1. Use the binary search algorithm to try to locate the name NIGEL in the following alphabetical list. Clearly indicate how you chose your pivots and which part of the list is being rejected at each stage.

1. Bhavika
2. Clive
3. Elizabeth
4. John
5. Mark
6. Nicky
7. Preety
8. Steve
9. Trevor
10. Verity

(Total 4 marks)

2. 650 431 245 643 455 134 710 234 162 452

(a) The list of numbers above is to be sorted into **descending** order. Perform a Quick Sort to obtain the sorted list, giving the state of the list after each pass, indicating the pivot elements.

(5)

The numbers in the list represent the lengths, in mm, of some pieces of wood. The wood is sold in one metre lengths.

(b) Use the first-fit decreasing bin packing algorithm to determine how these pieces could be cut from the minimum number of one metre lengths. (You should ignore wastage due to cutting.)

(4)

(c) Determine whether your solution to part (b) is optimal. Give a reason for your answer.

(2)

(Total 11 marks)

3.

Hajra (H)	Vicky (V)	Leisham (L)	Alice (A)	Nicky (N)	June (J)	Sharon (S)	Tom (T)	Paul (P)

The table shows the names of nine people.

(a) Use a quick sort to produce the list of names in ascending alphabetical order.

You must make your pivots clear.

(4)

(b) Use the binary search algorithm on your list to locate the name Paul.

(4)

(Total 8 marks)

4. A builder is asked to replace the guttering on a house. The lengths needed, in metres, are

0.6, 4.0, 2.5, 3.2, 0.5, 2.6, 0.4, 0.3, 4.0 and 1.0

Guttering is sold in 4 m lengths.

(a) Carry out a quick sort to produce a list of the lengths needed in **descending** order. You should show the result of each pass and identify your pivots clearly.

(5)

(b) Apply the first-fit decreasing bin-packing algorithm to your ordered list to determine the total number of 4 m lengths needed.

(4)

(c) Does the answer to part (b) use the minimum number of 4 m lengths? You must justify your answer.

(2)

(Total 11 marks)

5.

Miri
Jessie
Edward
Katie
Hegg
Beth
Louis
Philip
Natsuko
Dylan

(a) Use the quick sort algorithm to sort the above list into alphabetical order.

(5)

(b) Use the binary search algorithm to locate the name Louis.

(4)
(Total 9 marks)

6. Max Lauren John Hannah Kieran Tara Richard Imogen

(a) Use a quick sort to produce a list of these names in ascending alphabetical order. You must make your pivots clear.

(5)

(b) Use the binary search algorithm on your list from part (a) to try to locate the name 'Hugo'.

(4)
(Total 9 marks)

7. Use the binary search algorithm to try to locate the name NIGEL in the following alphabetical list. Clearly indicate how you chose your pivots and which part of the list is being rejected at each stage.

1. Bhavika
2. Clive
3. Elizabeth
4. John
5. Mark
6. Nicky
7. Preety
8. Steve
9. Trevor
10. Verity

(Total 4 marks)

8. 45, 56, 37, 79, 46, 18, 90, 81, 51

(a) Using the quick sort algorithm, perform **one** complete iteration towards sorting these numbers into **ascending** order.

(2)

(b) Using the bubble sort algorithm, perform **one** complete pass towards sorting the **original** list into **descending** order.

(2)

Another list of numbers, in ascending order, is

7, 23, 31, 37, 41, 44, 50, 62, 71, 73, 94

(c) Use the binary search algorithm to locate the number 73 in this list.

(4)
(Total 8 marks)

9.

1. Glasgow
2. Newcastle
3. Manchester
4. York
5. Leicester
6. Birmingham
7. Cardiff
8. Exeter
9. Southampton
10. Plymouth

A binary search is to be performed on the names in the list above to locate the name Newcastle.

(a) Explain why a binary search cannot be performed with the list in its present form.

(1)

(b) Using an appropriate algorithm, alter the list so that a binary search can be performed. State the name of the algorithm you use.

(4)

(c) Use the binary search algorithm on your new list to locate the name Newcastle.

(4)
(Total 9 marks)

10. The following list gives the names of some students who have represented Britain in the International Mathematics Olympiad.

