

Name: Josh Clemens

CS 113 Midterm Exam

Date: 3-28-23

Grade: _____ /100

Instructions: You are not allowed to use any **notes** or **books**. **YOU MAY NOT USE THE INTERNET NOR ANYONE ELSE**. If I suspect cheating, I have the right to challenge your work and be able to show you know the material. There are 11 problems, the 11th is extra credit.

Make sure you show all your work and be as detailed as possible.

1. (10 points) Determine the big-O for each of the following functions.

- a. $f(n) = \underline{1}$ $O(1)$
- b. $f(n) = 100n + \underline{2n!}$ $O(n!)$
- c. $f(n) = n^2 \log(n) + \underline{n^3}$ $O(n^3)$
- d. $f(n) = 2^n + \underline{3^n}$ $O(3^n)$
- e. $f(n) = 9n^3 + n^3 \log(n)$ $O(n^3 \log n)$
- f. $f(n) = n^4 \log(n) + 9n^n + \underline{4n} + 7$ $O(n!)$
- g. $f(n) = (n \log(n) + \underline{n^2})(3^n + 2^n)$ $O(n^3)$

2. (10 points) **Determine $T(n)$** relationship between processing time and n . Then **determine a big-O** estimate for the number of operations (a Simple Statement takes one unit of time) used in this segment of an algorithm. **SHOW YOUR WORK.**

```
for(int i = 0; i < n; i++){  
    for(int j = 0; j < n; j++){  
        Simple Statement  
        Simple Statement  
        Simple Statement  
        Simple Statement  
        Simple Statement  
    }  
}
```

$i=0, i=1, i=2 \dots i=n-1$
 $j=0, j=1, j=2 \dots j=n-1$
 n times

$k=0, k=1, k=2 \dots k=n-1$
 n times

```
for(int k = 0; k < n; k++){  
    Simple Statement  
    Simple Statement  
}
```

Simple Statement
Simple Statement
Simple Statement
Simple Statement

$$T(n) = 5n^2 + 2n + 4 = O(n^2)$$

3. (10 points) **Determine $T(n)$** relationship between processing time and n . Then **determine a big-O estimate** for the number of operations (a Simple Statement takes one unit of time) used in this segment of an algorithm. **SHOW YOUR WORK.**

```
for(int i = 0; i < n; i++){
    for(int j = n-1; j >= i; j--){
        Simple Statement
        Simple Statement
        Simple Statement
    }
}
```

```
for(int i = 0; i < n; i = i + 2){
    Simple Statement
    Simple Statement
    Simple Statement
    Simple Statement
}
```

$$\frac{4n}{2}$$

$$i = 0$$

$$j = n-1 \dots j = n-1 ?$$

$$i = 0, i = 2, i = 4, i = 6 \dots 2k$$

$$+4 \quad +4 \quad +4 \quad +4 \quad +4$$

$$4(k+1) = \frac{4n}{2}$$

4. (10 points) Find $C, n_0, f(n)$ such that $|T(n)| \leq C|f(n)|$ whenever $n > n_0$. **SHOW YOUR WORK.**

a. $T(n) = 3n^5 - 2n^3 + 4n - 7$ $f(n) = n^3, C = -2, n_0 = 1$

$$3n^5 - 2n^3 + 4n - 7 \leq Cn^3$$

$$3 \cdot 1^5 - 2 \cdot 1^3 + 4 \cdot 1 - 7 \leq C \cdot 1^3$$

$$3 - 2 + 4 - 7 \leq C$$

$$1 - 3 \leq C$$

$$-2 \leq C$$

5. (10 points) Update the Array with the given commands. **Draw a new picture for each part.**

0	1	2	3	4	5	6	7	8	9

- Add the following Strings to the array: "John", "Jonas", "Hans", "Jani", "Juan", "Gio", "Joao", "Jana", "Johnny", "Jon" in that order.
- Replace index 6, with "Ivan."
- What happens if we add "Jane" at the end of the array?

