QUESTION 1: Algorithms and flowcharts

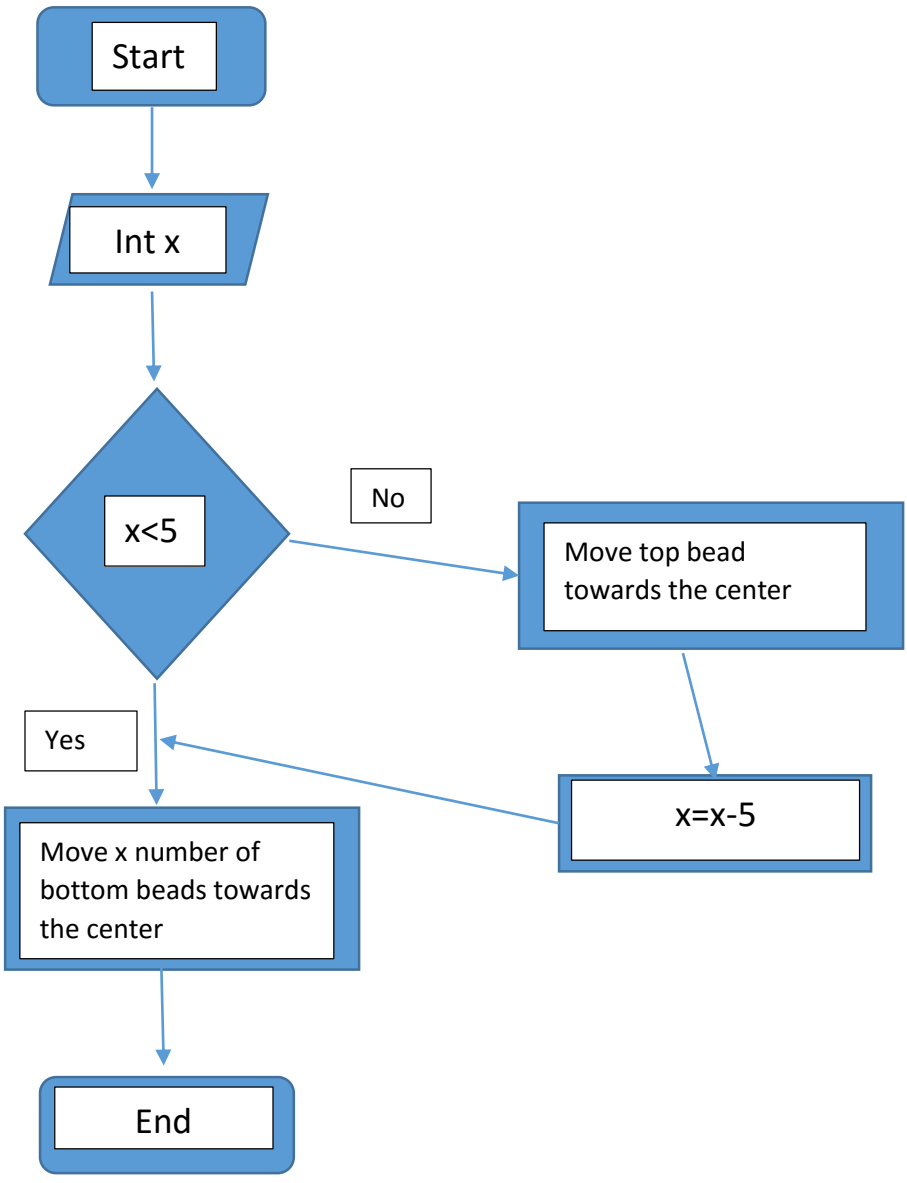
a.

1. In the rightmost column, Move up 3 bottom deck beads towards the center.
2. Move to the column to the left.
3. Move down the single top deck bead and move up 3 bottom deck beads towards the center.
4. Move two columns to the left.
5. Move down the single top deck bead towards the center.

b.

1. Let **x** be the integer we want to encode
2. Make sure all the bottom beads of the abacus are aligned to the bottom and all the top beads aligned to the top of the abacus.
3. If **x** is less than 5, go to step 6.
4. In the rightmost column, move the top bead of the abacus in the current column towards the center
5. Set the new value of **x** to be **x-5**.
6. In the rightmost column, move **x** number of bottom beads towards the center.

c.



