

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

一、 **Fill in the blank** (20%)

1. A _____ is a complete binary tree whose root contains no element and the left subtree is a min heap while the right tree is a max heap.
2. Assuming that there is a hash table which is partitioned into b buckets, while each bucket has s slots and each slot can hold exactly one record. The address of an identifier, x , is determined by a hash function f . If we limit the identifier to be exactly eight characters long, with the first one being a letter, and the second one being one of the three smallest prime numbers, and the remaining ones either letters or the three smallest prime numbers, there will thus be _____ distinct possible values for x . Assuming we have n identifiers in the hash table, the loading density of the hash table is _____.
3. A _____ consists of a sequence of rotations, in which a failure can be modeled as a different successful operation.
4. The difference between an algorithm and a computer program is that an algorithm must be _____.

二、 **Short-Answer Questions** (30%)

1. Use any program language you prefer to develop a function that inserts a positive number E into to a sequence of ordered numbers (size is equal to i), which are in ascending order, in a way that the resulting sequence of $i+1$ is also ordered. (5%)
2. Use any program language you prefer to develop a function that takes in n positive numbers (n must be larger than 10) and returns the largest number and the second smallest number in the end. (7%)
3. In a classic knapsack problem, there are n items, each of which has a specific weight (w_i) monetary value (v_i), for you to carry away using your knapsack, which can hold a maximum weight of W kilograms. One extra condition is that you have to take your loaded knapsack to a train station that is 10 kilometers away in 3 hours to catch the train that can take you away from the city. Normally you can travel 5 kilometers per hour with an empty knapsack, while one kilogram increase in the weight of your knapsack will slow you down by 0.1 kilogram per hour. Assuming that it does not take a significant time for you to select and pack the items you want to take away using you knapsack, your goal is to maximize the total values of the items you carry away while taking into considerations those constraints. Please use any program language you prefer to develop a program that can help you achieve the purpose specified above using backtracking method and the state space tree. (12%)
4. Briefly describe why a circular queue is more efficient than an array queue. (6%)

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三、Let the values in a set be 22, 65, 79, 34, 8, 53, 60, 41, 15, and 90.

1. (10%) Show how heapsort processes these values.
2. (10%) Show how quicksort processes these values.

四、(10%) The worst-case running times of two programs A and B are no greater than $c n \log_2 n$ and n^2 , respectively, where c is a positive integer. Which program will you use? Please justify your answer.

五、The numeric values in a set are all different and sorted in ascending order. Those sorted values will then be stored in a linked list, a stack, or a queue.

1. (5%) Which data structure will you choose to store two sets of values when the task is to find the largest common value in the two sets? Please justify your answer.
2. (5%) Which data structure will you choose to store two sets of values when the task is to compare the mean values of the two sets? Please justify your answer.

六、(10%) For any nonempty binary tree, show that the number of terminal nodes (the nodes that have no subtrees) is equal to the number of nodes of degree 2 (the nodes that have two subtrees) plus 1.