Question Number	Scheme	Marks
1.(a)	Bin 1: **5.2** **4.7** **3.1** Bin 2: **6.5** **4.5** 1.8 1.2 Bin 3: 5.1 2.9 3.4 Bin 4: 3.8	**M1** A1 A1**(3)**
(b)	e.g. middle right 5.2 4.7 6.5 4.5 3.1 **5.1** 1.8 2.9 3.4 3.8 1.2 — Pivots 5.1 4.7 4.5 3.1 1.8 **2.9** 3.4 3.8 1.2 5.1 5.2 **6.5** — 2.9, 6.5 1.8 **1.2** 2.9 4.7 4.5 **3.1** 3.4 3.8 5.1 5.2 6.5 — 1.2, 3.1, (5.2) 1.2 1.8 2.9 3.1 4.7 4.5 **3.4** 3.8 5.1 5.2 6.5 — (1.8), 3.4 1.2 1.8 2.9 3.1 3.4 4.7 **4.5** 3.8 5.1 5.2 6.5 — 4.5 1.2 1.8 2.9 3.1 3.4 3.8 4.5 4.7 5.1 5.2 6.5 — (Sort Complete)	M1 A1 A1ft A1 **(4)**
	e.g. middle left 5.2 4.7 6.5 4.5 3.1 **5.1** 1.8 2.9 3.4 3.8 1.2 — Pivots 5.1 4.7 4.5 3.1 **1.8** 2.9 3.4 3.8 1.2 5.1 **5.2** 6.5 — 1.8, 5.2 1.2 1.8 4.7 4.5 **3.1** 2.9 3.4 3.8 5.1 5.2 6.5 — (1.2), 3.1, (6.5) 1.2 1.8 2.9 3.1 4.7 **4.5** 3.4 3.8 5.1 5.2 6.5 — (2.9), 4.5 1.2 1.8 2.9 3.1 **3.4** 3.8 4.5 4.7 5.1 5.2 6.5 — 3.4, (4.7) 1.2 1.8 2.9 3.1 3.4 3.8 4.5 4.7 5.1 5.2 6.5 — (Sort Complete)	
(c)	Bin 1: **6.5** **5.2** 1.8 Bin 2: **5.1** **4.7** **3.8** Bin 3: **4.5** 3.4 3.1 2.9 Bin 4: 1.2	**M1** A1ft A1**(3)**
(d)	$\frac{1.2+1.8+\cdots+6.5}{14}=\frac{42.2}{14}=3.01...$ so a minimum of 4 bins is required and (c) is optimal	B1 **(1)**
(e)	$\left[\frac{1+11}{2}\right]=6$ 3.8 > 3.0 so reject 3.8 to 6.5 (or reject 6th to 11th items) $\left[\frac{1+5}{2}\right]=3$ 2.9 < 3.0 so reject 1.2 to 2.9 (or reject 1st to 3rd item) $\left[\frac{4+5}{2}\right]=5$ 3.4 > 3.0 so reject 3.4 (or reject 5th item) [4] = 4 3.1 is not 3.0 so 3.0 not found	M1 A1ft A1 **(3)**
		14 marks

