1- What's wrong with this definition:

Arrays arrays = new Arrays();

الخطا في استخدام كلمة Arrays

2- Write and test this method:

void reverse(int[] a)

// reverses the elements of a[]

```
public void reverse(int[] a) {
    int left = 0;
    int right = a.length - 1;

    while (left < right) {
        // Swapping elements at left and right indices
        int temp = a[left];
        a[left] = a[right];
        a[right] = temp;

        // Move the left index forward and the right index backward
        left++;
        right--;
    }
}
```

3- If linked lists are so much better than arrays, why are arrays used at all?

(1

سهولة الاستخدام: المصفوفات أكثر بساطة في الاستخدام مقارنة بالقوائم المرتبطة. فهي تعمل بشكل مباشر ومبسط بدون الحاجة لإنشاء وإدارة وصيانة العقد والروابط بين العناصر

2) الوصول العشوائي

3) الكفاءة في التكرار

4) توفير الذاكرة الزائدة

4- Mark the following statements as true or false.

a. In a linked list, the order of the elements is determined by the order in which the nodes were created to store the elements.

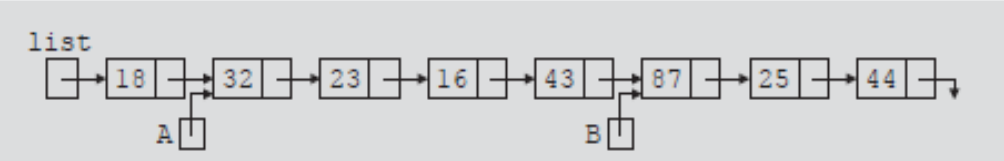
b. In a linked list, memory allocated for the nodes is sequential.

c. A single linked list can be traversed in either direction.

d. In a linked list, nodes are always inserted either at the beginning or the end because a linked link is not a random access data structure.

e. The head pointer of a linked list cannot be used to traverse the list.

Consider the linked list shown in Figure. Assume that the nodes are in the usual Element-Next form. Use this list to answer Exercises 5 through 8. If necessary, declare additional variables. (Assume that list, p, s, A, and B are references of type Node.)



Linked list for Exercises 2–7

5- What is the output of each of the following java statements?

a. System.out.println(list.getElement());
b. System.out.println(A. getElement());
c. System.out.println(B.getNext().getElement());
d. System.out.println(list.getNext().getNext().getElement());

6- What is the value of each of the following relational expressions?

a. list. getElement() >= 18
b. list.getNext() == A
c. A.getNext().getElement() == 16
d. B.getNext() == (NULL)
e. list. getElement() == 18

7- Write java Fragment code to do the following:

a- Make A point to the node containing element 23.

```
8- Node currentNode = list;
9- while (currentNode != null) {
10-   if (currentNode.getElement() == 23) {
11-     currentNode.setMarked(true);
12-     break;
13-   }
14-   currentNode = currentNode.getNext();
15-     }
```

b-Make list point to the node containing 16.

```
Node currentNode = list;
while (currentNode != null) {
  if (currentNode.getElement() == 16) {
    list = currentNode;
    break;
  }
  currentNode = currentNode.getNext();
}
```

c-Make B point to the last node in the list.

```
Node currentNode = list;
Node lastNode = null;
while (currentNode != null) {
  lastNode = currentNode;
  currentNode = currentNode.getNext();
}
```

```
B = lastNode;
```

d-Make list point to an empty list.

```
list = null;
```

e-Set the value of the node containing 25 to 35.

```
Node currentNode = list;
while (currentNode != null) {
  if (currentNode.getElement() == 25) {
    currentNode.setElement(35);
    break;
  }
  currentNode = currentNode.getNext();
}
```

f-Create and insert the node with element 10 after the node pointed by A.

```
Node newNode = new Node(10);
newNode.setNext(A.getNext());
A.setNext(newNode);
```

g-Delete the node with element 23. Also, deallocate the memory occupied by this node.

```
Node previousNode = null;
Node currentNode = list;
while (currentNode != null) {
  if (currentNode.getElement() == 23) {
    if (previousNode == null) {
      list = currentNode.getNext();
    } else {
      previousNode.setNext(currentNode.getNext());
    }
    currentNode = null;
    break;
  }
  previousNode = currentNode;
  currentNode = currentNode.getNext();
}
```

16- What is the output of the following java code?

```
p = list;
while (p != NULL){
System.out.println(  p.getElement());
p = p.getNext();  }
```

طباعة قيم عناصر القائمة واحدًا تلو الآخر حتى يصل المتغير "ع" إلى قيمة NULL.