A-

0	1	2	3	4	5	6	7	8	9
John	Jonas	Hans	Jani	Juan	Gio	Joao	Jana	Johnny	Jon

B

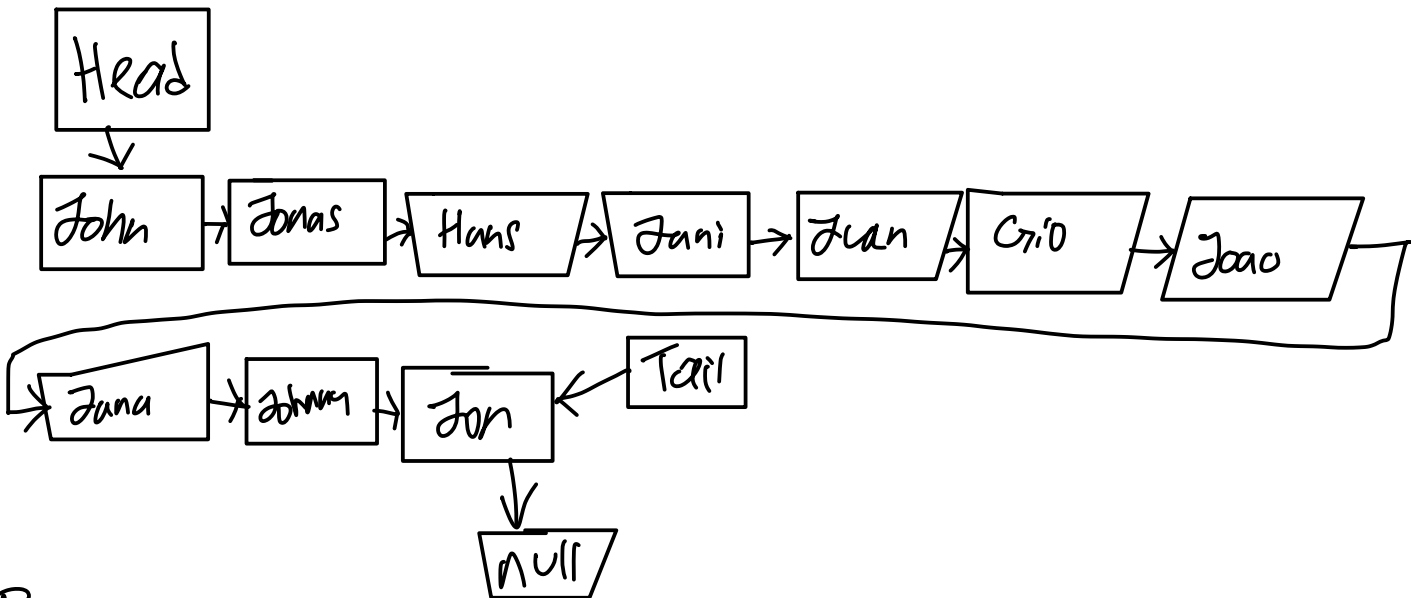
0	1	2	3	4	5	6	7	8	9
John	Jonas	Hans	Jani	Juan	Gio	Ivan	Jana	Johnny	Jon

C. Can't Add Elements to a full Array. Will crash program.

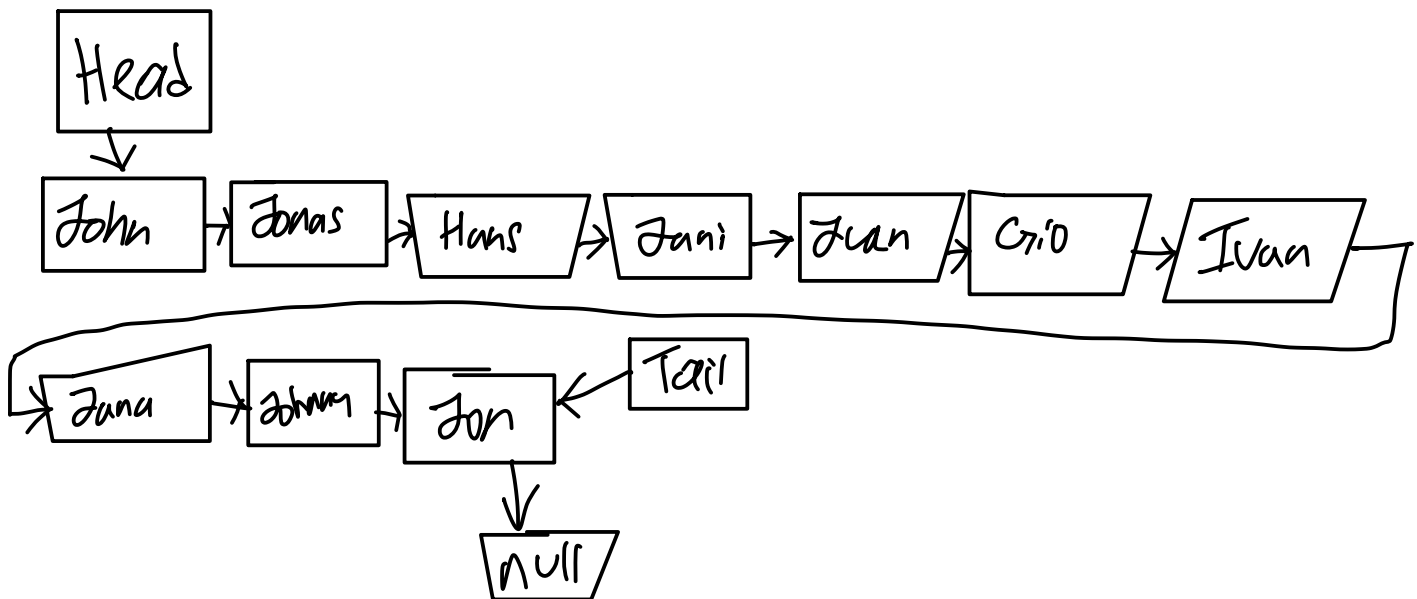
7. (10 points) Update the Single-Linked List with the given commands. **Draw a new picture for each part.**

- Add the following Strings to the Single-Linked List: "John", "Jonas", "Hans", "Jani", "Juan", "Gio", "Joao", "Jana", "Johnny", "Jon" in that order.
- Replace index 6, with "Ivan".
- What happens if we add "Jane" at the end of the list?
- What happens if we add "Jorge" by index 7 what do we get?
- What happens if remove the elements in index 6 what do you get?

