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INTERNATIONAL A LEVEL MATHEMATICS • DECISION MATHEMATICS 1

Decision 1

Chapter 1: Algorithms

Exam Questions by Topic

Pearson Edexcel International Advanced Level (WDM11/01) • Calculator allowed • Answer book pages included

Multi-step exam questions at the difficulty of the real WDM11 paper, with a full mark scheme

Chapters (tap a chapter to jump to it)		Qs	Marks	Page	My score
1	**Algorithms** Flow charts, bubble sort, quick sort, bin packing, binary search	10	80	2	
2	**Graphs and Networks** Vocabulary, types of graph, degrees, adjacency and distance matrices	10	80	separate file	
3	**Algorithms on Graphs** Kruskal, Prim (networks and matrices), Dijkstra	10	80	separate file	
4	**Route Inspection** Eulerian graphs, pairing odd vertices, start and finish points	10	80	separate file	
5	**The Travelling Salesman Problem** Classical and practical problems, upper and lower bounds	10	80	separate file	
6	**Critical Path Analysis** Activity networks, event times, floats, Gantt charts, scheduling	10	80	separate file	
7	**Linear Programming** Formulation, feasible regions, objective lines, integer solutions	10	80	separate file	

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CHAPTER 1 • KEY SKILLS

1 Algorithms

Specification D1: Algorithms • 10 questions • 80 marks • about 96 minutes

1 Tracing algorithms

Work through the instructions in order, recording every variable in a table. Write the final answer on the output line.

2 Flow charts

Ovals start and stop, rectangles are instructions, diamonds are decisions. Follow each loop back to exactly the box it points to.

3 Bubble sort

Compare adjacent pairs, swapping when out of order. After each pass one more item is fixed; finish with a pass that makes no swaps.

4 Quick sort

Pivot is the middle item (middle-right for an even number). Keep items in their original order either side; give every sublist a pivot.

5 Order asked for

Sort into the order the question states (ascending or descending): the other order loses marks.

6 Binary search

Middle item at position $\left\lceil \frac{\text{first+last}}{2} \right\rceil$, rounded up. Discard the half that cannot contain the target, including the middle.

7 Bin packing

First fit: each item into the first bin it fits. First-fit decreasing: sort first. Full bin: look for combinations that fill bins.

8 Lower bound

Total ÷ bin size, rounded up. A packing that uses this many bins is optimal.

9 Deductions

Every item that went into (or did not fit) a bin gives an inequality for the bin size.

Skills map every skill above is tested at least once; interleaved skills come from GCSE or other chapters

Skill	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Marks	6	6	6	6	6	10	10	10	10	10
1 Tracing algorithms				●				●		
2 Flow charts								●		
3 Bubble sort	●									●
4 Quick sort		●				●			●	
5 Order asked for	●	●				●			●	●
6 Binary search					●				●	
7 Bin packing			●			●	●			●
8 Lower bound			●			●	●			●
9 Deductions							●			
Interleaved: integer division and remainders (GCSE)				●				●		
Interleaved: inequalities (P1)							●			
Interleaved: alphabetical ordering					●				●	

Exam difficulty. Questions 1 to 5 check each skill on its own. Questions 6 to 10 are multi-step questions built like the last questions on a real WDM11 paper, where one part leads into the next.

Answer book. After each question is a copy of the page the real D1 answer book prints for it (lists, tables, answer lines), so you can practise using the answer book exactly as in the exam.

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1.

19 7 25 12 30 4 16 21

(a) Use a bubble sort, starting at the left-hand end of the list, to sort the numbers into **descending** order. You need only give the state of the list after each pass.

(4)

(b) State the number of comparisons and the number of swaps made in the first pass.

(1)

(c) State the maximum number of passes a bubble sort could need for a list of 8 numbers.

(1)

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Question 1 continued **D1 ANSWER BOOK**

In the exam this page is printed in the separate D1 answer book. Write your working here, on the copy provided.

19	7	25	12	30	4	16	21

19	7	25	12	30	4	16	21

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(Total for Question 1 is 6 marks)

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2.

23 8 41 15 32 11 27 6 19 36

(a) Use a quick sort to sort the list into **ascending** order. You must make your pivots clear.

(5)

(b) Explain how you know that your sort is complete.