17- Show what is produced by the following java code. Assume the node is in the usual **getElement()-getNext()** form with the info of type int. (**list** and **p** are pointers of type **node<E>()**.)

a-
```
list = new node<E>();
list.setElement(10);
p = new node<E>();
p. setElement(13);
p.setNext(null);
list.setNext(p);
p = new node<E>(18, list.getNext());
list.setNext(p);
System.out.println(list.getElement());
System.out.println(p.getElement());
p = p.getNext();
System.out.println(p.getElement());
```

```
10
18
13
```

b-
```
list = new node<E>();
list.setElement(20);
p = new node<E>();
p. setElement(28);
p.setNext(NULL);
list. setNext(p);
p = new node<E>();
p.setElement(30);
p.setNext(list);
list = p;
p = new node<E>();
p.setElement(42);
p.setNext(list.getNext());
list.setNext(p);
p = List;
while (p != NULL)
{
System.out.println(  p.getElement());
p = p.getNext();     }
```

```
30
20
28
42
```

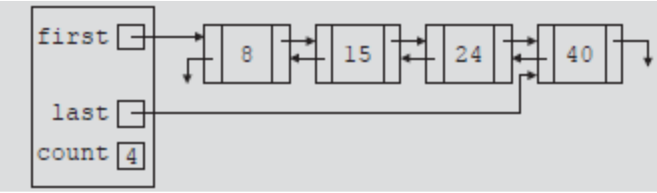
18- Consider the following java statements. (The class SingleLinkedList is as defined in the lectures).

```
SingleLinkedList<int> list;
list.addFirst(15);
list.addLast(28);
list.addFirst(30);
list.addFirst(2);
list.addLast(45);
list.addFirst(38);
list.addLast(25);
list.removeNode(30);
list.addFirst(18);
list.removeNode(28);
list.removeNode(12);
list.print();
```

What is the output of this program segment?

```
38 2 18 15 45 25
```

19- For the following doubly linked list figure, show by java code how to insert value (info) 20 between values 15 & 24?




```
public class DoublyLinkedList {
    private Node head;
    private Node tail;

    private class Node {
        int data;
        Node prev;
        Node next;

        public Node(int data) {
            this.data = data;
            this.prev = null;
            this.next = null;
        }
    }

    // إضافة قيمة في البداية
    public void addFirst(int data) {
        Node newNode = new Node(data);
        if (head == null) {
            head = newNode;
```

```
            tail = newNode;
        } else {
            newNode.next = head;
            head.prev = newNode;
            head = newNode;
        }
    }

    // إضافة قيمة في النهاية
    public void addLast(int data) {
        Node newNode = new Node(data);
        if (tail == null) {
            head = newNode;
            tail = newNode;
        } else {
            tail.next = newNode;
            newNode.prev = tail;
            tail = newNode;
        }
    }

    // إدراج قيمة بين قيمتين محددين
    public void insertBetween(int data, int value1, int value2) {
        Node newNode = new Node(data);
        Node currentNode = head;

        while (currentNode != null) {
            if (currentNode.data == value1 && currentNode.next != null && currentNode
.next.data == value2) {
                Node nextNode = currentNode.next;
                currentNode.next = newNode;
                newNode.prev = currentNode;
                newNode.next = nextNode;
                nextNode.prev = newNode;
                break;
            }
            currentNode = currentNode.next;
        }
    }

    // طباعة قيم القائمة
    public void print() {
        Node currentNode = head;
        while (currentNode != null) {
            System.out.print(currentNode.data + " ");
            currentNode = currentNode.next;
        }
        System.out.println();
    }

    public static void main(String[] args) {
        DoublyLinkedList list = new DoublyLinkedList();
        list.addFirst(15);
        list.addLast(24);
        list.insertBetween(20, 15, 24);
```

```
        list.print(); // 24 20 15 :ستطبع
    }
}
```

20- Write and test this method for **SingleLinkedList class** :

Public int sum(Node<int> list)

// returns: the sum of the integers in the specified list;

For example, if list is {25, 45, 65, 85}, then sum(list) will return 220.

```
public int sum() {
    int sum = 0;
    Node currentNode = head;

    while (currentNode != null) {
        sum += currentNode.data;
        currentNode = currentNode.next;
    }

    return sum;
}
public static void main(String[] args) {
    SingleLinkedList list = new SingleLinkedList();
    list.addLast(25);
    list.addLast(45);
    list.addLast(65);
    list.addLast(85);

    int sum = list.sum();
    System.out.println("مجموع القائمة: " + sum); // 220 :القائمة مجموع :ستطبع
}
```

21- Write and test this method for **DoublyLinkedList class**:

Public E removeLast(Node<E> list)