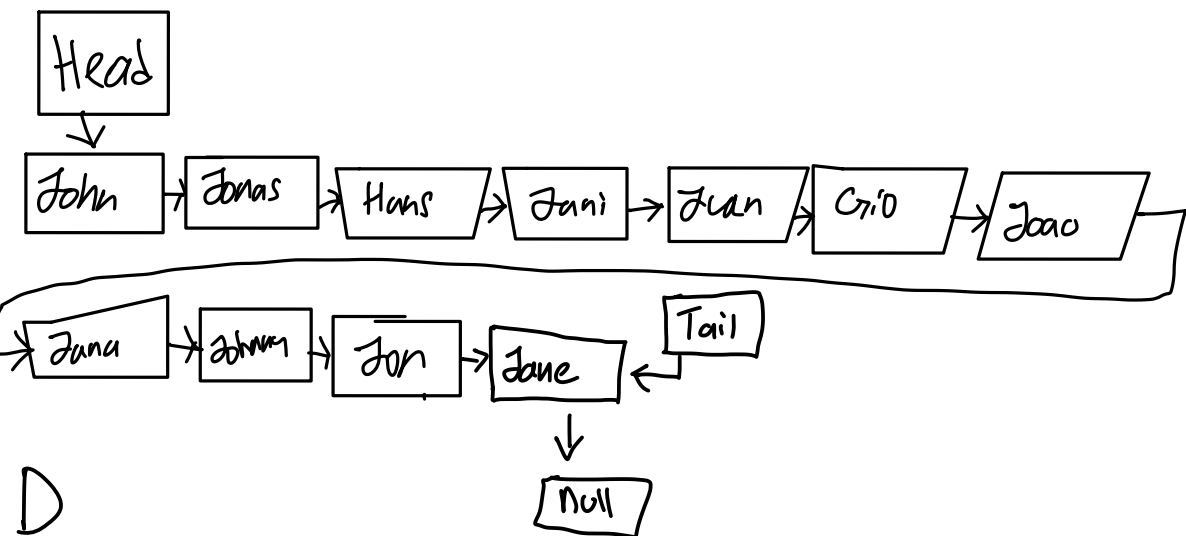
A.



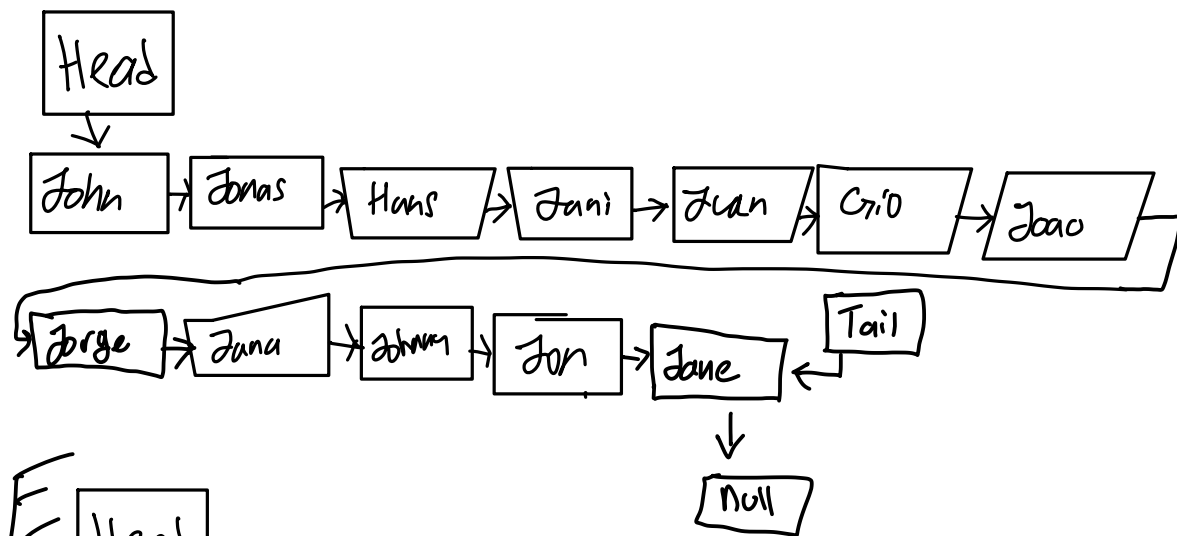
B.



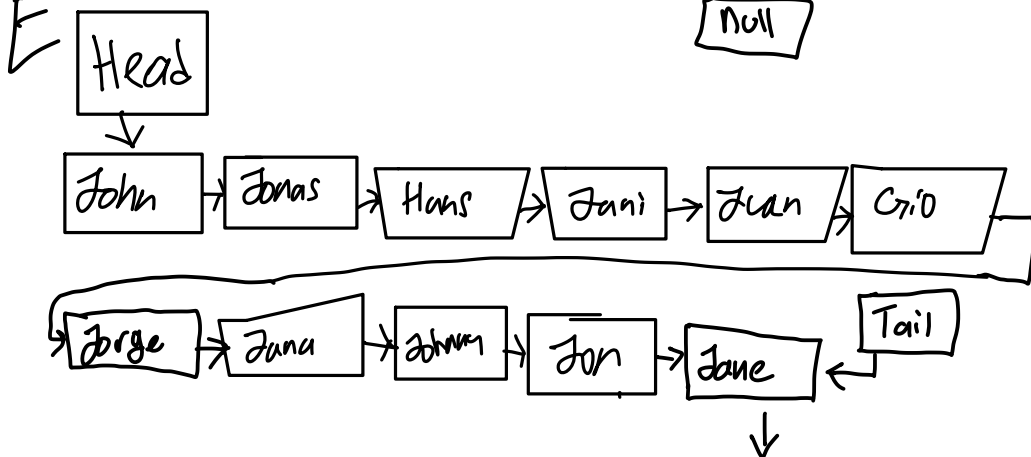
C.



