Materials required for examination	Items included with question papers
Nil	D1 answer book

Candidates may use any calculator EXCEPT those with the facility for symbolic algebra, differentiation and/or integration. Thus candidates must NOT use calculators such as the Texas Instruments TI 89, TI 92, Casio CFX 9970G, Hewlett Packard HP 48G.

Instructions to Candidates

Write your answers for this paper in the D1 answer book provided.
In the boxes on the answer book, write your centre number, candidate number, your surname, initial(s) and signature.
Check that you have the correct question paper.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.
You must complete your answers in blue or black ink or pencil.

Information for Candidates

Full marks may be obtained for answers to ALL questions.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 8 questions in this question paper.
The total mark for this paper is 75. There are 12 pages in this question paper.
The answer book has 16 pages. Any blank pages are indicated.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner. Answers without working may gain no credit.

N 2 2 0 9 8 A

Turn over

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Write your answers in the D1 answer book for this paper.

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.
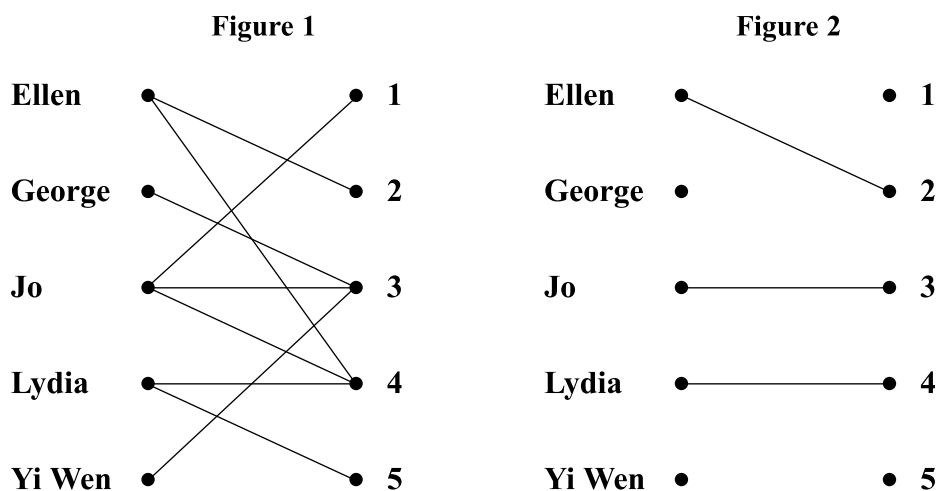

Figure 1   **Figure 2**

Figure 1 shows the possible allocations of five people, Ellen, George, Jo, Lydia and Yi Wen to five tasks, 1, 2, 3, 4 and 5.

Figure 2 shows an initial matching.

(a) Find an alternating path linking George with 5. List the resulting improved matching this gives.

(3)

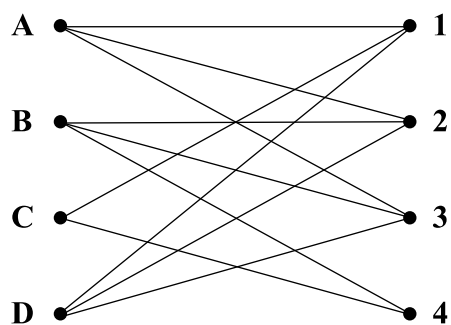(b) Explain why it is not possible to find a complete matching.

(1)

George now has task 2 added to his possible allocation.

(c) Using the improved matching found in part (a) as the new initial matching, find an alternating path linking Yi Wen with task 1 to find a complete matching. List the complete matching.

(3)

(Total 7 marks)

3.

Figure 3

(a) Write down the name given to the type of graph drawn in Figure 3.

(1)

A Hamiltonian cycle for the graph in Figure 3 begins A, 3, B, ….

(b) Complete this Hamiltonian cycle.

(2)

(c) Starting with the Hamiltonian cycle found in (b), use the planarity algorithm to determine if the graph is planar.

(3)

(Total 6 marks)

4. A three-variable linear programming problem in x, y and z is to be solved. The objective is to maximise the profit P. The following initial tableau was obtained.

Basic variable	x	y	z	r	s	Value
r	2	0	4	1	0	80
s	1	4	2	0	1	160
P	–2	–8	–20	0	0	0

(a) Taking the most negative number in the profit row to indicate the pivot column, perform one complete iteration of the simplex algorithm, to obtain tableau T. State the row operations that you use.

(5)

(b) Write down the profit equation shown in tableau T.