(1)

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Question 2 continued **D1 ANSWER BOOK**

In the exam this page is printed in the separate D1 answer book. Write your working here, on the copy provided.

23	8	41	15	32	11	27	6	19	36

23	8	41	15	32	11	27	6	19	36

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(Total for Question 2 is 6 marks)

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3.

8 15 4 12 9 6 11 7 5

The numbers in the list are the weights, in kg, of nine parcels. They are to be packed into crates that each hold up to 20 kg.

(a) Calculate a lower bound for the number of crates needed. You must make your method clear.

(2)

(b) Use the first-fit bin packing algorithm to allocate the parcels to crates, in the order given.

(3)

(c) Explain why your answer to part (b) is optimal.

(1)

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Question 3 continued **D1 ANSWER BOOK**

In the exam this page is printed in the separate D1 answer book. Write your working here, on the copy provided.

8	15	4	12	9	6	11	7	5

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(Total for Question 3 is 6 marks)

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4. An algorithm is described below.

1. Input positive integers A and B
2. Let $C = 0$
3. If B is odd, replace C with $C + A$
4. Replace A with $2A$ and replace B with INT $\left(\frac{B}{2}\right)$
5. If $B > 0$, go to step 3
6. Output C and stop

INT(x) means the integer part of x, so INT(5.5) = 5

(a) Implement the algorithm with $A = 37$ and $B = 22$, completing the table in the answer book.

(5)

(b) State the purpose of the algorithm.

(1)

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Question 4 continued **D1 ANSWER BOOK**

In the exam this page is printed in the separate D1 answer book. Write your working here, on the copy provided.

A	B	Is B odd?	C

Output: _____

(Total for Question 4 is 6 marks)

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5. The list below is in alphabetical order.

Adams, Begum, Chen, Diaz, Evans, Fofana, Garcia, Haddad, Ito, Kapoor, Lopez

(a) Use the binary search algorithm to locate the name Kapoor in the list. You must make your method clear.

(4)

(b) Use the binary search algorithm to show that the name Baker is not in the list.

(2)

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Question 5 continued D1 ANSWER BOOK

In the exam this page is printed in the separate D1 answer book. Write your working here, on the copy provided.

Position	Name
1	Adams
2	Begum
3	Chen
4	Diaz
5	Evans
6	Fofana
7	Garcia
8	Haddad
9	Ito
10	Kapoor
11	Lopez

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(Total for Question 5 is 6 marks)

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6.

18 31 12 26 9 22 35 14 27 7 20 16

The list shows the lengths, in minutes, of twelve video clips. They are to be stored on discs that each hold up to 50 minutes.

(a) Use a quick sort to sort the list into **descending** order. You must make your pivots clear.

(4)

(b) Apply the first-fit decreasing bin packing algorithm to your sorted list.

(3)

(c) Calculate a lower bound for the number of discs needed, and hence explain whether your packing in part (b) is optimal.

(2)

(d) Explain why first-fit decreasing usually gives a better packing than first fit.

(1)

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Question 6 continued D1 ANSWER BOOK

In the exam this page is printed in the separate D1 answer book. Write your working here, on the copy provided.

18	31	12	26	9	22	35	14	27	7	20	16

18	31	12	26	9	22	35	14	27	7	20	16

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Question 6 continued

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(Total for Question 6 is 10 marks)

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7.

24 13 19 8 15 11 6

The list shows the sizes, in GB, of seven files. They are copied, in the order given, onto storage cards that each hold n GB, where n is an integer. The first-fit bin packing algorithm gives this allocation.

Card 1: 24 13 Card 2: 19 8 11 Card 3: 15 6

(a) Using the allocation, explain why $n \geqslant 38$

(2)

(b) Find the greatest possible value of n, giving reasons.

(3)

For the rest of this question, $n = 40$

(c) Apply the first-fit decreasing algorithm to the files.

(3)

(d) Calculate a lower bound for the number of cards, and comment on your answer to part (c).

(2)

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Question 7 continued **D1 ANSWER BOOK**

In the exam this page is printed in the separate D1 answer book. Write your working here, on the copy provided.

24	13	19	8	15	11	6

Possible values of n: _____

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Question 7 continued

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(Total for Question 7 is 10 marks)

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8.