D



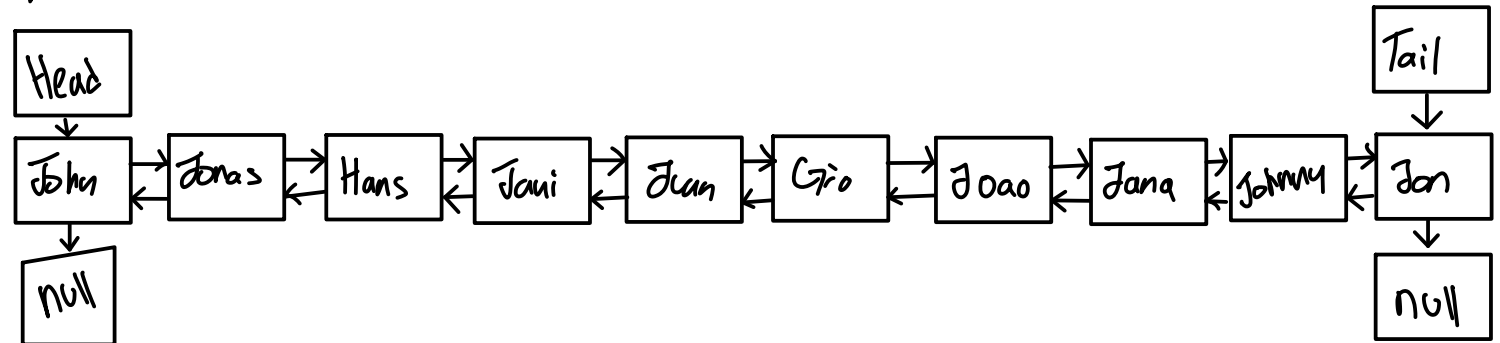
E



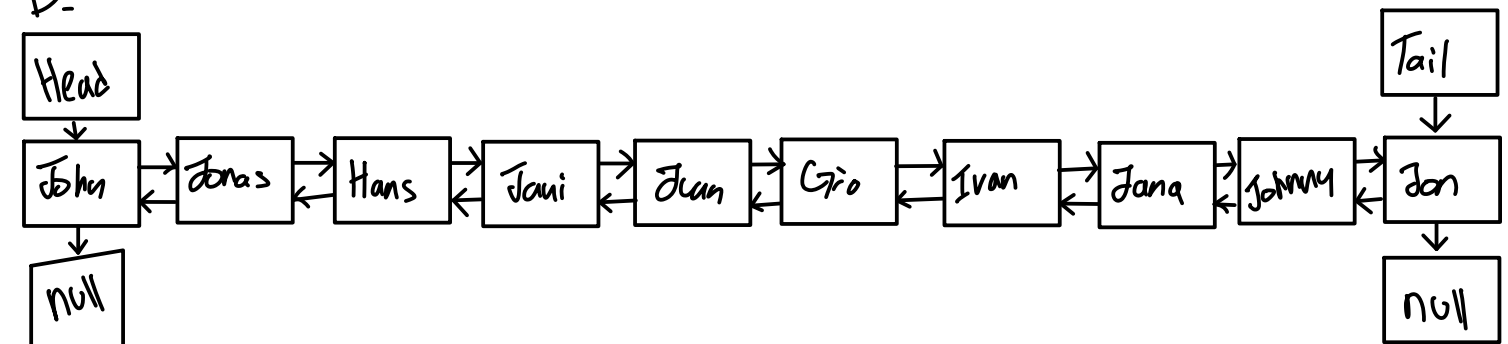
8. (10 points) Update the Double-Linked List with the given commands. **Draw a new picture for each part.**

- Add the following Strings to the Double-Linked List: "John", "Jonas", "Hans", "Jani", "Juan", "Gio", "Joao", "Jana", "Johnny", "Jon" in that order.
- Replace index 6, with "Ivan".
- What happens if we add "Jane" at the end of the list?
- What happens if we add "Jorge" by index 7 what do we get?
- What happens if remove the elements in index 6 what do you get?

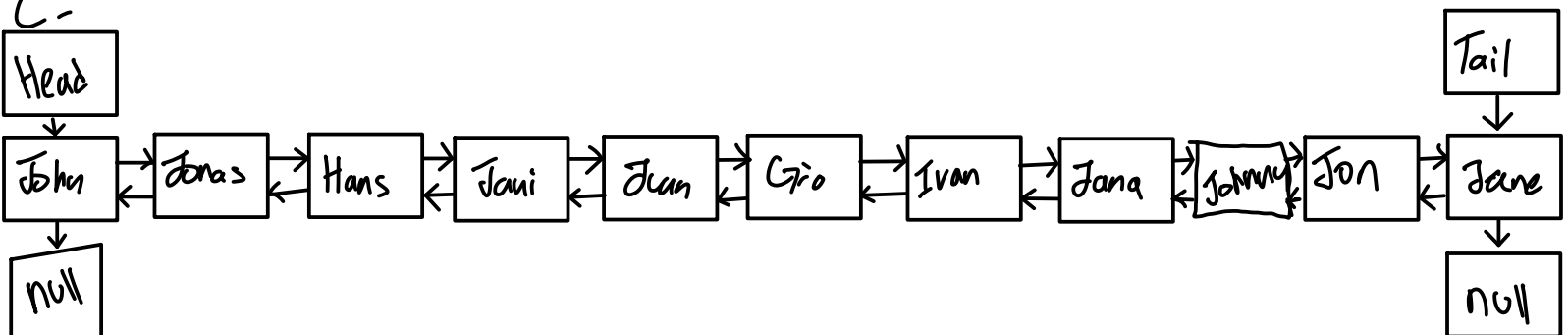
A.