(1)

(c) State whether tableau T is optimal. Give a reason for your answer.

(1)

(Total 7 marks)

5. (a) Explain why a network cannot have an odd number of vertices of odd degree.
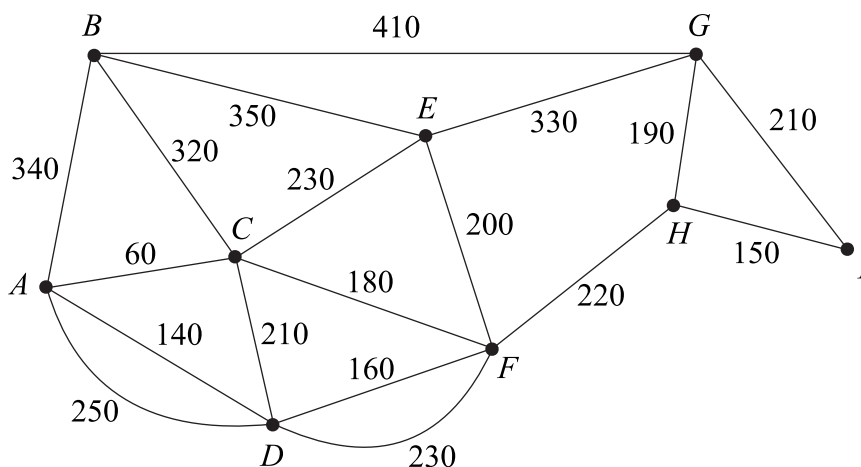
(2)

Figure 4

Figure 4 shows a network of paths in a public park. The number on each arc represents the length of that path in metres. Hamish needs to walk along each path at least once to check the paths for frost damage starting and finishing at *A*. He wishes to minimise the total distance he walks.

(b) Use the route inspection algorithm to find which paths, if any, need to be traversed twice.

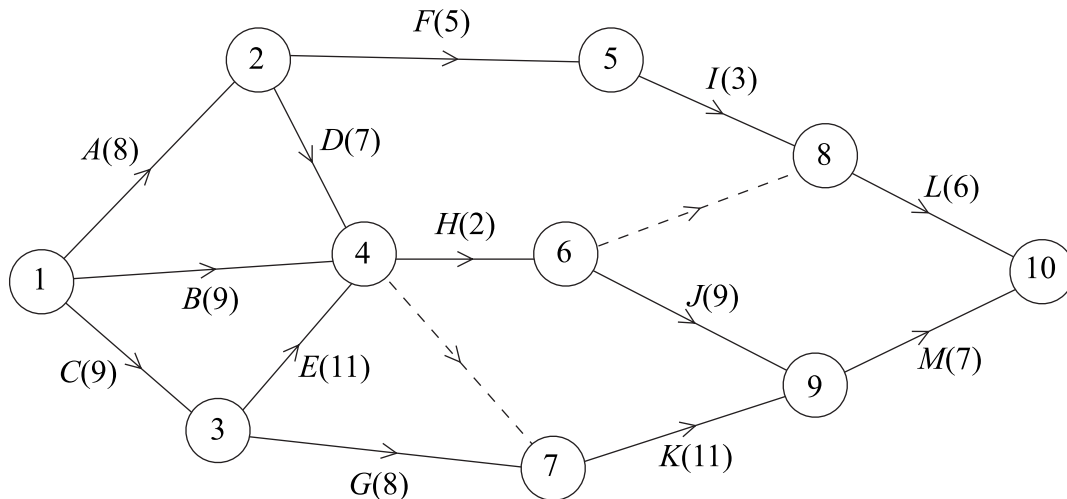**(4)**

(c) Find the length of Hamish's route.
[The total weight of the network in Figure 4 is 4180 m.]

(1)