Roper (*R*), Palmer (*P*), Boase (*B*), Young (*Y*), Thomas (*T*), Kenney (*K*), Morris (*M*), Halliwell (*H*), Wicker (*W*), Garesalingam (*G*).

(a) Use the quick sort algorithm to sort the names above into alphabetical order.

(5)

(b) Use the binary search algorithm to locate the name Kenney.

(4)

(Total 9 marks)

1. $\left\lfloor \frac{1+10}{2} \right\rfloor$ = 6 Nicky M1

reject top of list

$\left\lfloor \frac{7+10}{2} \right\rfloor$ = 9 Trevor A1

reject bottom of list

$\left\lfloor \frac{7+8}{2} \right\rfloor$ = 8 Steve A1

reject bottom of list

[7] = 7 Preety A1 4

reject

Nigel not in list

[4]

2. (a) E.g:

650	431	245	643	**455**	710	234	162	452	**134**	M1
650	643	710	**455**	431	245	234	162	452	134	A1
650	710	643	455	431	**245**	452	**234**	**162**	134	A1 ft
710	650	643	455	431	452	245	234	162	134	A1 ft
710	650	643	455	**452**	431	245	234	162	134	A1

5

(b) Bin 1 710 + 245 Bin 3 643 + 162 + 134 Bin 5 431 M1A1

Bin 2 650 + 234 Bin 4 455 + 452 A1A1(ft) 4

(c) $\frac{4116}{1000}$ = 4.116 5 bins needed optimal M1A1(ft) 2

[11]

3. (a)

H	V	L	A	N	J	S	T	P	(N)	M1
H	L	A	J	N	V	S	T	P	(A, T)	A1
A	H	L	J	N	S	P	T	V	(L, P)	A1 ft
A	H	J	L	N	P	S	T	V	(J)	
A	H	J	L	N	P	S	T	V		A1 cso 4

Note

1M1: quick sort, pivots, p, chosen and two sublists one <p one >p.
1A1: first pass correct and next pivots chosen correctly/consistently.
2A1ft: second pass correct, next pivots correctly/consistently chosen.
3A1: all correct, cso.

(b) 1st choice $\left\lceil \frac{1+9}{2} \right\rceil = 5$ Nicky, reject 1 – 5 M1 A1

2nd choice $\left\lceil \frac{6+9}{2} \right\rceil = \lceil 7.5 \rceil = 8$ Tom, reject 8 – 9 A1

3rd choice $\left\lceil \frac{6+7}{2} \right\rceil = \lceil 6.5 \rceil = 7$ Sharon, reject 7

4th choice 6 Paul name found A1 cso 4

Note

1M1: binary search on what they think is a alphabetical list, choosing pivot, rejecting half list.
1A1: first pass correct, condone 'sticky' pivot here, bod generous
2A1: second pass correct, pivot rejected.
3A1: cso.
Note: If incorrect list in (a) mark (b) as a misread.

Alternative solutions

Middle right

H	V	L	A	N	J	S	T	P	(N)	M1
H	L	A	J	N	V	S	T	P	(A T)	A1
A	H	L	J	N	S	P	T	V	(L P)	A1ft
A	H	J	L	N	P	S	T	V	(J)	
A	H	J	L	N	P	S	T	V		A1cso

list sorted

Middle left

H	V	L	A	N	J	S	T	P	(N)	M1
H	L	A	J	N	V	S	T	P	(L S)	A1
H	A	J	L	N	P	S	V	T	(A V)	A1ft
A	H	J	L	N	P	S	T	V	(H)	
A	H	J	L	N	P	S	T	V		A1cso

First

H	V	L	A	N	J	S	T	P	(H)	M1
A	H	V	L	N	J	S	T	P	(V)	A1
A	H	L	N	J	S	T	P	V	(L)	
A	H	J	L	N	S	T	P	V	(N)	A1ft
A	H	J	L	N	S	T	P	V	(S)	
A	H	J	L	N	P	S	T	V		A1cso

[8]

4. (a)

