4.1 Decision Maths: Algorithms, Sorting and Bin Packing: 2-hour Pack

Total Marks

EDEXCEL 9FM0 · Calculator allowed · about 120 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The items with the following sizes are to be packed into bins of capacity 40: 35, 9, 11, 12, 24, 7, 33, 35.

(a) Find a lower bound for the number of bins needed. **(2)**

(b) Use the first-fit algorithm, taking the items in the order given, to pack the items into bins. State the contents of each bin. **(3)**

(c) Use the first-fit decreasing algorithm to pack the items. State the number of bins used and the contents of each bin. **(3)**

(Total for Question 1 is 8 marks)

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2 The items with the following sizes are to be packed into bins of capacity 40: 25, 21, 24, 23, 22, 29, 4, 16, 12, 36.

(a) Find a lower bound for the number of bins needed. **(2)**

(b) Use the first-fit algorithm, taking the items in the order given, to pack the items into bins. State the contents of each bin. **(3)**

(c) Use the first-fit decreasing algorithm to pack the items. State the number of bins used and the contents of each bin. **(3)**

(Total for Question 2 is 8 marks)

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3 The items with the following sizes are to be packed into bins of capacity 20: 12, 14, 14, 6, 14, 7, 14, 5, 10.

(a) Find a lower bound for the number of bins needed. **(2)**

(b) Use the first-fit algorithm, taking the items in the order given, to pack the items into bins. State the contents of each bin. **(3)**

(c) Use the first-fit decreasing algorithm to pack the items. State the number of bins used and the contents of each bin. **(3)**

(Total for Question 3 is 8 marks)

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4 The items with the following sizes are to be packed into bins of capacity 25: 21, 18, 14, 19, 7, 20, 19, 10, 8.

(a) Find a lower bound for the number of bins needed. **(2)**

(b) Use the first-fit algorithm, taking the items in the order given, to pack the items into bins. State the contents of each bin. **(3)**

(c) Use the first-fit decreasing algorithm to pack the items. State the number of bins used and the contents of each bin. **(3)**

(Total for Question 4 is 8 marks)

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5 The list 33, 3, 14, 31, 8, 44, 56 is to be sorted into ascending order using a bubble sort. In each pass, adjacent items are compared from the left and swapped if they are in the wrong order.

(a) Show the list after the first pass and state the number of swaps made in the first pass. **(3)**

(b) Show the list after the second pass. **(2)**

(c) State the number of passes needed to sort the list completely, not counting a final pass in which no swaps are made, and the total number of swaps. **(2)**

(Total for Question 5 is 7 marks)

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6 The items with the following sizes are to be packed into bins of capacity 50: 8, 11, 34, 39, 35, 31, 18, 13.

(a) Find a lower bound for the number of bins needed. **(2)**

(b) Use the first-fit algorithm, taking the items in the order given, to pack the items into bins. State the contents of each bin. **(3)**

(c) Use the first-fit decreasing algorithm to pack the items. State the number of bins used and the contents of each bin. **(3)**

(Total for Question 6 is 8 marks)

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7 The items with the following sizes are to be packed into bins of capacity 20: 8, 8, 8, 14, 15, 10, 16, 9, 9, 5.

(a) Find a lower bound for the number of bins needed. **(2)**

(b) Use the first-fit algorithm, taking the items in the order given, to pack the items into bins. State the contents of each bin. **(3)**

(c) Use the first-fit decreasing algorithm to pack the items. State the number of bins used and the contents of each bin. **(3)**

(Total for Question 7 is 8 marks)

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8 The items with the following sizes are to be packed into bins of capacity 20: 14, 4, 7, 5, 8, 3, 6, 3.

(a) Find a lower bound for the number of bins needed. **(2)**

(b) Use the first-fit algorithm, taking the items in the order given, to pack the items into bins. State the contents of each bin. **(3)**

(c) Use the first-fit decreasing algorithm to pack the items. State the number of bins used and the contents of each bin. **(3)**

(Total for Question 8 is 8 marks)

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9 The list 26, 57, 14, 34, 16, 48, 3 is to be sorted into ascending order using a bubble sort. In each pass, adjacent items are compared from the left and swapped if they are in the wrong order.

(a) Show the list after the first pass and state the number of swaps made in the first pass. **(3)**

(b) Show the list after the second pass. **(2)**

(c) State the number of passes needed to sort the list completely, not counting a final pass in which no swaps are made, and the total number of swaps. **(2)**

(Total for Question 9 is 7 marks)

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Mark scheme · 4.1 Decision Maths: Algorithms, Sorting and Bin Packing: 2-hour Pack

Question 1

(a) total size = 166 **M1**

(a) 166/40 = 4.15, so at least 5 bins **A1**

(a) Answer: 5

(b) places each item in the first bin with enough room, in the order given **M1**

(b) first bins correct **A1**

(b) bins: (35); (9, 11, 12, 7); (24); (33); (35) **A1**

(b) Answer: (35); (9, 11, 12, 7); (24); (33); (35)

(c) sorts the items into descending order **M1**

(c) applies first-fit to the sorted list **M1**

(c) 5 bins: (35); (35); (33, 7); (24, 12); (11, 9) **A1**

(c) Answer: 5 bins: (35); (35); (33, 7); (24, 12); (11, 9)

Question 2

(a) total size = 212 **M1**

(a) 212/40 = 5.30, so at least 6 bins **A1**

(a) Answer: 6

(b) places each item in the first bin with enough room, in the order given **M1**

