

General Certificate of Education
June 2005
Advanced Level Examination



MATHEMATICS (SPECIFICATION A)
Unit Discrete 2

MAD2

Wednesday 22 June 2005 Afternoon Session

In addition to this paper you will require:

- an 8-page answer book;
- an insert for use in Questions 1, 3 and 4 (enclosed);
- the AQA booklet of formulae and statistical tables.

You may use a graphics calculator.

Time allowed: 1 hour 20 minutes

Instructions

- Use blue or black ink or ball-point pen. Pencil should only be used for drawing.
- Write the information required on the front of your answer book. The *Examining Body* for this paper is AQA. The *Paper Reference* is MAD2.
- Answer **all** questions.
- All necessary working should be shown; otherwise marks for method may be lost.
- The **final** answer to questions requiring the use of tables or calculators should normally be given to three significant figures.
- Tie loosely any additional sheets you have used, including the insert for use in Questions 1, 3 and 4, to the back of your answer book before handing it to the invigilator.

Information

- The maximum mark for this paper is 60.
- Mark allocations are shown in brackets.
- Further copies of the insert for use in Questions 1, 3 and 4 are available on request.
- Sheets of graph paper are available on request.

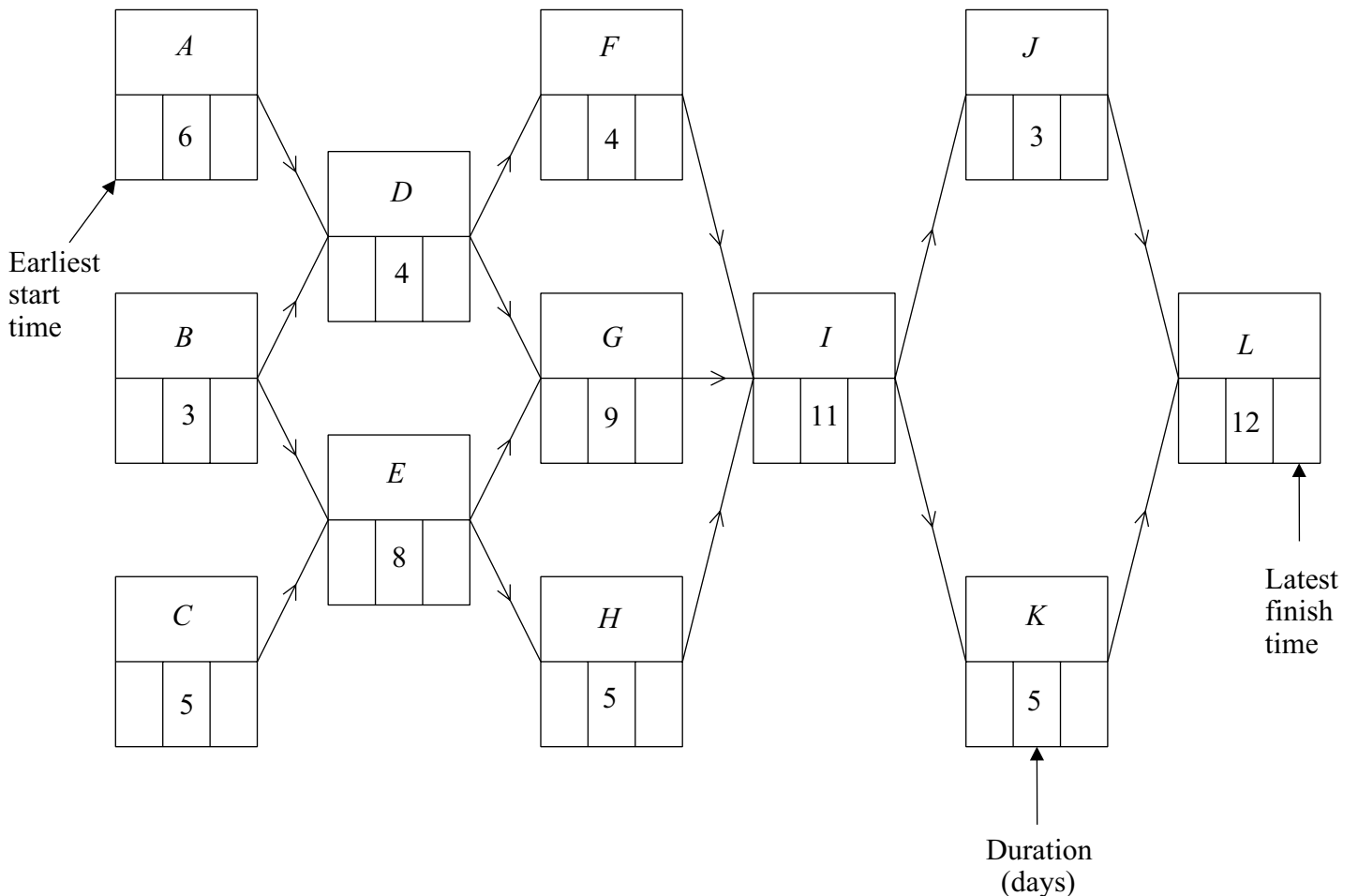