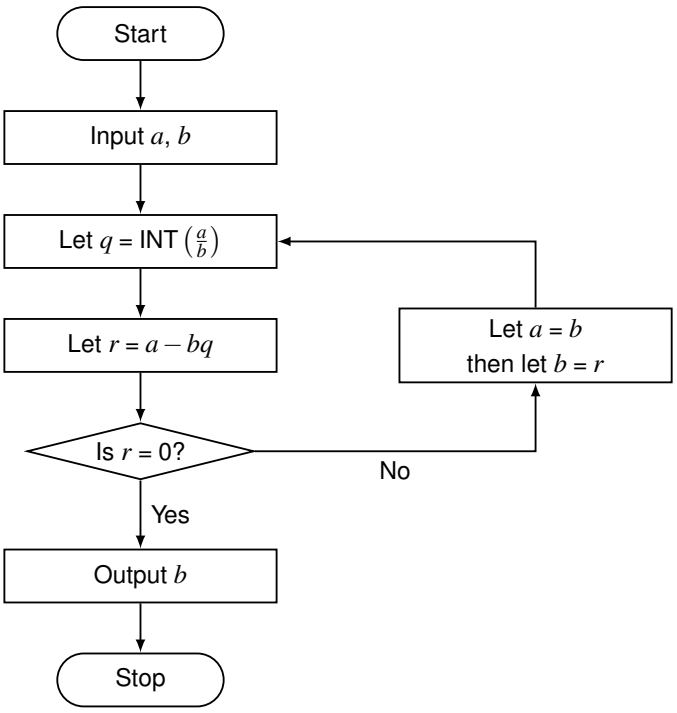


Figure 1

Figure 1 shows a flow chart. INT(x) means the integer part of x.

(a) Implement the algorithm with $a = 168$ and $b = 120$, completing the table in the answer book and stating the output.

(5)

(b) State the purpose of the algorithm.

(1)

(c) Implement the algorithm with $a = 120$ and $b = 168$, and comment on how this run differs from part (a).

(2)

(d) Without completing a new table, state the output when $a = 91$ and $b = 35$, showing the values of r that are found.

(2)

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Question 8 continued **D1 ANSWER BOOK**

In the exam this page is printed in the separate D1 answer book. Write your working here, on the copy provided.

a	b	q	r	Is $r = 0$?

Output: _____

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Question 8 continued

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(Total for Question 8 is 10 marks)

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9.

Okafor, Bell, Singh, Moreau, Tanaka, Diallo, Kowalski, Hughes, Rossi

(a) Use a quick sort to sort the names into alphabetical order. You must make your pivots clear.

(5)

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

(3)

(c) Use the binary search algorithm to show that the name Patel is not in the list.

(2)

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Question 9 continued D1 ANSWER BOOK

In the exam this page is printed in the separate D1 answer book. Write your working here, on the copy provided.

Okafor	Bell	Singh	Moreau	Tanaka	Diallo	Kowalski	Hughes	Rossi

Okafor	Bell	Singh	Moreau	Tanaka	Diallo	Kowalski	Hughes	Rossi

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Question 9 continued

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(Total for Question 9 is 10 marks)

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10.

14 9 21 6 17 11 25 8 19 4

The list shows the masses, in kg, of ten bags of sand.

(a) Use a bubble sort, starting at the left-hand end, to sort the masses into **descending** order. Give the list after each pass, and the number of comparisons and swaps in each pass, using the table in the answer book.

(5)

(b) Find the maximum number of comparisons that a bubble sort could need for a list of ten values.

(1)

The bags are to be loaded, **in the order given in the original list**, onto trolleys that each carry up to 30 kg.

(c) Use the first-fit bin packing algorithm to allocate the bags to trolleys.

(3)

(d) Calculate a lower bound for the number of trolleys, and comment on your answer to part (c).

(1)

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Question 10 continued D1 ANSWER BOOK

In the exam this page is printed in the separate D1 answer book. Write your working here, on the copy provided.

14	9	21	6	17	11	25	8	19	4

Pass	Comparisons	Swaps
1		
2		
3		
4		
5		
6		
7		
8		
9		

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Question 10 continued

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(Total for Question 10 is 10 marks)

TOTAL FOR CHAPTER 1 IS 80 MARKS

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