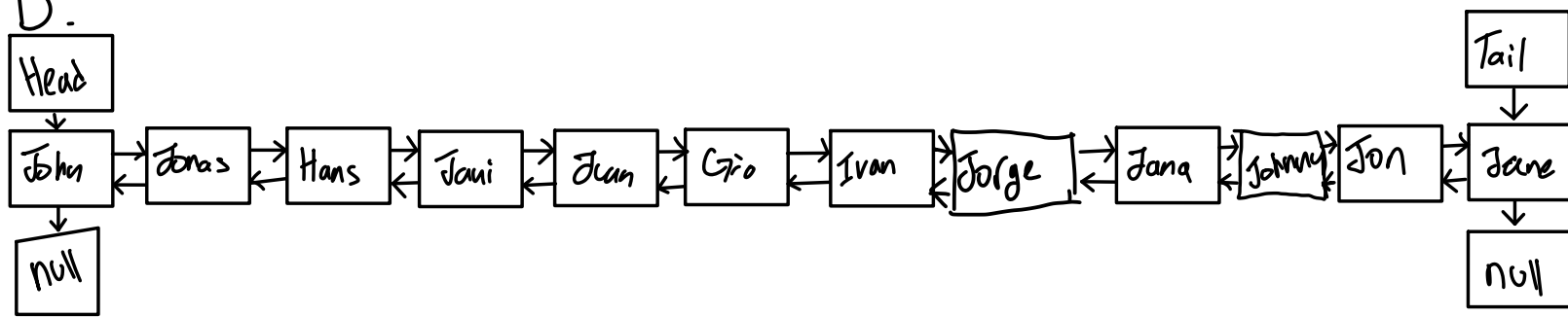
B.



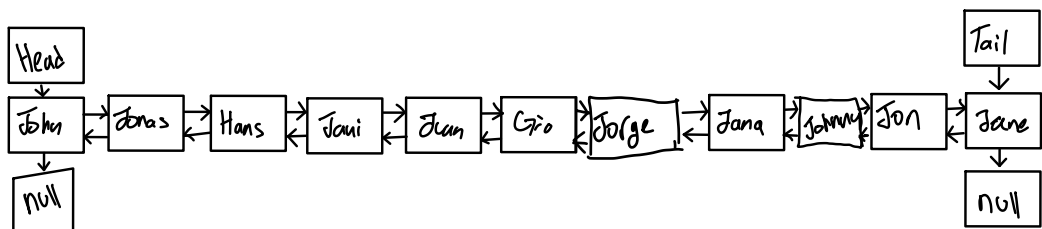
C.



D.



E.



9. (10 points) Update the Stack List with the given commands. **Draw a new picture for each part.**
- Add the following Strings to the Stack using an ArrayList: "John", "Jonas", "Hans", "Jani", "Juan", "Gio", "Joao", "Jana", "Johnny", "Jon" in that order.
 - Push "Ivan".
 - Push "Jane".
 - Peek the list.
 - Pop the list.

A.

0	1	2	3	4	5	6	7	8	9
John	Jonas	Hans	Jani	Juan	Gio	Joao	Jana	Johnny	Jon

Top
↓

B

0	1	2	3	4	5	6	7	8	9
John	Jonas	Hans	Jani	Juan	Gio	Joao	Jana	Johnny	Jon

10	11	12	13	14	15	16	17	18	19
Ivan									

C. ↑ Top

0	1	2	3	4	5	6	7	8	9
John	Jonas	Hans	Jani	Juan	Gio	Joao	Jana	Johnny	Jon

10	11	12	13	14	15	16	17	18	19
Ivan	Jane								

↑
Top

D. Returns Element At Top of Stack, Does not Delete.

11
Jane

E.