Advice

- Unless stated otherwise, formulae may be quoted, without proof, from the booklet.

Answer **all** questions.

1 [Figure 1, printed on the insert, is provided for use in answering this question.]

The following diagram shows an activity network for a major building project.



(a) On **Figure 1** find:

(i) the earliest start time for each activity;

(2 marks)

(ii) the latest finish time for each activity.

(2 marks)

(b) Identify the critical path.

(1 mark)

(c) State the activity with the greatest float time.

(1 mark)

(d) Construct a Gantt (cascade) diagram for the project.

(3 marks)

(e) Activities *D* and *J* overrun by 5 days each. Find:

(i) the new minimum completion time for the project;

(3 marks)

(ii) the new critical path.

- 2 A computer repair company has five workers, *A*, *B*, *C*, *D* and *E*. The company carries out four types of repair, 1, 2, 3 and 4. The times, in minutes, taken by each of the workers to carry out each type of repair are given in the following table.

	Repair 1	Repair 2	Repair 3	Repair 4
<i>A</i>	18	24	26	22
<i>B</i>	17	25	23	19
<i>C</i>	19	26	24	23
<i>D</i>	16	22	28	20
<i>E</i>	20	23	22	21

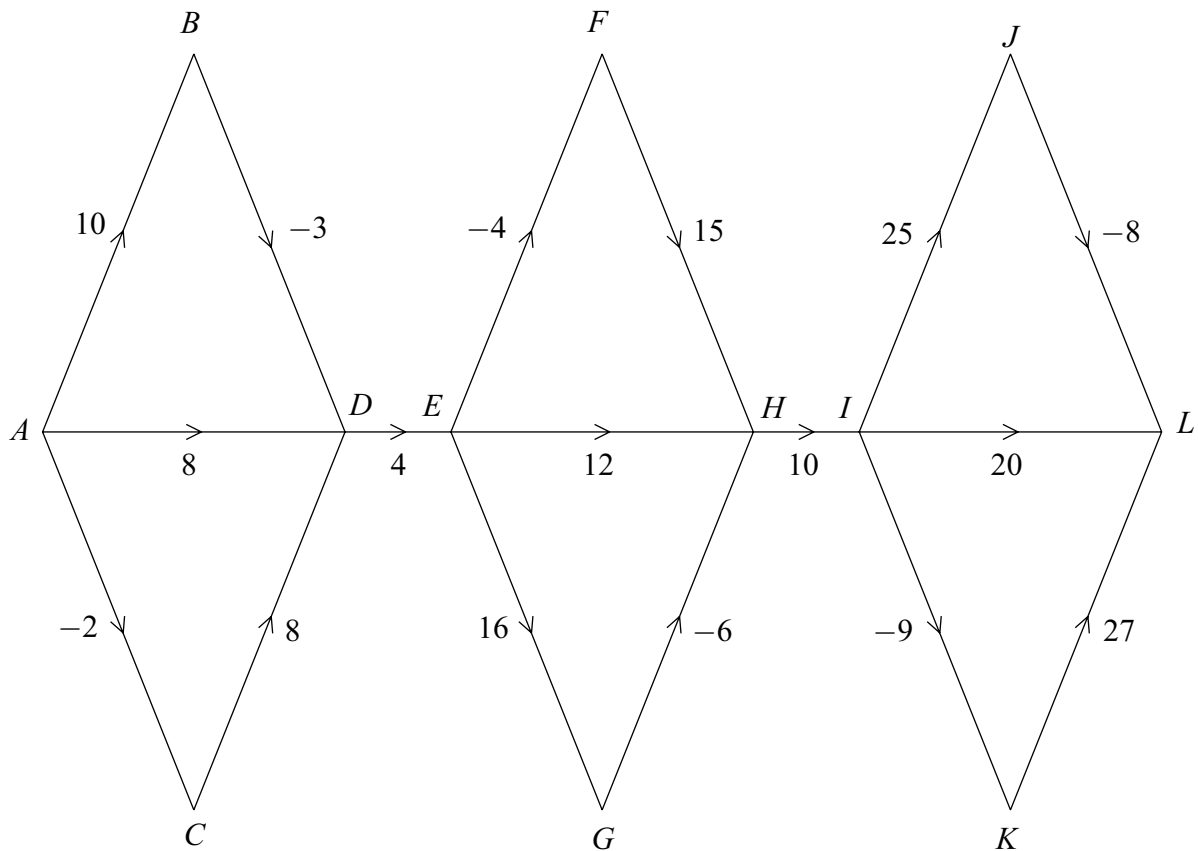
On a certain day, the company needs to carry out one of each type of repair and each repair is to be carried out by a different worker.