(Total 7 marks)
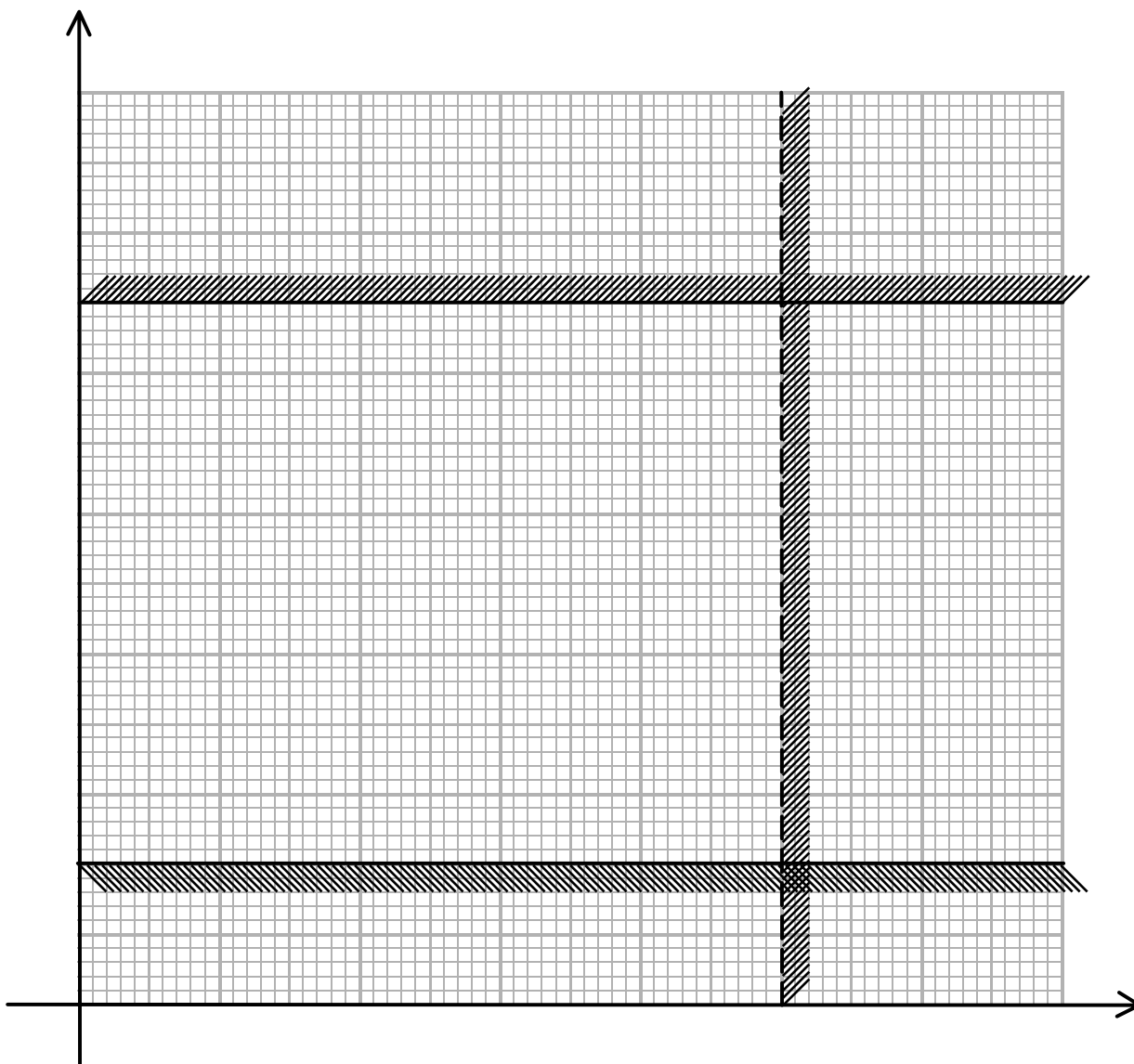
6.

Figure 5

A project is modelled by the activity network shown in Figure 5. The activities are represented by the arcs. The number in brackets on each arc gives the time, in hours, to complete the activity. The numbers in circles are the event numbers. Each activity requires one worker.

(a) Explain the purpose of the dotted line from event 6 to event 8.

(1)

(b) Calculate the early time and late time for each event. Write these in the boxes in the answer book.

(4)

(c) Calculate the total float on activities *D*, *E* and *F*.

(3)

(d) Determine the critical activities.

(2)

(e) Given that the sum of all the times of the activities is 95 hours, calculate a lower bound for the number of workers needed to complete the project in the minimum time. You must show your working.

(2)

(f) Given that workers may not share an activity, schedule the activities so that the process is completed in the shortest time using the minimum number of workers.

(4)

(Total 16 marks)

7.

Figure 6

The captain of the *Malde Mare* takes passengers on trips across the lake in her boat.

The number of children is represented by x and the number of adults by y.

Two of the constraints limiting the number of people she can take on each trip are

$$x < 10$$

and

$$2 \leqslant y \leqslant 10$$

These are shown on the graph in Figure 6, where the rejected regions are shaded out.

(a) Explain why the line $x = 10$ is shown as a dotted line.

(1)

(b) Use the constraints to write down statements that describe the number of children and the number of adults that can be taken on each trip.