0.6	4.0	2.5	3.2	0.5	**2.6**	0.4	0.3	4.0	1.0	**2.6**		
4.0	**3.2**	4.0	2.6	0.6	2.5	0.5	**0.4**	0.3	1.0	**3.2 0.4**	M1	
4.0	4.0	3.2	2.6	0.6	2.5	**0.5**	**1.0**	0.4	**0.3**	**4.0 0.5**	A1	
4.0	4.0	3.2	2.6	0.6	2.5	**1.0**	0.5	0.4	0.3	**2.5**	A1ft	
4.0	4.0	3.2	2.6	2.5	0.6	**1.0**	0.5	0.4	0.3	**1.0**	A1ft	
4.0	4.0	3.2	2.6	2.5	1.0	**0.6**	0.5	0.4	0.3		A1 cso	5

Notes

1M1 Pivot, p, chosen. List sorted, >p, p. <p or <p, p, >p. **If only choosing 1 pivot per iteration M1 only**

1A1 1st pass correct and chosen next **two** pivots correctly for sublists >1

2A1ft 2nd pass correct and chosen next **two** pivots correctly for sublists >1

3A1ft 3rd pass correct and next pivot for sublist >1 chosen correctly.

4A1 cso.

Misread in part (a)

- If they have misread a number **at the start of part (a), so genuinely miscopied** and got for example 0.1 instead of 1.0 then mark the whole question as a misread – removing the last two A or B marks earned. This gives a maximum total of 9.
- If they misread their own numbers **during the course of part (a)** then count it as an **error in part (a)** but mark parts (b) and (c) as a misread. So they would lose marks in (a) for the error and then the last two A or B marks earned in (b) and (c) – giving a maximum of 8 or maybe 7 marks depending on how many marks they lose in (a).

The most popular misread is the one listed above – where 1.0 has changed to 0.1 giving

4.0 4.0 3.2 2.6 2.5 0.6 0.5 0.4 0.3 **0.1** at the end of (a) for this one (b) and (c) are:

(b)

Length 1:	4					
Length 2:	4					
Length 3:	3.2	0.6		left column & 1.0 in place	M1	
Length 4:	2.6	1.0	0.4	0.6 & 0.5	A1	
Length 5:	2.5	0.5	0.3	0.4	A1	
				All correct (c.s.o)	A1	4

Note

Length 1:	4			
Length 2:	4			
Length 3:	3.2	0.6	0.1	
Length 4:	2.6	0.5	0.4	0.3
Length 5:	2.5			

(c) 19.1/4 = 4.775 so 5 lengths needed, accept
total is 19.1m, or refer to 0.9 'spare . B1

Yes, the answer to (b) does use the minimum
number of bins. DB1 2

Note

18.2/4 = 4.55 so 5 bins, or total is 18.2 or 1.8 'spare'

Yes answer in (b) uses the minimum number of bins.

Alternate

Choosing middle left

0.6	4.0	2.5	3.2	0.5	2.6	0.4	0.3	4.0	1.0	(pivot 0.5)
0.6	4.0	2.5	3.2	2.6	4.0	1.0	**0.5**	0.4	0.3	(pivots 3.2, 0.4)
4.0	4.0	**3.2**	0.6	2.5	2.6	1.0	**0.5**	**0.4**	0.3	(pivots 4.0, 2.5)
4.0	4.0	**3.2**	2.6	**2.5**	0.6	1.0	**0.5**	**0.4**	**0.3**	(pivot 0.6)
4.0	**4.0**	**3.2**	**2.6**	**2.5**	1.0	**0.6**	**0.5**	**0.4**	**0.3**	
4.0	**4.0**	**3.2**	**2.6**	**2.5**	**1.0**	**0.6**	**0.5**	**0.4**	**0.3**	

Choosing first

0.6	4.0	2.5	3.2	0.5	2.6	0.4	0.3	4.0	1.0	(pivot 0.6)
4.0	2.5	3.2	2.6	4.0	1.0	**0.6**	0.5	0.4	0.3	(pivots 4.0, 0.5)
4.0	2.5	3.2	2.6	4.0	1.0	**0.6**	**0.5**	0.4	0.3	(pivots 2.5, 0.4)
4.0	3.2	2.6	4.0	**2.5**	1.0	**0.6**	**0.5**	**0.4**	0.3	(pivot 3.2)
4.0	4.0	**3.2**	2.6	**2.5**	**1.0**	**0.6**	**0.5**	**0.4**	**0.3**	
4.0	**4.0**	**3.2**	**2.6**	**2.5**	**1.0**	**0.6**	**0.5**	**0.4**	**0.3**	

