

# Pearson Edexcel Level 3 GCE

**Friday 17 May 2024**

Afternoon

Paper  
reference

**8FM0/28**

## Further Mathematics

**Advanced Subsidiary  
Further Mathematics options  
28: Decision Mathematics 2  
(Part of option K only)**

### You must have:

Mathematical Formulae and Statistical Tables (Green),  
calculator, D2 Answer Book (enclosed)

**Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.**

### Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of the answer book with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the answer book provided  
– *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Inexact answers should be given to three significant figures unless otherwise stated.
- Do not return the question paper with the D2 Answer Book.

### Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- The total mark for this part of the examination is 40. There are 4 questions.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*

### Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

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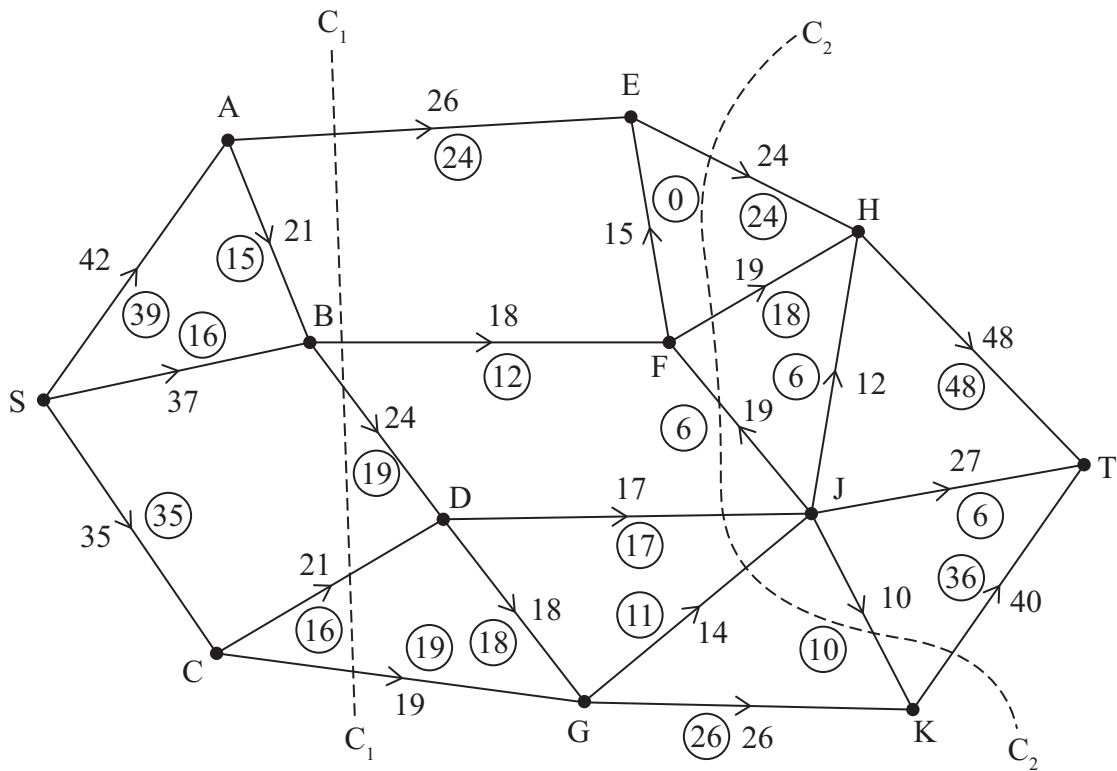


Figure 1

Figure 1 shows a capacitated, directed network of pipes. The number on each arc represents the capacity of the corresponding pipe. The numbers in circles represent a feasible flow from S to T.

- (a) State the value of this flow. (1)
  - (b) Explain why arcs CD and CG cannot both be saturated. (1)
  - (c) Find the capacity of
    - (i) cut  $C_1$
    - (ii) cut  $C_2$  (2)
  - (d) Write down a flow augmenting route of weight 6 which saturates BF. (1)
- The flow augmenting route in part (d) is applied to give an increased flow.
- (e) Prove that this increased flow is maximal. (3)

(Total for Question 1 is 8 marks)



2. A team of 5 players, A, B, C, D and E, competes in a quiz. Each player must answer one of 5 rounds, P, Q, R, S and T.

Each player must be assigned to exactly one round, and each round must be answered by exactly one player.

Player B cannot answer round Q, player D cannot answer round T, and player E cannot answer round R.

The number of points that each player is expected to earn in each round is shown in the table.

	P	Q	R	S	T
A	32	40	35	41	37
B	38	–	40	27	33
C	41	28	37	36	35
D	35	33	38	36	–
E	40	38	–	39	34

The team wants to maximise its total expected score.

The Hungarian algorithm is to be used to find the maximum total expected score that can be earned by the 5 players.

- (a) Explain how the table should be modified. (2)

- (b) (i) Reducing rows first, use the Hungarian algorithm to obtain an allocation which maximises the total expected score.

- (ii) Calculate the maximum total expected score. (6)

**(Total for Question 2 is 8 marks)**

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3. Haruki and Meera play a zero-sum game. The game is represented by the following pay-off matrix for Haruki.

		Meera		
		Option X	Option Y	Option Z
Haruki	Option A	4	-2	-5
	Option B	1	4	-3
	Option C	-1	6	1
	Option D	-4	5	3

- (a) Determine whether the game has a stable solution. (2)

Option Y for Meera is now removed.

