Please use either C++ or Java languages for all programming questions.

1. **(15 %)** A singly linked list originally stores n nodes of integers not in order. It is desired to convert this singly linked list into a special doubly linked list with a particular dummy node, which is not seen from outside. The converted list has three different sections. The first section contains all nodes with negative integers starting from the head. The second section is the dummy node, whose value indicates the number of zeros encountered during the conversion. The final section contains all nodes with positive integers to the end. There is no need to sort the integers in the first and final sections.
   a. (5 %) Write down the definitions of the singly and doubly linked list classes and nodes.
   b. (10 %) Write a program that accepts a singly linked list and returns the specified doubly linked list.

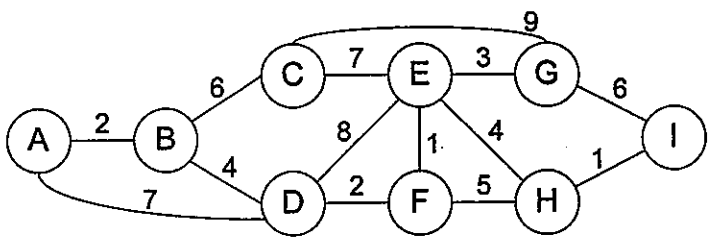
2. **(10 %)** Let $f(n) = \sum_{i=1}^{n} \sqrt{i} = 1 + \sqrt{2} + \sqrt{3} + \cdots + \sqrt{n}$. By showing both the upper and lower bounds, prove that $f(n) = \Theta(n\sqrt{n})$.

3. **(10 %)** What does the following minimum binary heap look like after removeMin( )?

⊠	1	4	3	5	4	15	9	16	8

4. **(25 %)** Suppose that there are particles moving in a 2D space and we are interested in their coordinates and the associated magnitude. Let (x, y) represent the particle coordinates with double precision and mag be an integer representing the magnitude whose value is between 0 and 255. Design data structures of your choice to fulfill the following tasks.
   a. (5 %) Write down the name(s) of data structures you choose and all required class definitions.
   b. (10 %) Write a program that outputs the number of particles that have the same given magnitude. Additionally, please output their coordinates.
   c. (10 %) Write a program that finds the largest magnitude smaller than the given magnitude, if it is not found. Additionally, please output the number of particles with the found magnitude.

5. **(15 %)** For the following graph as shown:
   a. (5 %) Give the adjacency list representation.
   b. (10 %) Draw the minimum spanning tree.



6. **(15 %)** Trace the sorting of the following array into ascending order using:
   3812 1600 4012 3934 1234 2724 3333 5432 1008
   a. (5 %) Insertion sort.
   b. (10 %) Radix sort.

7. **(10 %)** Suppose you have a deque D containing the numbers (1,2,3,4,5,6,7,8), in this order. Suppose further that you have an initially empty queue Q. Give a pseudo-code description of a function that uses only D and Q (and no other variables or objects) and results in D storing the elements (1,2,3,5,4,6,7,8), in this order.

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