	Notes for Question 1
a1M1	The **correct** first five items placed correctly (the bold values) and at least eight values placed in bins (allow repeated values). Condone cumulative totals for M1 only
a1A1	First eight values placed correctly (the bold **and** underlined values) with all eleven correct values only placed in bins. This mark cannot be awarded if **any** repeated values or incorrect values are seen (even if the first eight values have been placed correctly)
a2A1	CSO – no additional or repeated values (dependent on both previous marks)
b1M1	Quick sort using all 11 numbers (condone one slip), pivot, p, chosen (must be choosing middle left or right – choosing first/last item as the pivot is M0). After the first pass the list must read (values less than the pivot), pivot, (values greater than the pivot). **If only choosing one pivot per iteration then M1 only. Bubble sort is M0.**
b1A1	First and second passes correct and pivots correctly chosen for third pass
b2A1ft	Third and fourth passes correct following through from their second pass and choice of pivots for the third pass. The pivots for the third pass must be consistent (if appropriate either both middle left or both middle right)
b3A1	CSO (correct solution only – all previous marks in this part **must** have been awarded) including a **fifth pass** (we do not need to see "sort complete" oe)
	Special Case for (b) If the candidate sorts into descending order they can score M1 as per the main scheme (but with the values either side of the pivot reversed), A1 for a fully correct sort then A0 A0 even if the list is reversed at the end (so 2 marks max.). See below
c1M1	**Their** six largest items placed correctly and at least eight values placed in bins (if correct this will be the bold items but must check **their** packing if any of **their** six largest values are incorrect – note that the maximum weight of a bin is 14). Condone cumulative totals for M1 only. First-fit increasing scores no marks in this part. If no sort seen in (b) then mark (c) assuming the correct ordered list is being used
c1A1ft	**Their** first nine values placed correctly (the bold **and** underlined values) with all **their** eleven values only placed in bins. This mark cannot be awarded if **any** repeated values are seen (even if their first nine values have been placed correctly)
c2A1	CSO – must be the correct values with no additional or repeated values (dependent on both previous marks)
d1B1	CAO using either a correct lower bound calculation (accept awrt 3.01 without seeing the full calculation) or spare capacity in the first 3 bins (e.g. total spare in first three bins is $0.5 + 0.4 + 0.1 = 1 < 1.2$ so not possible to pack into 3 bins oe e.g. $42.2 > 42$ hence cannot fit in 3 bins) and conclusion of optimal or states using the minimum number of bins (**dependent on scoring at least M1 in (c)**)
e1M1	**Must be using their sorted list.** Choosing their middle pivot (3.8) and an attempt at discarding/retaining half the list (condone if retaining the wrong half of the list) (If pivot is retained at any stage M1 only). The actual rejections may be shown as values from the list or the positions in the list.
e1A1ft	First and second passes correct for their list i.e. selecting the 6^{th} item in the first pass and using 1^{st} to 5^{th} items in the second pass (must not be using the 6^{th} item for the second pass) and then correctly selecting the 3^{rd} item (the 2.9) in the second pass and rejecting the 1^{st} to 3^{rd} items. Candidates may either compare 3.0 with the actual values or the positions of items in a correctly sorted list. Comparisons may be implied by the choice of the correct item and corresponding rejection. **If a candidate renumbers the list after a pass check the position numbers and values carefully.**
e2A1	CSO – must be the correct values with the search completed correctly (so rejecting the 3.4 in the third pass) together with 'not found'.

	In (e) if candidates use the list sorted into descending order, they can score full marks. The scheme above applies in the same way. **Note there are only 3 comparisons needed.** 6.5 5.2 5.1 4.7 4.5 3.8 3.4 3.1 2.9 1.8 1.2 $\left[\frac{1+11}{2}\right] = 6$ $3.8 > 3.0$ so reject 6.5 to 3.8 $\left[\frac{7+11}{2}\right] = 9$ $2.9 < 3.0$ so reject 2.9 to 1.2 $\left[\frac{7+8}{2}\right] = 8$ $3.1 > 3.0$ so reject 3.4 to 3.1 3.0 is not in the list

For reference – descending sort

Middle right

											Pivots
5.2	4.7	6.5	4.5	3.1	**5.1**	1.8	2.9	3.4	3.8	1.2	5.1
5.2	**6.5**	5.1	4.7	4.5	3.1	1.8	**2.9**	3.4	3.8	1.2	6.5, 2.9
6.5	5.2	5.1	4.7	4.5	**3.1**	3.4	3.8	2.9	1.8	**1.2**	(5.2), 3.1, 1.2
6.5	5.2	5.1	4.7	4.5	**3.4**	3.8	3.1	2.9	1.8	1.2	3.4 (1.8)
6.5	5.2	5.1	4.7	**4.5**	3.8	3.4	3.1	2.9	1.8	1.2	4.5
6.5	5.2	5.1	4.7	4.5	3.8	3.4	3.1	2.9	1.8	1.2	(Sort Complete)

Middle left

											Pivots
5.2	4.7	6.5	4.5	3.1	**5.1**	1.8	2.9	3.4	3.8	1.2	5.1
5.2	6.5	5.1	4.7	4.5	3.1	**1.8**	2.9	3.4	3.8	1.2	5.2, 1.8
6.5	5.2	5.1	4.7	4.5	**3.1**	2.9	3.4	3.8	1.8	1.2	(6.5), 3.1, (1.2)
6.5	5.2	5.1	4.7	**4.5**	3.4	3.8	3.1	2.9	1.8	1.2	4.5, (2.9)
6.5	5.2	5.1	4.7	4.5	**3.4**	3.8	3.1	2.9	1.8	1.2	(4.7), 3.4
6.5	5.2	5.1	4.7	4.5	3.8	3.4	3.1	2.9	1.8	1.2	(Sort Complete)