- (b) Write down the reduced pay-off matrix for Meera. (1)

- (c) (i) Given that Meera plays Option X with probability  $p$ , determine her best strategy.

(ii) State the value of the game to Haruki.

- (iii) State which option(s) Haruki should never play. (7)

The number of points scored by Haruki when he plays Option C and Meera plays Option X changes from  $-1$  to  $k$

Given that the value of the game is now the same for both players,

- (d) determine the value of  $k$ . You must make your method and working clear. (4)

**(Total for Question 3 is 14 marks)**



4. Peter sets up a savings plan. He makes an initial deposit of £ $D$  and then pays in £ $M$  at the end of each month.

The value of the savings plan, in pounds, is modelled by

$$u_{n+1} = 1.025 u_n + 1800$$

where  $n \geq 0$  is an integer and  $u_n$  is the total value of the savings plan, in pounds, after  $n$  years.

- (a) Calculate the value of  $M$  (1)

Given that the value of the savings plan after 1 year is £6925

- (b) solve the recurrence relation for  $u_n$  (5)

- (c) Determine the value of  $D$  (1)

- (d) Hence determine, using algebra, the number of years it will take for the value of the savings plan to exceed £20 000 (3)

(Total for Question 4 is 10 marks)

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**TOTAL FOR DECISION MATHEMATICS 2 IS 40 MARKS**





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Please check the examination details below before entering your candidate information

Candidate surname

Other names

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**D2 Answer Book**

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Total Marks

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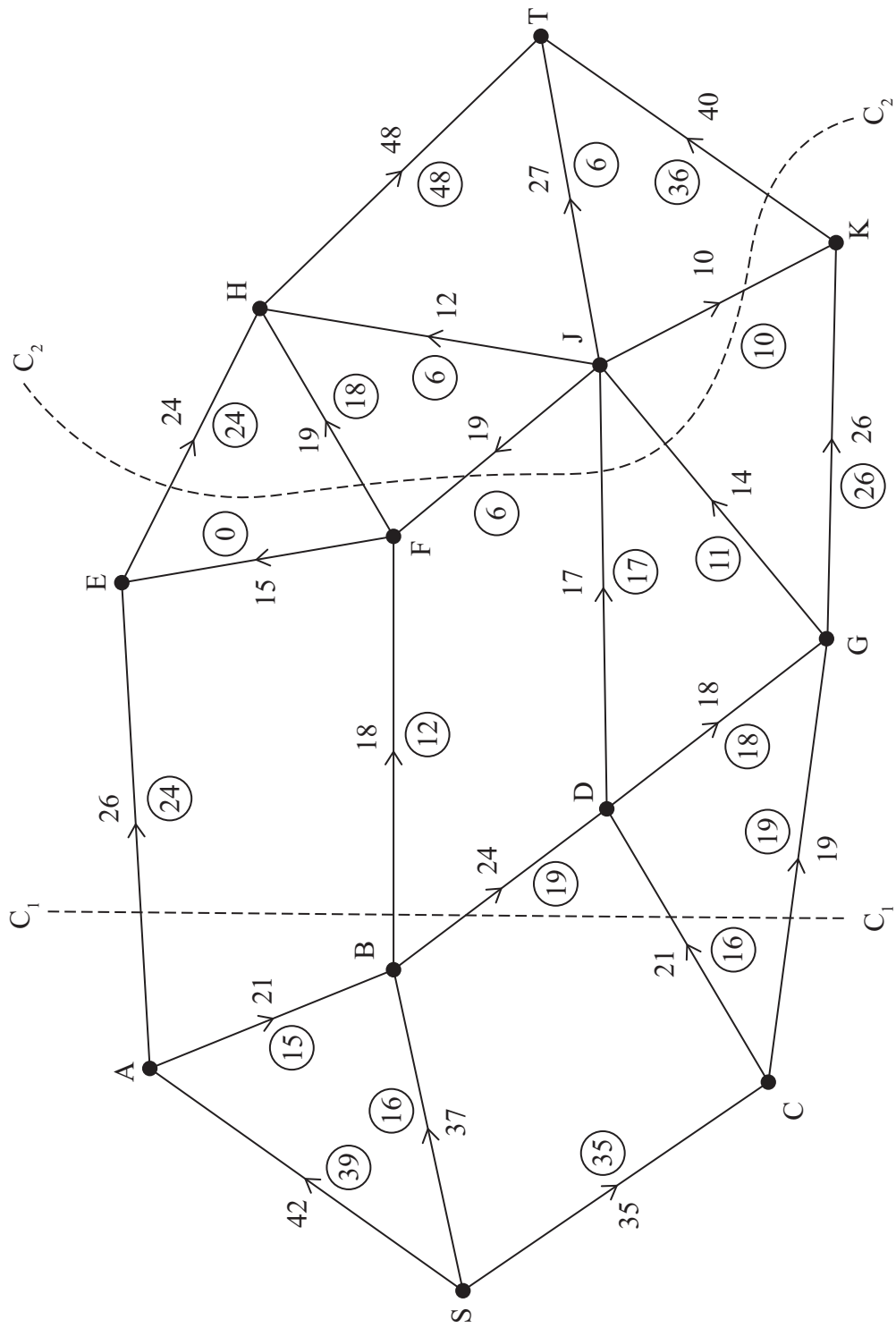


Figure 1

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