0	1	2	3	4	5	6	7	8	9
John	Jonas	Hans	Jani	Juan	Grig	Jana	Jana	Johnny	Jon

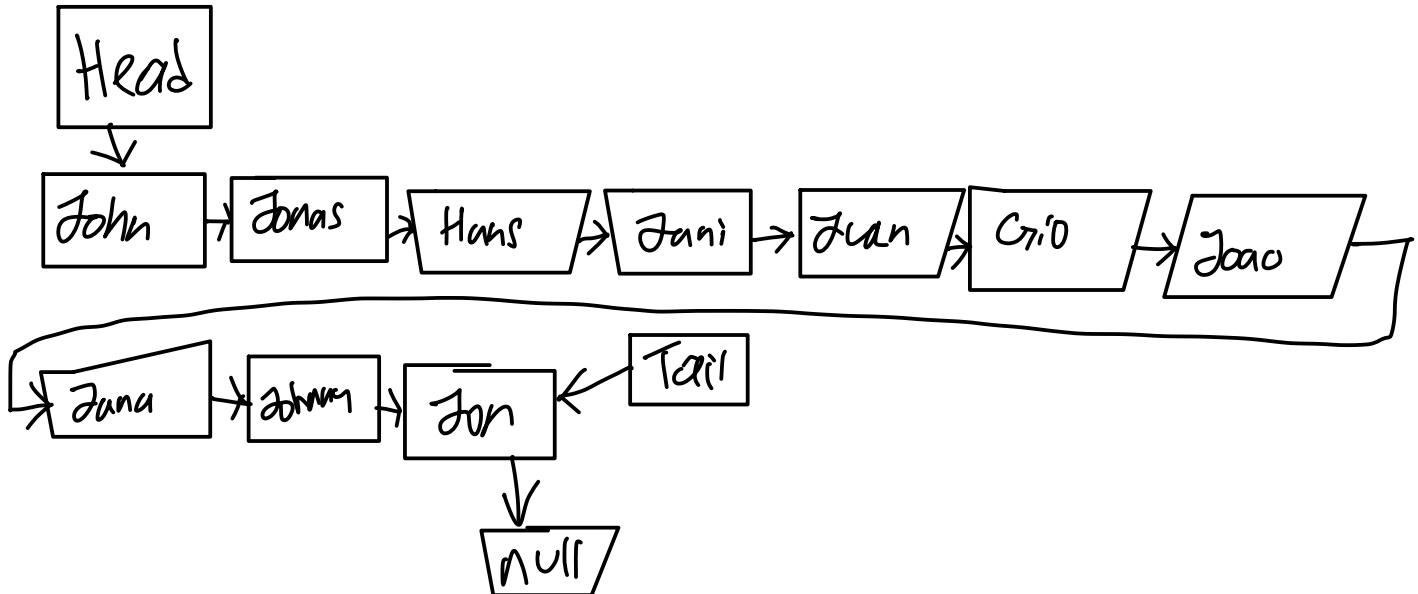
10	11	12	13	14	15	16	17	18	19
Ivan									

↑
Top

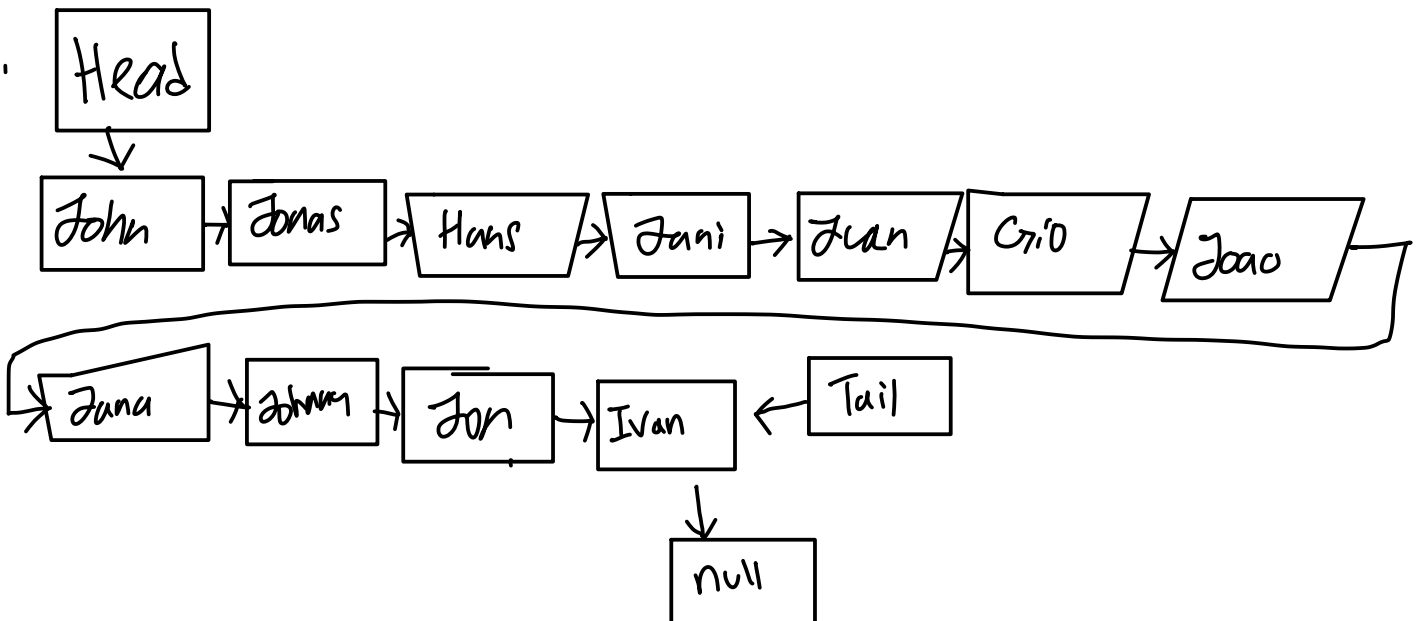
10. (10 points) Update the Queue List with the given commands. **Draw a new picture for each part.**

- Add the following Strings to the Single-LinkedList: "John", "Jonas", "Hans", "Jani", "Juan", "Gio", "Joao", "Jana", "Johnny", "Jon" in that order.
- Add "Ivan".
- Offer "Jane".
- Peek the list.
- Poll the list.