// precondition: the specified list has at least two nodes;

// postcondition: the last node in the list has been deleted;

For example, if list is {22, 44, 66, 88}, then removeLast(list) will change it to {22, 44, 66}.

```
public void removeLast() {
    if (tail == null) {
        // القائمة فارغة
        return;
    }

    if (head == tail) {
        // القائمة تحتوي على عقدة واحدة فقط
        head = null;
        tail = null;
        return;
    }

    tail = tail.prev;
    tail.next = null;
```

```
}
public static void main(String[] args) {
    DoublyLinkedList list = new DoublyLinkedList();
    list.addLast(22);
    list.addLast(44);
    list.addLast(66);
    list.addLast(88);

    System.out.print("القائمة قبل الإزالة: ");
    list.print(); // ستطبع: 88 66 44 22

    list.removeLast();

    System.out.print("القائمة بعد الإزالة: ");
    list.print(); // ستطبع: 66 44 22
}
```

22- Write and test this method for **SingleLinkedList class**:

Public void append(Node<E> list1, Node<E> list2)

// precondition: list1 has at least one node;

// postcondition: list1 has list2 appended to it;

For example, if list1 is {22, 33, 44, 55} and list2 is {66, 77, 88, 99}, then append(list1, list2) will change list1 to {22, 33, 44, 55, 44, 55, 66, 77, 88}. Note that no new nodes are created by this method.

```
public void append(SingleLinkedList<E> list2) {
    if (list2.head == null) {
        // لا يوجد عقد لإلحاقه
        return;
    }

    Node currentNode = head;

    // الوصول إلى نهاية القائمة الأولى
    while (currentNode.next != null) {
        currentNode = currentNode.next;
    }

    // إلحاق القائمة الثانية بالقائمة الأولى
    currentNode.next = list2.head;
}
public static void main(String[] args) {
    SingleLinkedList<Integer> list1 = new SingleLinkedList<>();
    list1.addLast(22);
    list1.addLast(33);
    list1.addLast(44);
    list1.addLast(55);

    SingleLinkedList<Integer> list2 = new SingleLinkedList<>();
    list2.addLast(66);
    list2.addLast(77);
    list2.addLast(88);
```

```
    list2.addLast(99);

    System.out.print("القائمة 1 قبل الإلحاق: ");
    list1.print(); // 55 44 33 22 :ستطبع

    list1.append(list2);

    System.out.print("القائمة 1 بعد الإلحاق: ");
    list1.print(); // 99 88 77 66 55 44 33 22 :ستطبع
}
```

23- Write and test this method for **SingleLinkedList class**:

Public Node<E> concat(Node<E> list1, Node<E> list2)

// returns: a new list that contains a copy of list1, followed by a copy of list2;

For example, if list1 is {22, 33, 44, 55} and list2 is {66, 77, 88, 99}, then concat(list1, list2) will return the new list {22, 33, 44, 55, 44, 55, 66, 77, 88}. Note that the three lists should be completely independent of each other. Changing one list should have no effect upon the others.

```
public SingleLinkedList<E> concat(SingleLinkedList<E> list2) {
    SingleLinkedList<E> newList = new SingleLinkedList<>();

    Node currentNode = head;

    // نسخ القائمة 1 إلى القائمة الجديدة
    while (currentNode != null) {
        newList.addLast(currentNode.data);
        currentNode = currentNode.next;
    }

    // نسخ القائمة 2 إلى القائمة الجديدة
    currentNode = list2.head;
    while (currentNode != null) {
        newList.addLast(currentNode.data);
        currentNode = currentNode.next;
    }

    return newList;
}
public static void main(String[] args) {
    SingleLinkedList<Integer> list1 = new SingleLinkedList<>();
    list1.addLast(22);
    list1.addLast(33);
    list1.addLast(44);
    list1.addLast(55);

    SingleLinkedList<Integer> list2 = new SingleLinkedList<>();
    list2.addLast(66);
    list2.addLast(77);
    list2.addLast(88);
    list2.addLast(99);

    System.out.print("1 القائمة: ");
    list1.print(); // 55 44 33 22 :ستطبع
```

```
    System.out.print("القائمة 2: ");
    list2.print(); // ستطبع: 99 88 77 66

    SingleLinkedList<Integer> newList = list1.concat(list2);

    System.out.print("القائمة الجديدة: ");
    newList.print(); // ستطبع: 99 88 77 66 55 44 33 22
}
```

24- Write and test this method for **DoublyLinkedList class**:

Public void swap(Node<E> list, int i, int j)

// swaps the i_{th} element with the j_{th} element;

