

2.3 ALGORITHMS · 2.3.1(F)

Bubble & insertion sort — Mark scheme

30 marks · spec 2.3.1(f)

AO key: AO1 = knowledge · AO2 = application. Traces verified. Penalise once for a slip then follow through.

Q	ANSWER	AO	MARKS
1(a)	Compares adjacent pairs and swaps if out of order (1); repeats in passes until sorted, the largest bubbling to the end each pass (1). (2)	AO1	2
1(b)	$O(n^2)$. (1)	AO1	1
1(c)	Use a flag/Boolean (1); if a complete pass makes no swaps, the list is sorted so stop (1). (2)	AO1	2
1(d)	Yes — it is in place (no second list needed). (1)	AO1	1

Q	ANSWER	AO	MARKS																								
2(a)	<table><tr><td>AFTER PASS 1</td><td>3</td><td>6</td><td>1</td><td>4</td><td>7</td></tr><tr><td>AFTER PASS 2</td><td>3</td><td>1</td><td>4</td><td>6</td><td>7</td></tr><tr><td>AFTER PASS 3</td><td>1</td><td>3</td><td>4</td><td>6</td><td>7</td></tr><tr><td>AFTER PASS 4</td><td>1</td><td>3</td><td>4</td><td>6</td><td>7</td></tr></table> 1 mark per correct pass row (passes 1–4); pass 4 = no change (sorted). (5 max)	AFTER PASS 1	3	6	1	4	7	AFTER PASS 2	3	1	4	6	7	AFTER PASS 3	1	3	4	6	7	AFTER PASS 4	1	3	4	6	7	AO2	5
AFTER PASS 1	3	6	1	4	7																						
AFTER PASS 2	3	1	4	6	7																						
AFTER PASS 3	1	3	4	6	7																						
AFTER PASS 4	1	3	4	6	7																						
2(b)	7 (the largest) is at the end after pass 1. (1)	AO2	1																								
2(c)	4 comparisons (n – 1). (1)	AO2	1																								

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3(a)	<table><tr><td>INSERT 2ND</td><td>3</td><td>6</td><td>7</td><td>1</td><td>4</td></tr><tr><td>INSERT 3RD</td><td>3</td><td>6</td><td>7</td><td>1</td><td>4</td></tr><tr><td>INSERT 4TH</td><td>1</td><td>3</td><td>6</td><td>7</td><td>4</td></tr><tr><td>INSERT 5TH</td><td>1</td><td>3</td><td>4</td><td>6</td><td>7</td></tr></table> 1 mark per correct row. (Inserting the 3rd item, 7, leaves the list unchanged.) (4)	INSERT 2ND	3	6	7	1	4	INSERT 3RD	3	6	7	1	4	INSERT 4TH	1	3	6	7	4	INSERT 5TH	1	3	4	6	7	AO2	4
INSERT 2ND	3	6	7	1	4																						
INSERT 3RD	3	6	7	1	4																						
INSERT 4TH	1	3	6	7	4																						
INSERT 5TH	1	3	4	6	7																						
3(b)	Takes the next item (1); inserts it into its correct position in the sorted left part, shifting larger items right (1). (2)	AO1	2																								

Q	ANSWER	AO	MARKS
4(a)	Any one: both $O(n^2)$ · both sort in place · both compare/move items repeatedly. (1)	AO1	1
4(b)	Bubble swaps adjacent pairs so the largest bubbles to the end (1); insertion inserts each item into the sorted left part (1). (2)	AO1	2
4(c)	$O(n)$ (1); one pass with no swaps (bubble) / little shifting (insertion) is enough on a sorted list (1). (2)	AO2	2

Q	ANSWER	AO	MARKS
5(a)	Each uses nested loops (1); for each of n items up to n comparisons/shifts $\rightarrow \sim n^2$ operations (1). (2)	AO2	2
5(b)	$O(n^2) \rightarrow \sim 10^{12}$ operations for a million items, far too slow (1); a better choice is merge sort / quick sort ($O(n \log n)$) (1). (2)	AO2	2
5(c)	Any one: a small list · a nearly-sorted list · where simplicity / in-place sorting matters. (2) (1 for situation + 1 for reason)	AO2	2

Total for paper: 30 marks