Use the Hungarian algorithm to allocate workers to repairs to minimise the total repair time. State this minimum time. (9 marks)

TURN OVER FOR THE NEXT QUESTION

3 [Figure 2, printed on the insert, is provided for use in answering this question.]

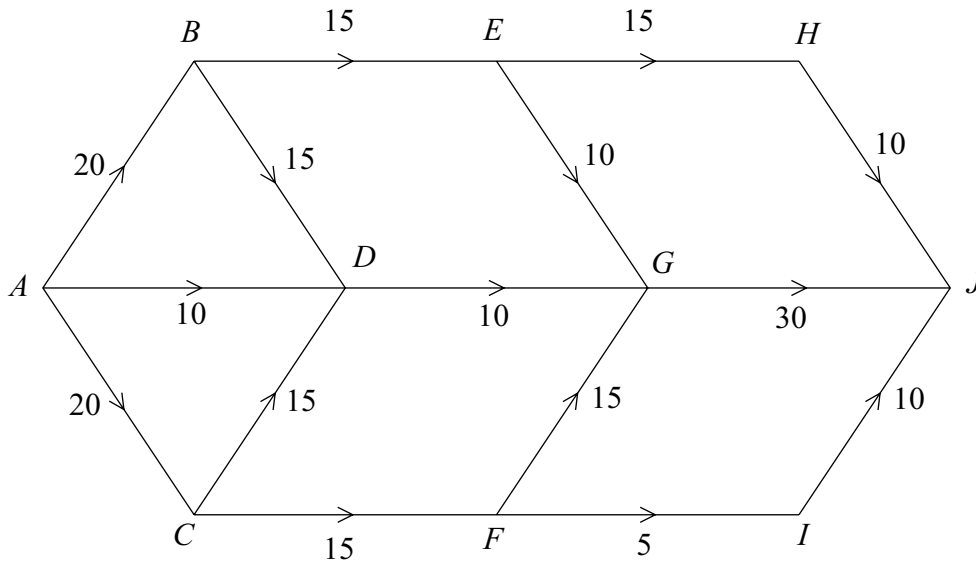
The following network shows 12 vertices. The number on each arc is the cost of a journey between a pair of vertices.



On Figure 2, or otherwise, use dynamic programming to find the minimum cost of a route from A to L . State the route corresponding to this minimum cost. (8 marks)

4 [Figure 3, printed on the insert, is provided for use in answering this question.]

The following diagram shows the maximum number of cars that can travel along each section of a one-way system in a 5 minute interval.



- (a) On **Figure 3**, starting from a position of no flow of cars along the one-way system, use flow augmentation to find the maximum flow. *(4 marks)*
- (b) Confirm that you have a maximum flow by finding a cut of the same value. *(1 mark)*
- (c) A new road is to be added to the system. Determine which two vertices this new road should connect in order to make a flow of more than 50 cars, in a 5 minute interval, possible. *(2 marks)*

TURN OVER FOR THE NEXT QUESTION

- 5 Arnie (A) and Ben (B) play a zero-sum game. The game is represented by the following pay-off matrix for Arnie (A).

		Ben (B)		
		I	II	III
Arnie (A)	I	1	2	2
	II	3	1	7
	III	2	3	6

- (a) Explain why the matrix can be reduced to

3	1
2	3

(2 marks)

- (b) Find the optimal mixed strategy for each player and the value of the game. *(9 marks)*

- 6 (a) Display the following linear programming problem in a Simplex tableau.