(b) first bins correct **A1**

(b) bins: (25, 4); (21, 16); (24, 12); (23); (22); (29); (36) **A1**

(b) Answer: (25, 4); (21, 16); (24, 12); (23); (22); (29); (36)

(c) sorts the items into descending order **M1**

(c) applies first-fit to the sorted list **M1**

(c) 7 bins: (36, 4); (29); (25, 12); (24, 16); (23); (22); (21) **A1**

(c) Answer: 7 bins: (36, 4); (29); (25, 12); (24, 16); (23); (22); (21)

Question 3

(a) total size = 96 **M1**

(a) 96/20 = 4.80, so at least 5 bins **A1**

(a) Answer: 5

(b) places each item in the first bin with enough room, in the order given **M1**

(b) first bins correct **A1**

(b) bins: (12, 6); (14, 5); (14); (14); (7, 10); (14) **A1**

(b) Answer: (12, 6); (14, 5); (14); (14); (7, 10); (14)

(c) sorts the items into descending order **M1**

(c) applies first-fit to the sorted list **M1**

(c) 6 bins: (14, 6); (14, 5); (14); (14); (12, 7); (10) **A1**

(c) Answer: 6 bins: (14, 6); (14, 5); (14); (14); (12, 7); (10)

Question 4

(a) total size = 136 **M1**

(a) 136/25 = 5.44, so at least 6 bins **A1**

(a) Answer: 6

(b) places each item in the first bin with enough room, in the order given **M1**

(b) first bins correct **A1**

(b) bins: (21); (18, 7); (14, 10); (19); (20); (19); (8) **A1**

(b) Answer: (21); (18, 7); (14, 10); (19); (20); (19); (8)

(c) sorts the items into descending order **M1**

(c) applies first-fit to the sorted list **M1**

(c) 7 bins: (21); (20); (19); (19); (18, 7); (14, 10); (8) **A1**

(c) Answer: 7 bins: (21); (20); (19); (19); (18, 7); (14, 10); (8)

Question 5

(a) compares adjacent pairs from the left, swapping when the left item is larger **M1**

(a) list after pass 1: 3, 14, 31, 8, 33, 44, 56 **A1**

(a) 4 swaps **B1**

(a) Answer: 3, 14, 31, 8, 33, 44, 56; 4 swaps

(b) repeats the process, ignoring the final item (already in place) **M1**

(b) 3, 14, 8, 31, 33, 44, 56 **A1**

(b) Answer: 3, 14, 8, 31, 33, 44, 56

(c) 3 passes **B1**

(c) 6 swaps in total **B1**

(c) Answer: 3 passes, 6 swaps

Question 6

(a) total size = 189 **M1**

(a) 189/50 = 3.78, so at least 4 bins **A1**

(a) Answer: 4

(b) places each item in the first bin with enough room, in the order given **M1**

(b) first bins correct **A1**

(b) bins: (8, 11, 31); (34, 13); (39); (35); (18) **A1**

(b) Answer: (8, 11, 31); (34, 13); (39); (35); (18)

(c) sorts the items into descending order **M1**

(c) applies first-fit to the sorted list **M1**

(c) 4 bins: (39, 11); (35, 13); (34, 8); (31, 18) **A1**

(c) Answer: 4 bins: (39, 11); (35, 13); (34, 8); (31, 18)

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Question 7

(a) total size = 102 **M1**

(a) 102/20 = 5.10, so at least 6 bins **A1**

(a) Answer: 6

(b) places each item in the first bin with enough room, in the order given **M1**

(b) first bins correct **A1**

(b) bins: (8, 8); (8, 10); (14, 5); (15); (16); (9, 9) **A1**

(b) Answer: (8, 8); (8, 10); (14, 5); (15); (16); (9, 9)

(c) sorts the items into descending order **M1**

(c) applies first-fit to the sorted list **M1**

(c) 6 bins: (16); (15, 5); (14); (10, 9); (9, 8); (8, 8) **A1**

(c) Answer: 6 bins: (16); (15, 5); (14); (10, 9); (9, 8); (8, 8)

Question 8

(a) total size = 50 **M1**

(a) 50/20 = 2.50, so at least 3 bins **A1**

(a) Answer: 3

(b) places each item in the first bin with enough room, in the order given **M1**

(b) first bins correct **A1**

(b) bins: (14, 4); (7, 5, 8); (3, 6, 3) **A1**

(b) Answer: (14, 4); (7, 5, 8); (3, 6, 3)

(c) sorts the items into descending order **M1**

(c) applies first-fit to the sorted list **M1**

(c) 3 bins: (14, 6); (8, 7, 5); (4, 3, 3) **A1**

(c) Answer: 3 bins: (14, 6); (8, 7, 5); (4, 3, 3)

Question 9

(a) compares adjacent pairs from the left, swapping when the left item is larger **M1**

(a) list after pass 1: 26, 14, 34, 16, 48, 3, 57 **A1**

(a) 5 swaps **B1**

(a) Answer: 26, 14, 34, 16, 48, 3, 57; 5 swaps

(b) repeats the process, ignoring the final item (already in place) **M1**

(b) 14, 26, 16, 34, 3, 48, 57 **A1**

(b) Answer: 14, 26, 16, 34, 3, 48, 57

(c) 6 passes **B1**

(c) 13 swaps in total **B1**

(c) Answer: 6 passes, 13 swaps

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