OR (alternate choosing first)

0.6	4.0	2.5	3.2	0.5	2.6	0.4	0.3	4.0	1.0	(pivot 0.6)
4.0	2.5	3.2	2.6	4.0	1.0	**0.6**	0.5	0.4	0.3	(pivots 4.0, 0.5)
4.0	**4.0**	2.5	3.2	2.6	1.0	**0.6**	**0.5**	0.4	0.3	(pivots 2.5, 0.4)
4.0	**4.0**	3.2	2.6	**2.5**	1.0	**0.6**	**0.5**	**0.4**	0.3	(pivots 3.2)
4.0	**4.0**	**3.2**	2.6	**2.5**	**1.0**	**0.6**	**0.5**	**0.4**	**0.3**	
4.0	**4.0**	**3.2**	**2.6**	**2.5**	**1.0**	**0.6**	**0.5**	**0.4**	**0.3**	

Sorting into ASCENDING order (full marks if then reversed, otherwise MISREAD)

Middle left

0.6	4.0	2.5	3.2	0.5	2.6	0.4	0.3	4.0	1.0	(pivot 0.5)
0.4	0.3	**0.5**	0.6	4.0	2.5	3.2	2.6	4.0	1.0	(pivots 0.4, 3.2)
0.3	**0.4**	**0.5**	0.6	2.5	2.6	1.0	**3.2**	4.0	4.0	(pivots 2.5, 4.0)
0.3	**0.4**	**0.5**	0.6	1.0	**2.5**	2.6	**3.2**	**4.0**	4.0	(pivot 0.6)
0.3	**0.4**	**0.5**	**0.6**	1.0	**2.5**	**2.6**	**3.2**	**4.0**	**4.0**	

Middle right

0.6	4.0	2.5	3.2	0.5	2.6	0.4	0.3	4.0	1.0	(pivot 2.6)
0.6	2.5	0.5	0.4	0.3	1.0	**2.6**	4.0	3.2	4.0	(pivots 0.4, 3.2)
0.3	**0.4**	0.6	2.5	0.5	1.0	**2.6**	**3.2**	4.0	4.0	(pivots 0.5, 4.0)
0.3	**0.4**	**0.5**	0.6	2.5	1.0	**2.6**	**3.2**	4.0	4.0	(pivot 2.5)
0.3	**0.4**	**0.5**	**0.6**	1.0	**2.5**	**2.6**	**3.2**	4.0	**4.0**	(pivot 1.0)

First (1)

0.6	4.0	2.5	3.2	0.5	2.6	0.4	0.3	4.0	1.0	(pivot 0.6)
0.5	0.4	0.3	**0.6**	4.0	2.5	3.2	2.6	4.0	1.0	(pivots 0.5, 4.0)
0.4	0.3	**0.5**	**0.6**	2.5	3.2	2.6	1.0	**4.0**	**4.0**	(pivots 0.4, 2.5)
0.3	**0.4**	**0.5**	**0.6**	1.0	**2.5**	3.2	2.6	**4.0**	**4.0**	(pivot 3.2)
0.3	**0.4**	**0.5**	**0.6**	**1.0**	**2.5**	2.6	**3.2**	**4.0**	**4.0**	

First (2)

0.6	4.0	2.5	3.2	0.5	2.6	0.4	0.3	4.0	1.0	(pivot 0.6)
0.5	0.4	0.3	**0.6**	4.0	2.5	3.2	2.6	4.0	1.0	(pivots 0.5, 4.0)
0.4	0.3	**0.5**	**0.6**	2.5	3.2	2.6	1.0	4.0	**4.0**	(pivots 0.4, 2.5)
0.3	**0.4**	**0.5**	**0.6**	1.0	**2.5**	3.2	2.6	4.0	**4.0**	(pivot 3.2)
0.3	**0.4**	**0.5**	**0.6**	**1.0**	**2.5**	2.6	**3.2**	4.0	**4.0**	

[11]

5. (a)

