranges. The median and mode were manually calculated. The $no.\ Simulations$ = 10000.

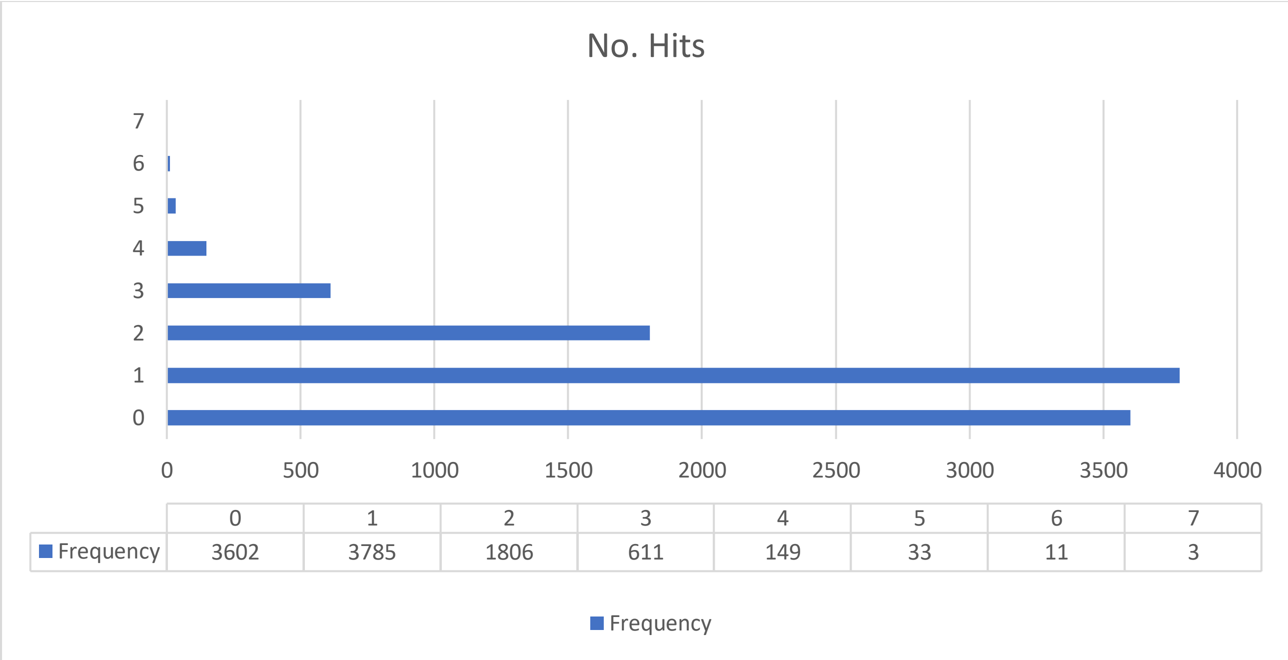
No. Hits (x)	0	1	2	3	4	5	6	7
Frequency (f)	3602	3785	1806	611	149	33	11	3

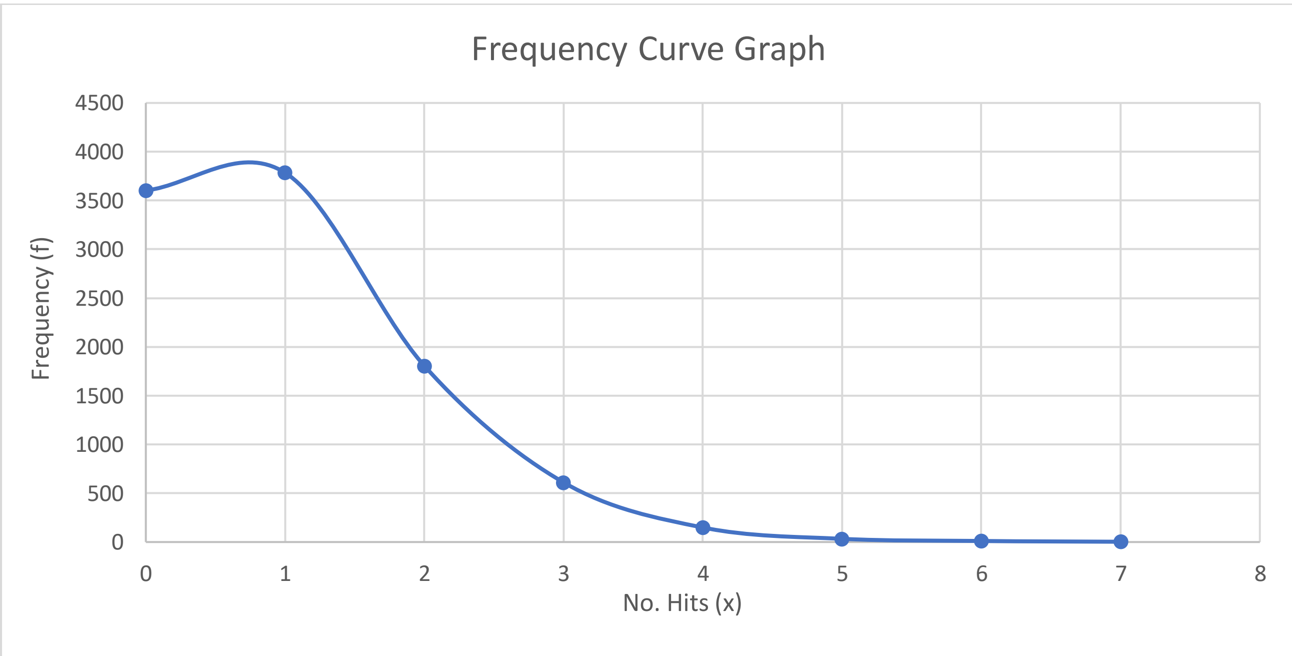
Statistic	Value
Expected Value	1.0078
Variation	1.01044
Standard Deviation	1.0052
Median	1
Mode	1
Minimum Value	0
Maximum Value	7

1st Quartile	2nd Quartile	3rd Quartile	Interquartile Range
0	1	2	2



	0	1	2	3	4	5	6	7
Frequency	3602	3785	1806	611	149	33	11	3





Conclusion:

The expected no. hits in a game is 1, this is also the median and mode value. But it should be noted that while 37% of games had 1 hit, 36% of games had 0 hits. A variation of 1.0104 was obtained, with a standard deviation of 1.0052. From the frequency curve graph, we see a right skewed distribution. Since the graph is positively skewed, we see the line quickly fall as it reaches a no. hits of 7 which is the max no. hits after 10000 simulations.

Sources:

1. Understanding Probability, Author: Henk Tijms
2. Lecture Notes in Applied Probability
3. https://www.excel-university.com/create-a-simple-dot-plot-in-excel/