Maximise

$$P = 2x - 3y + z$$

subject to

$$3x + 6y + z \leq 72$$

$$4x + 2y + z \leq 48$$

$$x - y + z \leq 36.$$

(2 marks)

- (b) Solve the problem using the Simplex algorithm, stating the values of P , x , y , z and the slack variables. *(10 marks)*

END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE

Surname						Other Names					
Centre Number						Candidate Number					
Candidate Signature											

General Certificate of Education
June 2005
Advanced Level Examination



MATHEMATICS (SPECIFICATION A)
Unit Discrete 2

MAD2

Wednesday 22 June 2005 Afternoon Session

Insert for use in answering Questions 1, 3 and 4.

Fill in the boxes at the top of this page.

Fasten this insert securely to your answer book.

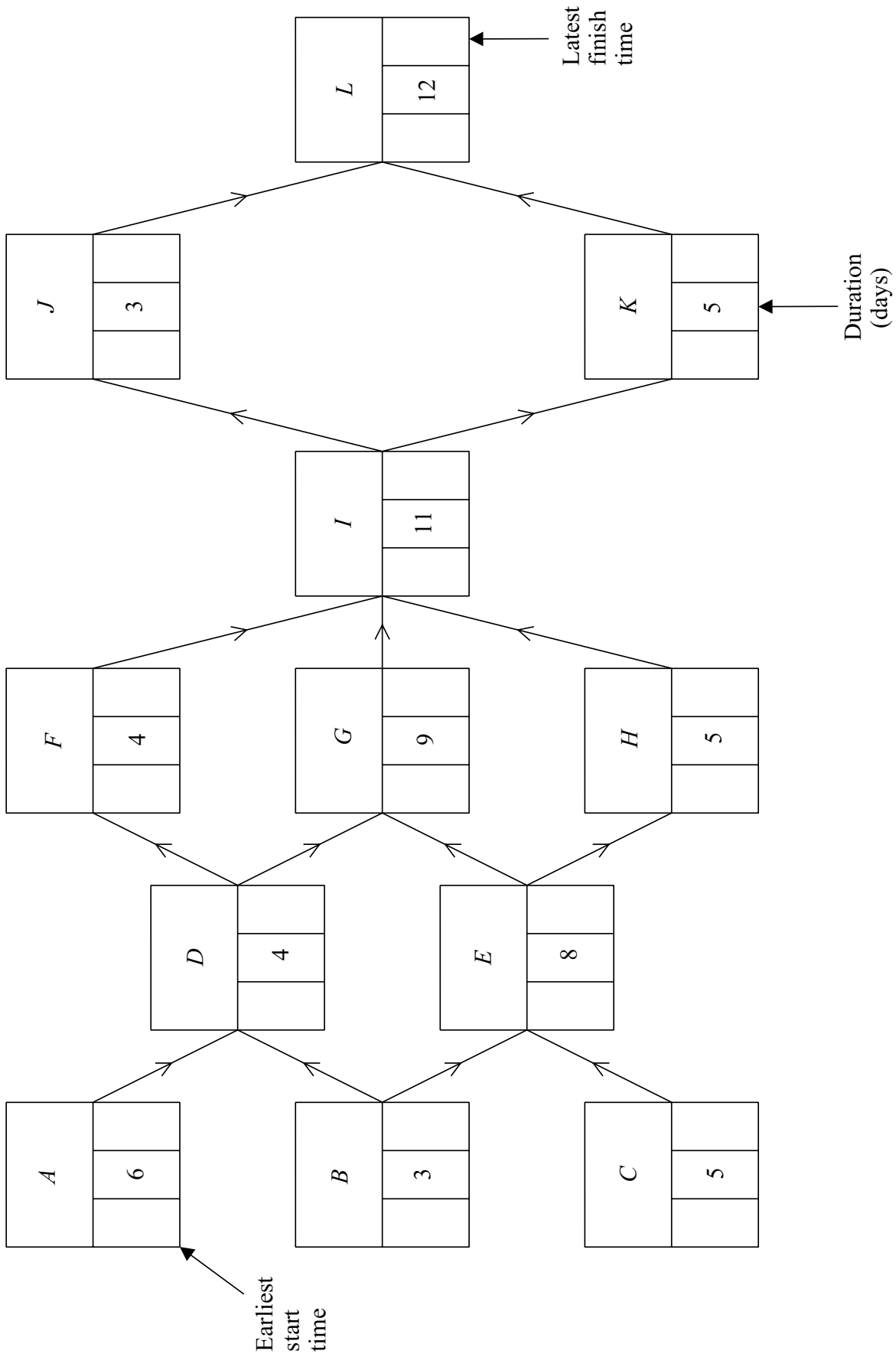


Figure 1 (for Question 1)