M	J	E	K	H	**B**	L	P	N	D	**B**	M1 1A1
B	M	J	E	K	**H**	L	P	N	D	**H**	
B	E	**D**	***H***	M	J	K	**L**	P	N	**D L**	2A1ft
B	***D***	**E**	***H***	J	**K**	***L***	M	**P**	N	**(E) K P**	
B	***D***	***E***	***H***	**J**	***K***	***L***	M	**N**	***P***	**(J) N**	3A1ft
B	***D***	***E***	***H***	***J***	***K***	***L***	**M**	***N***	***P***	**(M)**	

Sort completed 4A1 5

Note

1M1: quick sort, pivots, p, identified, two sublists one <p one >p.

If choosing one pivot only per iteration, M1 only.

1A1: first pass correct, next pivot(s) chosen consistently.

2A1ft: second pass correct, next pivot(s) chosen consistently

3A1ft: third pass correct, next pivot(s) chosen consistently

4A1: cso List re-written or end statement made or each element been chosen as a pivot.

(b) $\left\lceil \frac{1+10}{2} \right\rceil = 6$ Katie reject left M1

$\left\lceil \frac{7+10}{2} \right\rceil = 9$ Natsuko reject right 1A1

$\left\lceil \frac{7+8}{2} \right\rceil = 8$ Miri reject right 2A1ft

7 = Louis name found 3A1 4

Note

1M1: binary search, choosing pivot rejecting half list.

If using unordered list then M0.

If choosing J M1 ony

1A1: first two passes correct, condone 'sticky'pivots here, bod.

2A1ft: third pass correct, pivots rejected.

3A1: cso, including success statement.

Special case

If just one letter out of order, award maximum of M1A1A0A0

[9]

6. (a) e.g.

M	L	J	H	K	T	R	I
J	H	I	K	M	L	T	R

M1

A1

H	J	I	K	M	L	R	T	A1ft
H	I	J	K	L	M	R	T	A1ft
H	I	J	K	L	M	R	T	A1cso 5

Note

1M1: quick sort, pivots, p, chosen and two sublists one <p one >p.
If choosing 1 pivot per iteration only M1 only.
1A1: first pass correct and next pivots chosen correctly/consistently.
2A1ft: second pass correct, next pivots correctly/consistently chosen.
3A1ft: third pass correct, next pivots correctly/consistently chosen.
4A1: all correct, cso.

(b) Sort complete.

1st choice $\left\lceil \frac{1+8}{2} \right\rceil \rightarrow$ 5 Lauren reject right M1 A1

2nd choice $\left\lceil \frac{1+4}{2} \right\rceil \rightarrow$ 3 John reject right

3rd choice $\left\lceil \frac{1+2}{2} \right\rceil \rightarrow$ 2 Imogen reject right A1ft

4th choice 1 Hannah reject
List now empty so Hugo not in list A1 4

Note

1M1: binary search, choosing pivot, rejecting half list. If using unsorted list, M0. Accept choice of K for M1 only.
1A1: first pass correct, condone 'sticky'pivot here, bod.
2A1ft: second pass correct, pivot rejected.
3A1: cso.

[9]

7. $\left\lceil \frac{1+10}{2} \right\rceil$ = 6 Nicky – reject top of list. M1

$\left\lceil \frac{7+10}{2} \right\rceil$ = 9 Trevor – reject bottom of list A1

$\left\lceil \frac{7+8}{2} \right\rceil$ = 8 Steve – reject bottom of list A1

[7] = 7 Preety – reject A1
Nigel not in list

[4]

8. (a) eg. 45 37 18 46 56 79 90 81 51
or 37 18 45 56 79 46 90 81 51

	or	45	37	46	18	51	56	79	90	81	M1A1	2

(b)		56	45	79	46	37	90	81	51	18		
	or	90	45	56	37	79	46	18	81	51	M1A1	2

(c) $\left\lceil \frac{1+11}{2} \right\rceil$ = 6 value 44 discard top M1

$\left\lceil \frac{7+11}{2} \right\rceil$ = 9 value 71 discard top A1

$\left\lceil \frac{10+11}{2} \right\rceil$ = 11 value 94 discard bottom A1

list reduces to 10th value. This is 73 so
73 has been located as the 10th value A1 4

[8]

9. (a) The list is not in alphabetical order B1 1

(b) Use of Bubble Sort or Quick Sort M1
e.g.