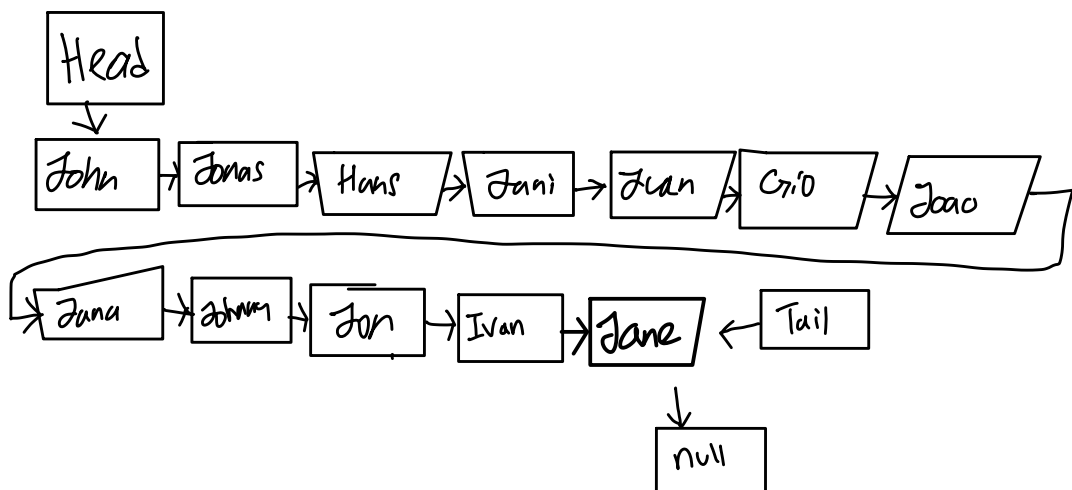
A.



B.



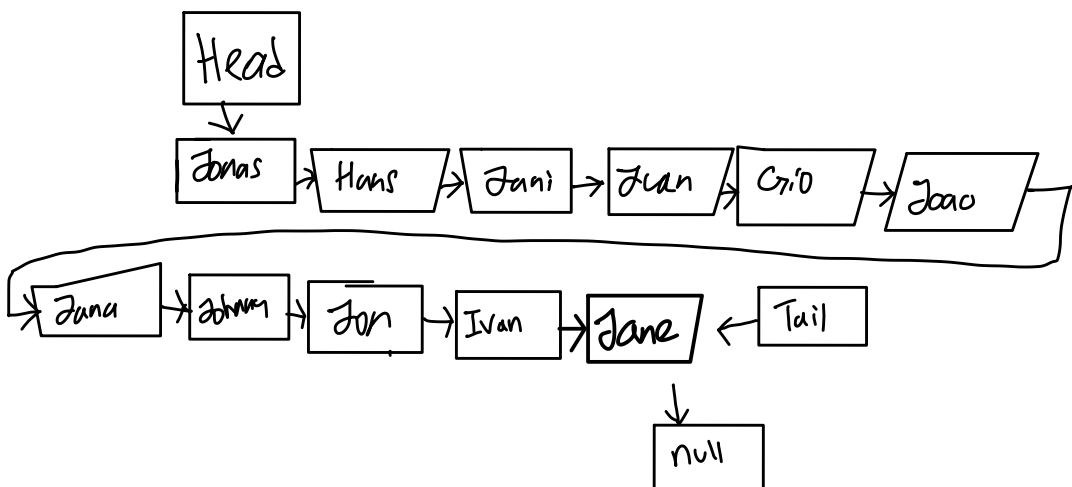
C.



