Extra Credit 3

Describe the algorithm which in 3 comparisons with lever scales finds among 12 coins a single false coin (which is different from standard in weight) and finds if the false coin is lighter or heavier than a standard.

To start, split coins into three groups {1, 2, 3, 4}, {5, 6, 7, 8}, {9, 10, 11, 12}

Next, we would compare the first two sets on the lever, which ultimately gives us a potential of three cases.

**In the first case:**

Both sets have the same weight. This means that our defective coin is in the set 3 with coins {9, 10, 11, 12}

From this point we take one coin from the working set, let's take coin 8, and add it with a coin from set 3, let's say 9. Then compare the new set {8, 9} with the next two in set 3, coins {10, 11}.

If {8, 9} is heavier than {10, 11}, then we compare coins {10} and {11}. If one is lighter… then that coin is the lighter fake, yet if they are both equal… then coin {9} is the heavier fake.

If {8, 9} is heavier than {10, 11}, then we compare coins {10} and {11}. If one is lighter than the other… then the other one is a heavier fake, but if they are equal to each other… then coin {9} is the lighter fake.

**In the second case:**

If we learn that set 1 is heavier than set 2, than set 1 has a heavy fake or set 2 has a light fake.

This ensures that set 3 does not contain the fake, so next comparison is {1, 2, 5} with

{3, 6, 9}. We are using 9 because we are certain it is not fake.

If they balance, that leaves either 4, 7, or 8 to be the fake (so we follow same steps in green set-in case 1)

If {1, 2, 5} is heavier… then we go on to compare {1} and {2} to see if they balance, so if that occurs coin {6} is the light fake… but if they are unbalanced then the heavier of the two is the heavy fake.

If {3, 6, 9} are heavier… then we go on to compare {5} and {9} to see if they balance, so if that occurs coin {3} is the heavy fake… but if they are unbalanced then {5} is the lighter fake.

**In the third case:**

If {5, 6, 7, 8} is the heavier set then we would do the same thing for case 2, only in the perspective of set 2.