(3)

For each trip she charges £2 per child and £3 per adult. She must take at least £24 per trip to cover costs.

The number of children must not exceed twice the number of adults.

(c) Use this information to write down two inequalities.

(2)

(d) Add two lines and shading to Diagram 1 in your answer book to represent these inequalities. Hence determine the feasible region and label it R.

(4)

(e) Use your graph to determine how many children and adults would be on the trip if the captain takes:
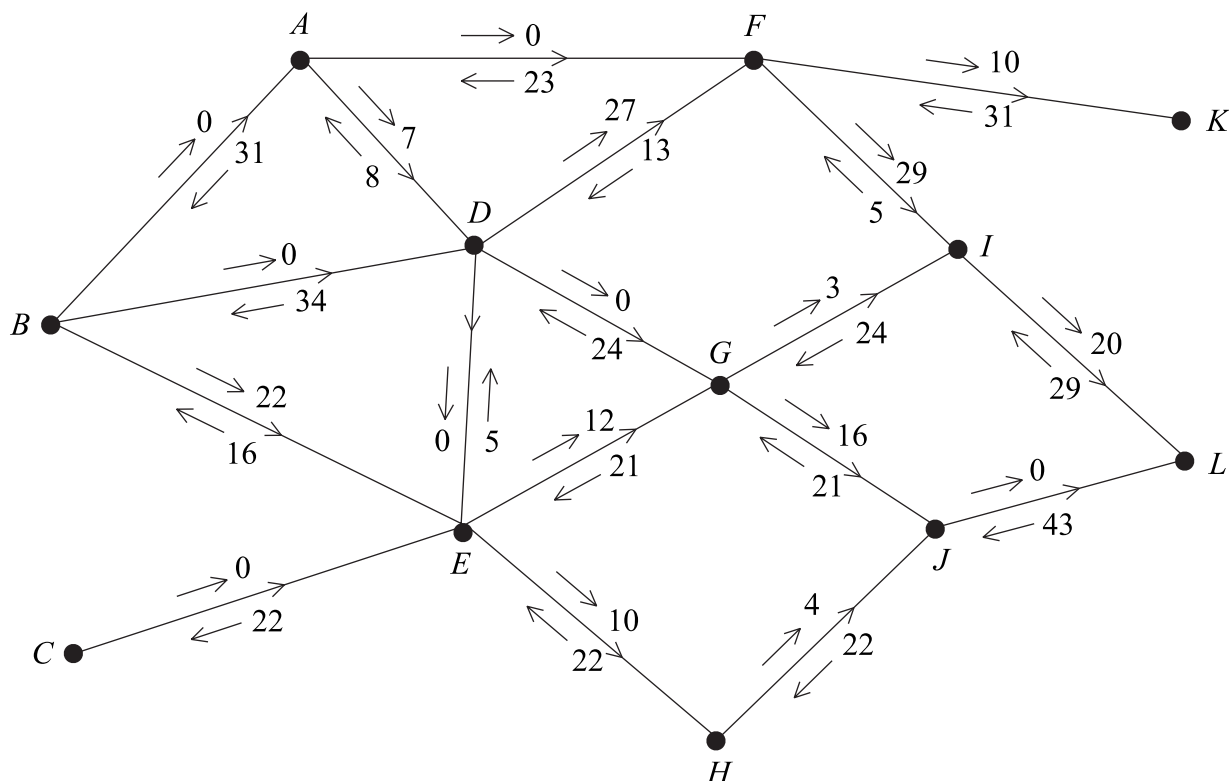
(i)   the minimum number of passengers,

(ii) the maximum number of passengers.

(4)

(Total 14 marks)

8.

Figure 7

In solving a network flow problem using the labelling procedure, the diagram in Figure 7 was created.

The arrow on each arc indicates the direction of the flow along that arc.

The arrows above and below each arc show the direction and value of the flow as indicated by the labelling procedure.

(a) Add a supersource S, a supersink T and appropriate arcs to Diagram 2 in the answer book, and complete the labelling procedure for these arcs.

(3)

(b) Write down the value of the initial flow shown in Figure 7.

(1)

(c) Use Diagram 2, the initial flow and the labelling procedure to find the maximal flow of 124 through this network. List each flow-augmenting path you use, together with its flow.

(5)

(d) Show your flow on Diagram 3 and state its value.

(3)

(e) Prove that your flow is maximal.

(2)

(Total 14 marks)

TOTAL FOR PAPER: 75 MARKS

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