D

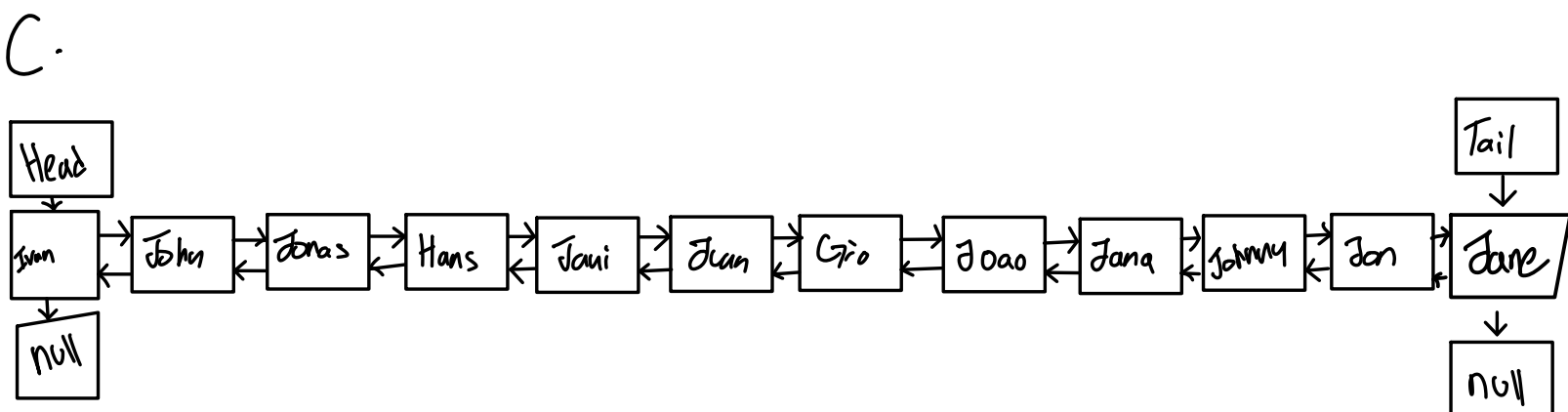
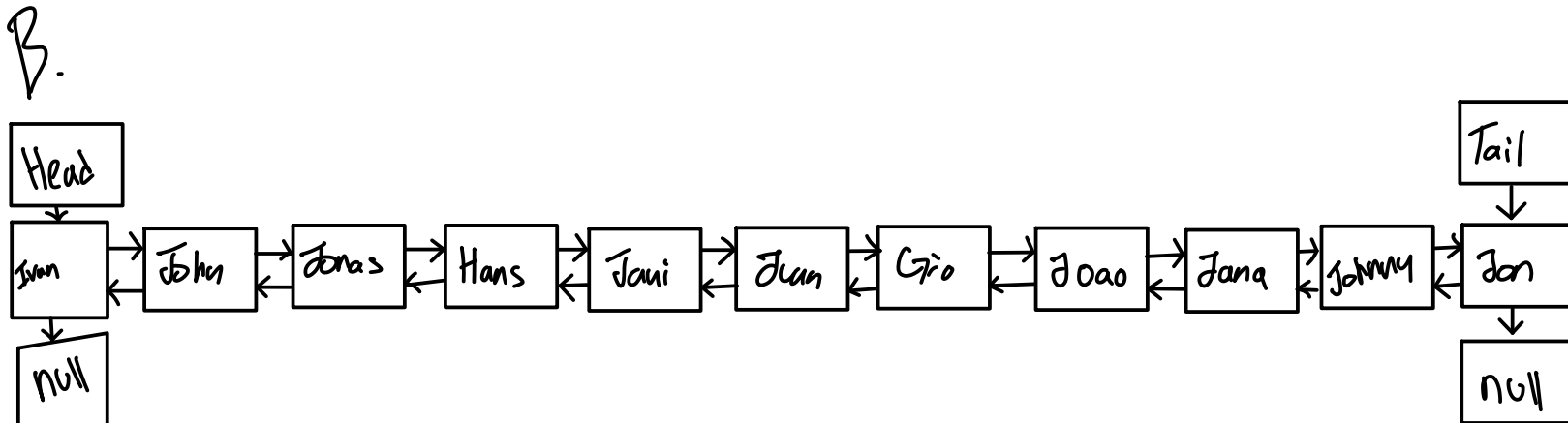
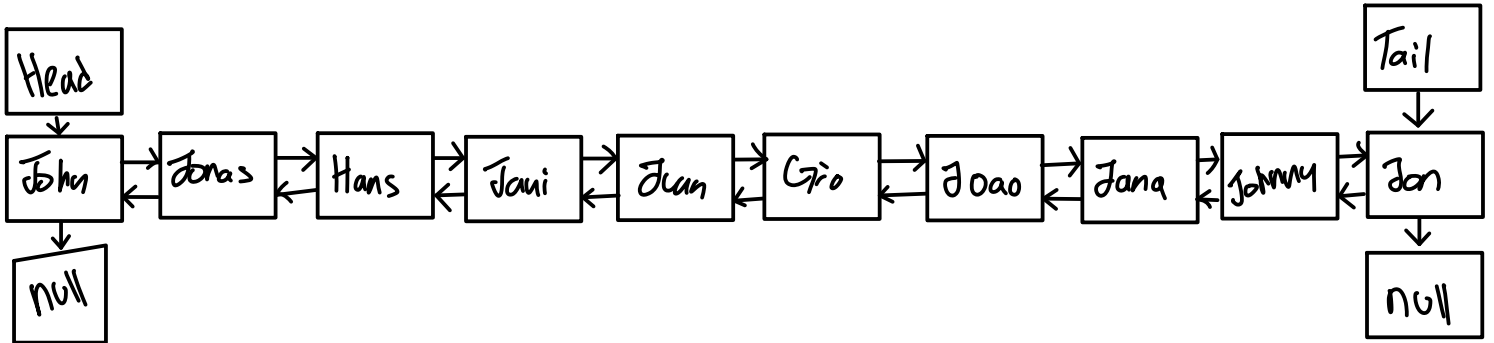


E

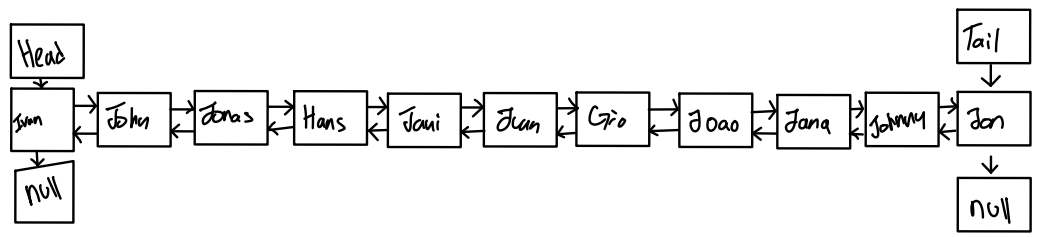


11. Extra Credit (10 points): Update the Deque List with the given commands. **Draw a new picture for each part.**

- Add the following Strings to the Double-LinkedList: "John", "Jonas", "Hans", "Jani", "Juan", "Gio", "Joao", "Jana", "Johnny", "Jon" in that order.
- addFirst "Ivan".
- addLast "Jane".
- pollLast the list.
- removeFirst the list.



D Removes and returns Jane



E

