

CS 201: Data Structures & Algorithms

Quiz 1 — Complexity & Sorting — ANSWER KEY

Duration: 30 minutes

Maximum marks: 13

SET A

Instructions

- Write your name and roll number before starting.
- This paper has 7 questions in 3 parts, for a total of 13 marks.

MCQ Answer Grid

Q	1	2	3	4
Ans	A	A	A	A

Part A — Multiple Choice

7 marks

Q1. What is the worst-case running time of binary search on a sorted array of n elements? [2 marks]

- (A) $\Theta(\log n)$ ✓
(B) $\Theta(1)$
(C) $\Theta(n)$
(D) $\Theta(n \log n)$

Q2. Dijkstra's algorithm produces correct shortest paths on graphs with negative edge weights. [1 mark]

- (A) False ✓
(B) True

Explanation. A negative edge can improve an already-finalized vertex; use Bellman-Ford instead.

Q3. What does this function print for $n = 6$? [2 marks]

```
def f(n):  
    c = 0  
    while n > 1:  
        n = n // 2  
        c += 1  
    print(c)
```

- (A) 2 ✓
(B) 1
(C) 6
(D) 3

Explanation. $6 \rightarrow 3 \rightarrow 1$: two halvings.

Q4. By the master theorem, $T(n) = 2T(n/2) + n$ solves to: [2 marks]

- (A) $\Theta(n \log n)$ ✓
(B) $\Theta(n)$
(C) $\Theta(n^2)$
(D) $\Theta(\log n)$

Part B — Fill in the Blanks

2 marks

-
- Q5.** The average-case running time of quicksort with uniformly random pivots is *[1 mark]*
 $\Theta(\underline{n \log n})$.
- Q6.** A sorting algorithm is **stable** if it preserves the relative order of equal keys. *[1 mark]*

Part C — Short Answer*4 marks*

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- Q7.** Sketch the decision-tree argument that any comparison-based sorting algorithm needs *[4 marks]*
 $\Omega(n \log n)$ comparisons in the worst case.

Model answer. Any comparison sort is a binary decision tree whose leaves are the $n!$ input permutations. A binary tree with $n!$ leaves has height at least $\log_2 n! = \Theta(n \log n)$ (Stirling), so some input forces that many comparisons.

Rubric. +1 model: binary decision tree, leaves = permutations; +1 at least $n!$ leaves; +1 height $\geq \log_2 n!$; +1 Stirling $\rightarrow \Omega(n \log n)$.

— End of paper —