Bubble sort

G	N	M	Y	L	B	C	E	S	P	
B	G	N	M	Y	L	C	E	P	S	1st pass
B	C	G	N	M	Y	L	E	P	S	2nd pass
B	C	E	G	N	M	Y	L	P	S	3rd pass
B	C	E	G	L	N	M	Y	P	S	4th pass
B	C	E	G	L	M	N	P	Y	S	5th pass
B	C	E	G	L	M	N	P	S	Y	6th pass

No more changes

Quick sort

G	N	M	Y	L	(B)	C	E	S	P	
B	G	N	M	Y	(L)	C	E	S	P	1st pass
B	G	(C)	E	L	N	M	(Y)	S	P	2nd pass
B	C	G	(E)	L	N	M	(S)	P	Y	3rd pass
B	C	E	(G)	L	N	(M)	P	S	Y	4th pass
B	C	E	G	L	M	N	(P)	S	Y	5th pass
B	C	E	G	L	M	N	P	S	Y	6th pass

No sublists > 2 and no more changes

		A1 A1ft	
No more changes	No sublists > 2 + no more changes	A1cso	4

(c)

1	2	3	4	5	6	7	8	9	10
B	C	E	G	L	M	N	P	S	Y

$\frac{[10+1]}{2} = 6$ Manchester discard first half of list and pivot M1 A1

$\frac{[7+10]}{2} = 9$ Southampton discard last half of list and pivot

$\frac{[7+8]}{2} = 8$ Plymouth discard last half of list and pivot A1ft

Final term 7 Newcastle $\therefore$ word found at 7 A1cso 4

[9]

10. (a) e.g.

R	P	B	Y	T	(K)	M	H	W	G
B	(H)	G	[K]	R	P	Y	(T)	M	W
B	(G)	[H]	[K]	R	(P)	M	[T]	Y	(W)
(B)	[G]	[H]	[K]	(M)	[P]	(R)	[T]	[W]	(Y)
B	G	H	K	M	P	R	T	W	Y

M1
A1
A1 ft
A1 ft
A1 ft

5

(b) $\left\lceil \frac{10+1}{2} \right\rceil = 6$ Palmer; reject Palmer $\rightarrow$ Young M1 A1

$\left\lceil \frac{5+1}{2} \right\rceil = 3$ Halliwell; reject Boase $\rightarrow$ Halliwell A1

$\left\lceil \frac{4+5}{2} \right\rceil = 5$ Morris; reject Morris

List reduces to Kenney – name found, search complete A1 4

[9]

1. No Report available for this question.

2. No Report available for this question.

3. This proved a good starter and was well answered by many candidates with around 55% getting full marks. The quick sort was well handled although some candidates did not choose their pivots consistently. A few candidates did not select a pivot when they had a two element sublist in the correct order – often HJ, and a minority sorted the list into reverse alphabetical order. It was alarming that some candidates only selected one pivot per iteration, so, in effect, just dealing with one sublist at a time. Candidates must show that they are selecting one pivot, per sublist, per iteration; that is what makes this algorithm so powerful. A number of candidates did not have the final list in alphabetical order.

Many candidates in part (b) lost marks for failing to reject the pivot and number of candidates attempted to use the original, unsorted list. Some, who tried for a more 'minimalist' solution, did not make their pivot choice clear, or the order in which they chose pivots.

4. Many candidates scored at least 8 marks here. In part (a) a minority produced an ascending list and failed to reverse it. Some candidates did not choose their pivots consistently, swapping between middle right and middle left pivots. The decimals here caused some problems and even though the original list was printed in the answer booklet, a surprising number of candidates initially lost one item or changed one, most commonly 1.0 became 0.1. Some candidates found only one pivot per row, with some not explicitly choosing pivots when sublists of length 2 happened to be in order – most frequently the two 4.0s and the 1.0, 0.6 at the end. Good presentation, with a list spread evenly, in columns, across the page, helps here. (Vertical listing is rarely successful). Part (b) was generally well done, the two most popular errors being to put 0.6 in bin 5 or 0.4 in bin 5. A significant number who had sorted the numbers into increasing order in part (a) proceeded to use a "first fit increasing" method here. In part (c) most candidates calculated the lower bound correctly. Other candidates correctly stated that since the five largest items were over half a bin in size they could not share a bin, so at least 5 bins would be needed. A few simply stated 'yes' without justification, gaining no credit.

