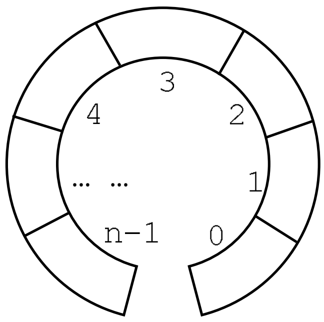
2 A circular queue is to be implemented with a fixed size array of n elements, indexed from `0` to `(n - 1)`.



Task 2.1

Following good programming practice, write program code for procedures

`setup_queue` to set up circular queue which allows user to input the value of `n`,

`enqueue` to add an element to the queue,

`dequeue` to remove an element from the queue.

Evidence 5: Program code for Task 2.1 for `setup_queue`, `enqueue`, `dequeue`. **[12]**

Task 2.2

Write program code for a main procedure to display a menu with these options:

```
1. Set up queue
2. Add to queue
3. Remove from queue
4. Display queue
5. Exit
```

Write additional code to implement menu options 1, 2 and 3 using procedures from Task 2.1.

Also write code to implement

- option 4 to display the contents of the queue and its pointers as shown in diagram below,

  option 5 to exit program.

The diagram shows the result of option 4 to display contents of queue and pointers for `n=5` with 3 items `'fig'`, `'lemon'` and `'cane'` in the queue:

```
   Queue
|   fig     | <- Front pointer
|  lemon    |
|   cane    | <- Rear pointer
|           |
|           |

Number in queue: 3
```

Evidence 6: Program code for Task 2.2 for main procedure, display queue and exit program. **[8]**

Task 2.3

Test run your program from using the following input:

Test run 1	**Test run 2**

`n = 8`
Add 5 words to queue in order:
`'Mary', 'had', 'a', 'little', 'lamb'`
• Display queue
	`n = 3`
	Add 4 words to queue in order:
	`'The', 'quick', 'brown', 'fox'`
	• Remove from queue once
	• Display queue

Evidence 7

Screenshots of test runs 1 and 2. **[2]**

[22 marks]

3 A linked list of nodes is used to store data for a college. The data include name of student and exam mark.

The linked list Abstract Data Type (ADT) has commands to create a new linked list, add data items to the list and display the list.

The program to implement this ADT will use the classes **`Node`** and **`LinkedList`** as follows:

`Node`
`name     : STRING`
`mark     : INTEGER`
`nextPtr : INTEGER`
`constructor()`
`setName(name : STRING)`
`setMark(mark : INTEGER)`
`setNextPtr(ptr : INTEGER)`
`getName()       : STRING`
`getMark()       : INTEGER`
`getNextPtr()    : INTEGER`

`LinkedList`
`nodes : ARRAY OF` **`Node`**
`head  : INTEGER`
`constructor()`
`addInOrder(name, mark)`
`print()`

In the `Node` class, `name` and `mark`
respectively, while `nextPtr` is a pointer to the next node.

In the `LinkedList` class, `head` is a pointer to the first node in the linked list.
When the linked list has no data, `head` will be set to –1.
Data added to the linked list will be stored in alphabetical order of name.
The print method will output for each node, in array order, the data and pointer of each node.

Task 3.1

Write program code to define the classes `Node` and `LinkedList`.

Evidence 8: Program code for Task 3.1. **[20]**

Task 3.2

Write code to create a linked list object in the main program, read from data file `COLLEGE.txt` and add in all the data items, and print the array contents.

The file contains name and mark of each student in the following format:

`<name>|<mark>`

Sample record: `Jenny Tan|49`

Evidence 9

Program code for Task 3.2.

Screenshot of running Task 3.2. **[5]**

Task 3.3

Write code for a method `countNodes` to count the number of nodes used for the data in the linked list.

Evidence 10: Program code for Task 3.3 `countNodes`. **[3]**

Task 3.4

Another method `sortByMark` is to be added to the `LinkedList` class to sort the linked list in descending order of exam mark.

Write program code to implement this method.

Test your program code by sorting the linked list from Task 3.2 in descending order of mark.

Evidence 11

Program code for Task 3.4 `sortByMark`.

Screenshot of running Task 3.4 `sortByMark`. **[8]**

Task 3.5

Write another method `displayByMark` to display the list of students in descending order of mark by traversing the sorted linked list from Task 3.4.

Evidence 12

Program code for Task 3.5 `displayByMark`. **[4]**

[40 marks]