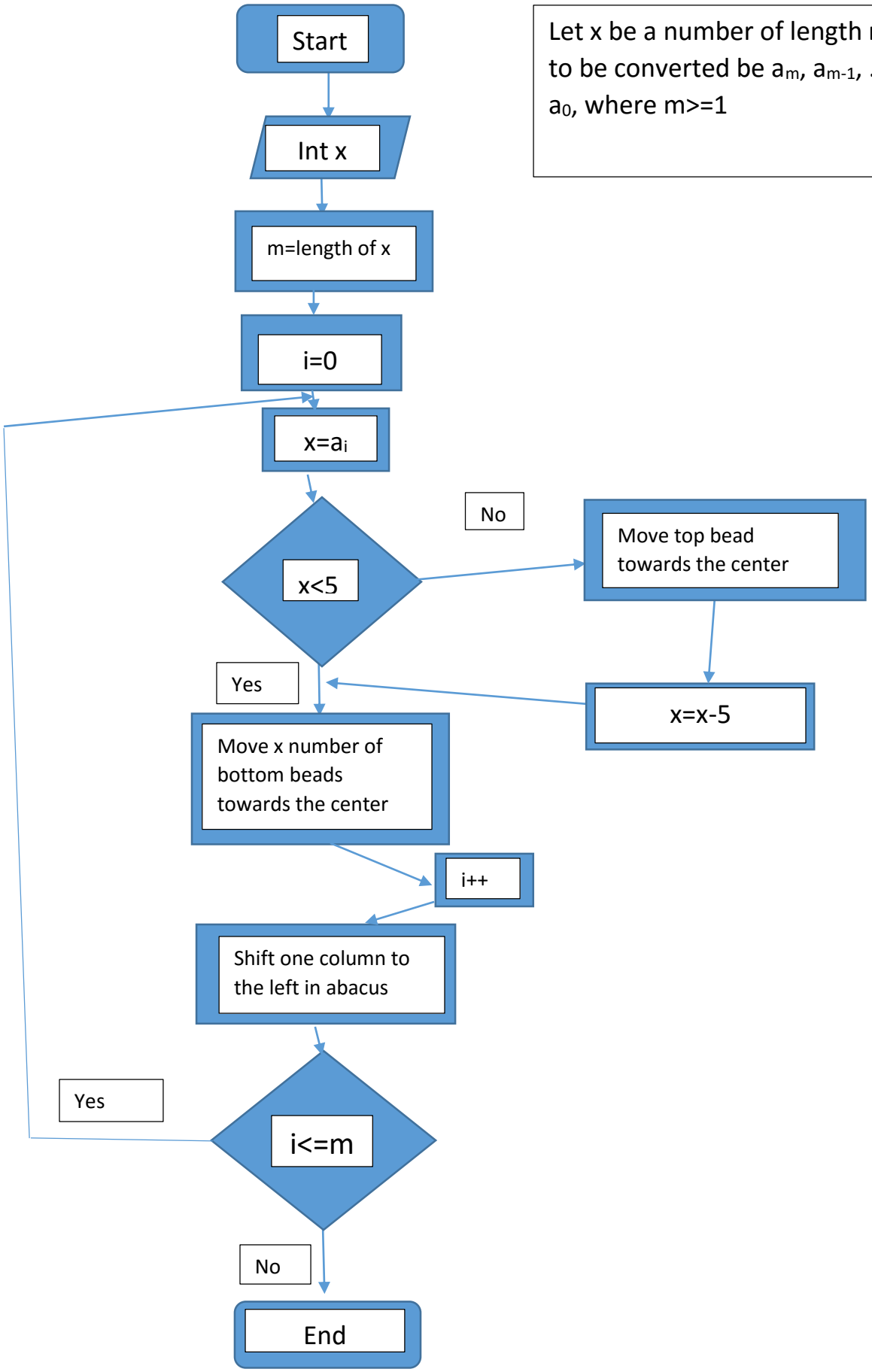
d.

Let the number of length **m** to be converted be a_m, a_{m-1}, …, a_0, where m>=1

1. Make sure all the bottom beads of the abacus are aligned to the bottom and all the top beads aligned to the top of the abacus.
2. Set the value of i to be zero.
3. Repeat Steps a-h while the value of i is less than or equal to m-1. Start with the rightmost column in the abacus.
    a. Let $x=a_i$
    b. Let **x** be the integer we want to encode
    c. If **x** is less than 5, go to step 5.
    d. In the rightmost column, move the top bead of the abacus in the current column towards the center
    e. Set the new value of **x** to be **x-5**.
    f. Move x number of bottom beads towards the center.
    g. Add 1 to i.
    h. Move one column to the left on the soroban abacus.

e.

Let x be a number of length **m** to be converted be a_m, a_{m-1}, …, a_0, where m>=1



QUESTION 2: Number Systems

Decimal	Binary	Hexadecimal
29	00011101	1D
70	01000110	46
-13	11110011	F3
-81	10101111	AF
-29	11100011	E3
-37	11011011	DB
16	00010000	10

QUESTION 3: Binary Representation

a. As the total number of combinations with 10 prisoners is 2^{10}=1024. He could have tested 24 more bottles without adding one more prisoner.

b. If the question is either YES/NO, there are only options, thus the total number of distinct words would be 2^n where n is the number of questions. If we change it to YES/NO/Maybe, there 3 options, thus the base would change to 3. In order to get at least 1000 different combination to represent each word, we need at least 7 questions as 3^7=2187. 3^6 is only 729, thus 6 questions would not be sufficient enough.