# Searching and Sorting

Standard difficulty · 20 questions · 40 marks · Time: 37 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

## Section A — Choose the correct answer — 8 × 1 = 8 marks

1. Binary search can be used only when the list is:
   **(a)** made of even numbers **(b)** unsorted
   **(c)** short **(d)** sorted

2. Linear search checks the items one by one from the left. How many items are checked when searching 77, 80, 72, 54, 74, 71, 94, 63, 97 for 58?
   **(a)** 5 **(b)** 8 **(c)** 9 **(d)** 10

3. Binary search: number the positions 1, 2, 3, …; check the middle position (the whole part of (low + high) ÷ 2); if the target is smaller, search the left half, if larger, the right half. How many items are checked when searching 2, 13, 27, 37, 41, 51, 58, 63, 87, 88 for 51?
   **(a)** 4 **(b)** 3 **(c)** 2 **(d)** 6

4. Bubble sort: in each pass, compare neighbours from left to right and swap any pair in the wrong order. What is the list 47, 22, 6, 36, 35, 19 after 2 passes?
   **(a)** 47, 22, 6, 36, 35, 19 **(b)** 6, 35, 22, 19, 36, 47
   **(c)** 6, 19, 22, 35, 36, 47 **(d)** 6, 22, 35, 19, 36, 47

5. Selection sort: in each pass, find the smallest item in the unsorted part and swap it to the front of that part. What is 24, 30, 28, 6, 26, 38 after 3 passes?
   **(a)** 6, 24, 26, 30, 28, 38 **(b)** 6, 24, 26, 30, 38, 28
   **(c)** 6, 24, 30, 26, 28, 38 **(d)** 6, 24, 26, 28, 30, 38

6. In the first pass of bubble sort on 26, 34, 17, 27, 37, 31, 33, how many swaps are made?
   **(a)** 5 **(b)** 7 **(c)** 3 **(d)** 4

7. A sorted list has 1,578 items. What is the greatest number of items binary search may need to check?
   **(a)** 789 **(b)** 10 **(c)** 11 **(d)** 12

8. For a sorted list of 1,485 items, how many more checks can linear search need than binary search, in the worst case?
   **(a)** 11 **(b)** 1,474 **(c)** 1,485 **(d)** 1,475

## Section B — Short answer — 8 × 2 = 16 marks

9. Why must a list be sorted before binary search?

**10.** Bubble sort compares neighbours from left to right in each pass, swapping any pair in the wrong order. Write 31, 57, 15, 55, 8, 41 after 3 passes, separated by commas.

**11.** Selection sort swaps the smallest item of the unsorted part to its front in each pass. Write 30, 44, 31, 46, 35, 17 after 3 passes, separated by commas.

**12.** Binary search: number the positions 1, 2, 3, …; check the middle position (the whole part of (low + high) ÷ 2); if the target is smaller, search the left half, if larger, the right half. Searching 26, 35, 38, 40, 52, 56, 62, 65, 71, 83, 86, 90 for 26, which numbers are checked? Write them in order.

**13.** Linear search checks 20, 84, 77, 59, 67, 63, 47, 26 from the left. How many items are checked to search for (a) 67 (b) 97?

**14.** Bubble sort swaps neighbouring items that are in the wrong order. How many swaps in all does it make to sort 52, 28, 36, 43, 3, 54?

**15.** A bubble sort stops after the first pass that makes no swaps. How many passes does it make for 19, 21, 30, 52, 7, 29, counting that last pass?

**16.** What is the greatest number of checks binary search needs for a sorted list of 4,230 items?

## Section C — Word problems — 4 × 4 = 16 marks

**17.** Explain binary search step by step for finding 23 in 4, 8, 15, 16, 23, 42, 50.

**18.** Binary search: number the positions 1, 2, 3, …; check the middle position (the whole part of (low + high) ÷ 2); if the target is smaller, search the left half, if larger, the right half. The list is 9, 13, 24, 25, 35, 48, 55, 58, 62, 64, 84, 94, 96 and the target is 62. (a) Which numbers are checked, in order? (b) How many checks is that? (c) How many checks would linear search from the left need?

**19.** Sort 38, 35, 54, 6, 40, 51 with bubble sort. (a) Write the list after pass 1. (b) after pass 2. (c) How many swaps does the whole sort make?

**20.** Sort 13, 16, 8, 40, 3, 49, 35 with selection sort. (a) Write the list after pass 1. (b) after pass 2. (c) How many passes does selection sort need for 7 items?

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# Answer key

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| Q | Answer | Working |
|---|---|---|
| 1 | **(d) sorted** | — |
| 2 | **(c) 9** | 58 is not there, so all 9 are checked |
| 3 | **(b) 3** | checked: 41, 63, 51 |
| 4 | **(d) 6, 22, 35, 19, 36, 47** | each pass carries the largest remaining number to its place |
| 5 | **(a) 6, 24, 26, 30, 28, 38** | the 3 smallest go to the front, in order |
| 6 | **(d) 4** | list after the pass: 26, 17, 27, 34, 31, 33, 37 |
| 7 | **(c) 11** | halving 1,578 until one item is left: $2^{10} \le 1{,}578 < 2^{11}$ |
| 8 | **(b) 1,474** | linear: 1,485; binary: 11; 1,485 − 11 |
| 9 | **Binary search throws away the half that cannot hold the target; that only works if smaller items are on one side and larger on the other.** | — |
| 10 | **15, 8, 31, 41, 55, 57** | swaps per pass: 4, 3, 1 |
| 11 | **17, 30, 31, 46, 35, 44** | one item fixed per pass |
| 12 | **56, 38, 26** | positions 1–12: middle 6 is 56; 26 < 56, so go left; positions 1–5: middle 3 is 38; 26 < 38, so go left; positions 1–2: middle 1 is 26, found |
| 13 | **(a) 5; (b) 8** | 97 is not in the list, so every item is checked |
| 14 | **7** | every swap fixes one out-of-order pair; count those pairs |
| 15 | **5** | swaps per pass: 2, 2, 1, 1, 0 |
| 16 | **13** | $2^{12} \le 4{,}230 < 2^{13}$ |
| 17 | **Middle (4th) is 16; 23 is larger, so search 23, 42, 50; middle is 42; 23 is smaller, so search 23; found in 3 checks.** | — |
| 18 | **(a) 55, 64, 58, 62; (b) 4; (c) 9** | positions 1–13: middle 7 is 55; 62 > 55, so go right; positions 8–13: middle 10 is 64; 62 < 64, so go left; positions 8–9: middle 8 is 58; 62 > 58, so go right; position 9: middle 9 is 62, found; linear: 62 is item 9 |
| 19 | **(a) 35, 38, 6, 40, 51, 54; (b) 35, 6, 38, 40, 51, 54; (c) 6** | swaps in pass 1: 4 |
| 20 | **(a) 3, 16, 8, 40, 13, 49, 35; (b) 3, 8, 16, 40, 13, 49, 35; (c) 6** | after n − 1 passes the last item is already in place |



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