Homework # 1

1. Ans. [d]

   i. Since we already have the exact coin specifications from the U.S. Mint, there is no specific requirement to apply learning here. Based on the statistical model developed by the developers, the coins can be scanned for the specification and categorized accordingly.
   ii. We have been given the coins in a labeled format, that is they are labeled as penny, dime, quarter and nickel and we can make a learning model on the basis of this classification. Since our model will learn given the result, this is a form of supervised learning.
   iii. The strategy is developed by penalizing moves and thus, even though we are not exactly classifying the moves, we are reinforcing the system to learn that some moves are better than others (i.e. the ones that lead to winning). This is an example of reinforced learning.

2. Ans. [a]

   i. The numbers can be classified into prime or non-prime very easily using standard algorithms, using machine learning here would be overkill.
   ii. Since we are talking about potential frauds here based on the data that we already have, this seems like a suitable candidate for machine learning application. There does not seem to be a specific pattern here that can be pinned down mathematically and data is present as well.
   iii. The time taken for a falling object can be easily determined using formulas of physics if the various quantities like air viscosity, gravity, etc are known. Not a suitable candidate for machine learning.
   iv. Optimal cycle for traffic lights in a busy intersection is a candidate for machine learning as there is a pattern that cannot be pinned down mathematically. Data is assumed to be given.

3. Ans. [d]

   This problem can be solved with the help of the Baye's theorem. Consider the following events :

   A : Ball is picked from bag 1
   B : Ball is picked from bag 2
   C : Ball picked is black
   D : Ball picked is white

Let us first find the probability that the ball is picked from bag 1 if it is a black ball. By Baye's theorem :

$$P(A/C) = \frac{P(C/A).P(A)}{P(C/A).P(A) + P(C/B).P(B)}$$

Inserting the values here we get P(A/C) = 2/3, it follows that P(B/C) is 1/3.
Now, we consider the probability that the second ball picked is black given that the first ball is black for both bags 1 and 2. This will be : 2/3 x 1 + 1/3 x 0 = 2/3, which is the answer.

Note to self : The logic that we can get the second ball black only if the first black ball is picked from bag 1 leading to a probability of 1/2 is flawed, as the probability that bag 1 is picked given that the first ball is black is higher as seen above from the baye's theorem. This leads to a higher probability that the second black ball is picked from the first bag.

4. Ans [b]

The probability of not getting a red from the bag is 1 - 0.55 = 0.45. We want this to happen 10 times, so the answer would be 0.45 ^ 10 = 3.405×10^{-4} .

Note to self : The application of Hoeffding's inequality here, does not make sense as that would require a tolerance level to which we believe that the result would deviate from 0.45. However, here we already know that the result has been deviated.

5. Ans [c]

The probability for at least one sample having no red ball can be easily calculated by subtracting from 1 the probability of all samples having a red marble. if $p = 3.405 \times 10^{-4}$ then the answer is given by $1 - (1 - p)^{1000}$ which is 0.2886 rounding off to 0.289.

6. Ans [e]

The score calculated for each given hypothesis in the option calculated comes out to be the same.

The code for problems 7-10 has been attached alongside.