5. This was generally well done. A disappointingly large number of candidates only chose one pivot per iteration, rather than choosing one pivot per sublist, and some candidates used lengthy methods of presentation that isolated each sublist in turn, making it difficult to see if they were choosing more than one pivot per iteration. The examiners would advise candidates to refrain from showing this unnecessary detail and simply indicate the pivots selected at each iteration. Some candidates did not select a pivot where the sublist was of order two, with the two items being in the correct order, and some did not consistently pick 'middle left' or 'middle right' when the sublist was of even order. Candidates are reminded that when the items are being transferred to the next line, the order of the items should be preserved, so if item Y is to the left of item X in the current line, neither of them being a pivot, then Y should be to the left of X in the next line. The best candidates allowed each item to become a pivot before declaring the sort complete. Some candidates did not check that their final list was in alphabetical order. In part (b) some candidates tried to apply the algorithm to the original unsorted list given at the start of (a) and others did not discard the pivot at each stage, but generally the binary search was very well done. A few candidates selected J as the first pivot, the specification makes it clear that candidates must take the 'middle right' where necessary.

6. Part (a) was done with mixed success. The majority of candidates gained full marks or three marks. The most common errors were to have HIJ after the second pass and neglecting to choose a pivot on the third pass with the entry MR. Most knew their alphabet, but not all. There was a temptation to go into too much detail about the choice of pivot, to the extent that examiners were not always sure that more than one pivot was being considered per iteration. It is an important feature of the quick sort that the number of pivots can potentially double at each iteration, so the selection of multiple pivots must be clearly shown. Some candidates did not abbreviate the names, by using the initial letter and this slowed them down.

Part (b) was usually very well done. The most common errors were not rejecting the pivot and not making a decision when Hannah was left. Some candidates added Hugo to the list and then found him, others confused Hannah and Hugo.

7. This proved a good starter question for the candidates with many gaining full marks. Some candidates were inconsistent in their pivot choice, the specification requires that they round up. Some incorrectly retained the pivot each time – often leading to a situation where they selected Nicky twice, once as the first pivot and once as the final pivot. Some candidates insisted on placing Nigel in the list – or locating the position in which Nigel should be added to the list. The binary search algorithm is both used to locate an item in the list and to demonstrate its absence. A few candidates confused binary search and quick sort.

8. This was generally well done. Many candidates completed the quick sort, wasting time. Some candidates did not understand the difference between an exchange and a pass in a bubble sort. Most candidates carried out the search well, but many did not give the location of the value. A large number are still assuming that the item is in the list, making statements such as ‘down to one item so found’. A surprisingly large minority of candidates used the mean of the end numbers in the remaining list to create a ‘pivot’ which is unacceptable.

9. This question was often well answered. Most candidates correctly competed part (a), although a very few stated that the list should be in ascending rather than alphabetical order. Most could correctly name and use a suitable sorting algorithm in part (b), although some did not make their stopping statement clear and a few used a shuttle sort (not in this specification) stating that it was a bubble sort. A surprisingly large minority confused the order of the alphabet with S and P (and then M and N) most frequently transposed. Part (c) was usually well done but candidates must make their pivots – and the order in which they select their pivots, clear. Candidates must remember to discard their pivots and note that the specification instructs them to 'round up'. Once again the stopping/found statement was sometimes missing, and some candidates assumed the presence of N, stating that once they had got down to 1 term only, that term must be N.

10. Many candidates were able to gain full marks on this question. The most common errors in part (a) were in re-ordering the letters in the sub-lists and choosing the pivots inconsistently. A surprising number of candidates seemed unsure of the alphabet. Part (b) was well done by the majority of candidates. A surprising number tried to use an unsorted list for their search, gaining no marks and others omitted to discard the pivot. The commonest error was in failing to select Morris after correctly selecting Palmer then Halliwell. A few candidates did not make the order in which they selected the pivots clear making it impossible to give credit.