For example, if list is {22, 33, 44, 55, 66, 77, 88, 99}, then swap(list, 2, 5) will change list to {22, 33, 77, 55, 66, 44, 88, 99}.

```
public void swap(Node<E> list, int i, int j) {
    if (i == j) {
        // No need to swap if i and j are the same
        return;
    }

    Node<E> node1 = getNodeAtIndex(list, i);
    Node<E> node2 = getNodeAtIndex(list, j);

    if (node1 == null || node2 == null) {
        // Invalid indices, cannot perform swap
        return;
    }

    E temp = node1.data;
    node1.data = node2.data;
    node2.data = temp;
}

private Node<E> getNodeAtIndex(Node<E> list, int index) {
    Node<E> currentNode = list;
    int currentIndex = 0;
    while (currentNode != null && currentIndex < index) {
        currentNode = currentNode.next;
        currentIndex++;
    }
    return currentNode;
}
public static void main(String[] args) {
    DoublyLinkedList<Integer> list = new DoublyLinkedList<>();
    list.addLast(22);
    list.addLast(33);
    list.addLast(44);
    list.addLast(55);
    list.addLast(66);
    list.addLast(77);
    list.addLast(88);
    list.addLast(99);
```

```
    System.out.print("List before swap: ");
    list.print(); // Will print: 22 33 44 55 66 77 88 99

    list.swap(list.head, 2, 5);

    System.out.print("List after swap: ");
    list.print(); // Will print: 22 33 77 55 66 44 88 99
}
```

25- Describe in detail(without java code) an algorithm for reversing a singly linked list L using only a constant amount of additional space.

قم بتعيين ثلاثة مؤشرات: الأول (previous) لتتبع العقدة الحالية ، والثاني (current) لتتبع العقدة التالية (next) لتخزين العقدة السابقة ، والثالث.
ابدأ بتعيين المؤشر current للعقدة الأولى في القائمة والمؤشر previous إلى null.
قم بتكرار الخطوات التالية حتى تصل إلى نهاية القائمة:

احفظ المؤشر next كمرجع للعقدة التالية.
قم بتغيير مؤشر العقدة التالية ليشير إلى العقدة السابقة بدلاً من العقدة التالية.
قم بتغيير مؤشر العقدة السابقة ليشير إلى العقدة الحالية.
قم بتغيير مؤشر العقدة الحالية ليشير إلى العقدة التالية المحفوظة في المؤشر next.
بمجرد الوصول إلى نهاية القائمة، قم بتغيير رأس القائمة ليشير إلى العقدة السابقة في المؤشر previous.

26- Implement the equals( ) method for the DoublyLinkedList class.

```
27- @Override
28- public boolean equals(Object obj) {
29-     if (this == obj) {
30-         // If the objects are the same instance, they are equal
31-         return true;
32-     }
33-
34-     if (obj == null || getClass() != obj.getClass()) {
35-         // If the objects are of different classes or obj is null, they are not e
    qual
36-         return false;
37-     }
38-
39-     DoublyLinkedList<E> otherList = (DoublyLinkedList<E>) obj;
40-
41-     if (size() != otherList.size()) {
42-         // If the lists have different sizes, they are not equal
```

```
43-         return false;
44-     }
45-
46-     Node<E> currentNode = head;
47-     Node<E> otherNode = otherList.head;
48-
49-     while (currentNode != null) {
50-         if (!currentNode.data.equals(otherNode.data)) {
51-             // If the data in the current nodes is not equal, the lists are not e
   qual
52-             return false;
53-         }
54-
55-         currentNode = currentNode.next;
56-         otherNode = otherNode.next;
57-     }
58-
59-     // If all elements are equal, the lists are equal
60-     return true;
61-      }
```

27-Implement the rotate() methode in CircularLinkedList class.

```
public void rotate() {
    if (head == null || head.next == null) {
        // If the list is empty or contains only one element, no rotation is needed
        return;
    }

    Node<E> lastNode = head;
    while (lastNode.next != head) {
        lastNode = lastNode.next;
    }

    // Move the head to the next node
    head = head.next;

    // Make the last node point to the new head
    lastNode.next = head;
}
```

28-Implement the addFirst() method in CircularLinkedList class.

```
public void addFirst(E data) {
    Node<E> newNode = new Node<>(data);

    if (head == null) {
        // If the list is empty, set the new node as the head and make it point to it
self
        head = newNode;
        newNode.next = newNode;
    } else {
        // If the list is not empty, insert the new node before the head and update t
he pointers
        Node<E> lastNode = head;
```

```
        while (lastNode.next != head) {
            lastNode = lastNode.next;
        }
        lastNode.next = newNode;
        newNode.next = head;
        head = newNode;
    }
}
```