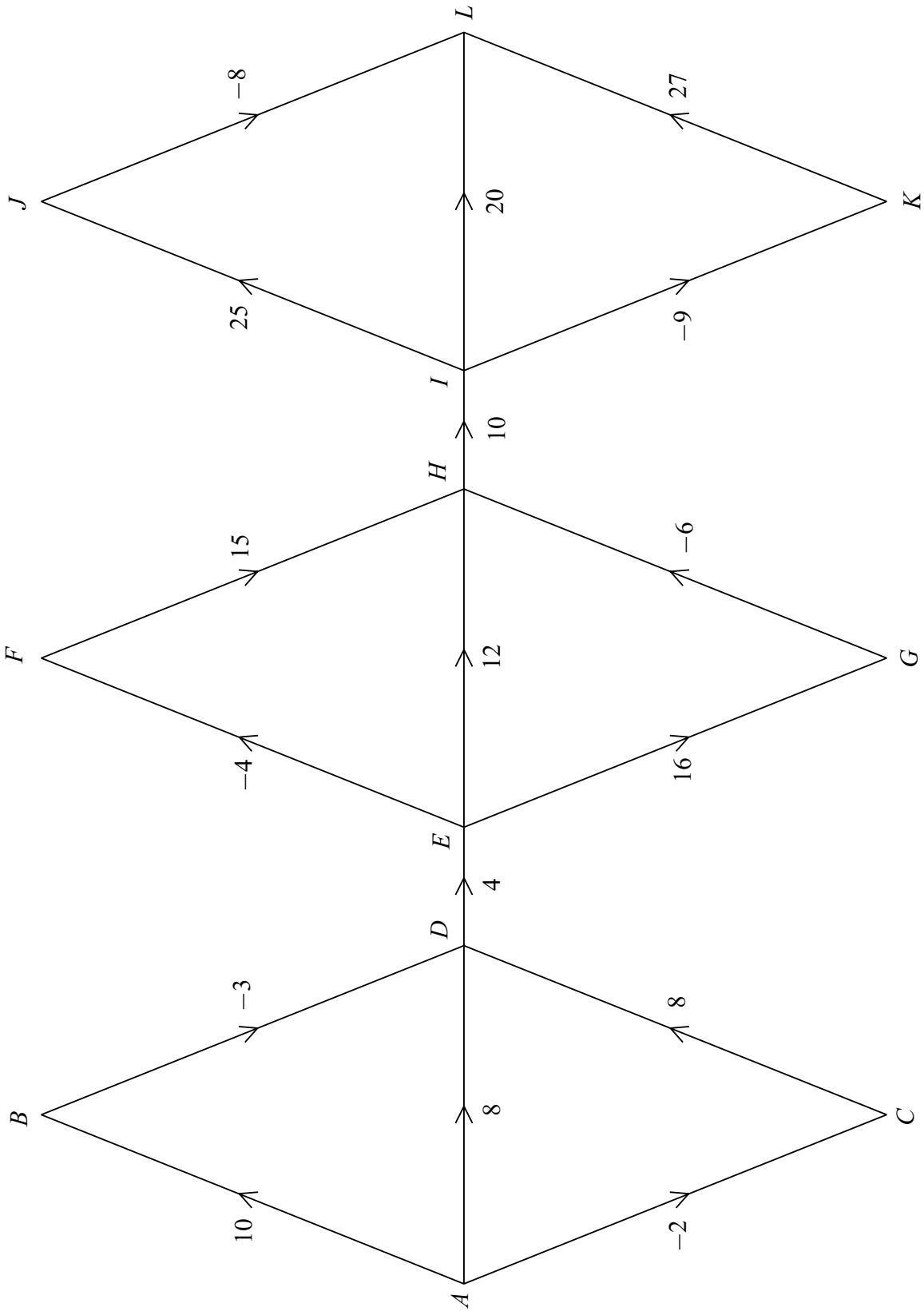


Figure 2 (for Question 3)

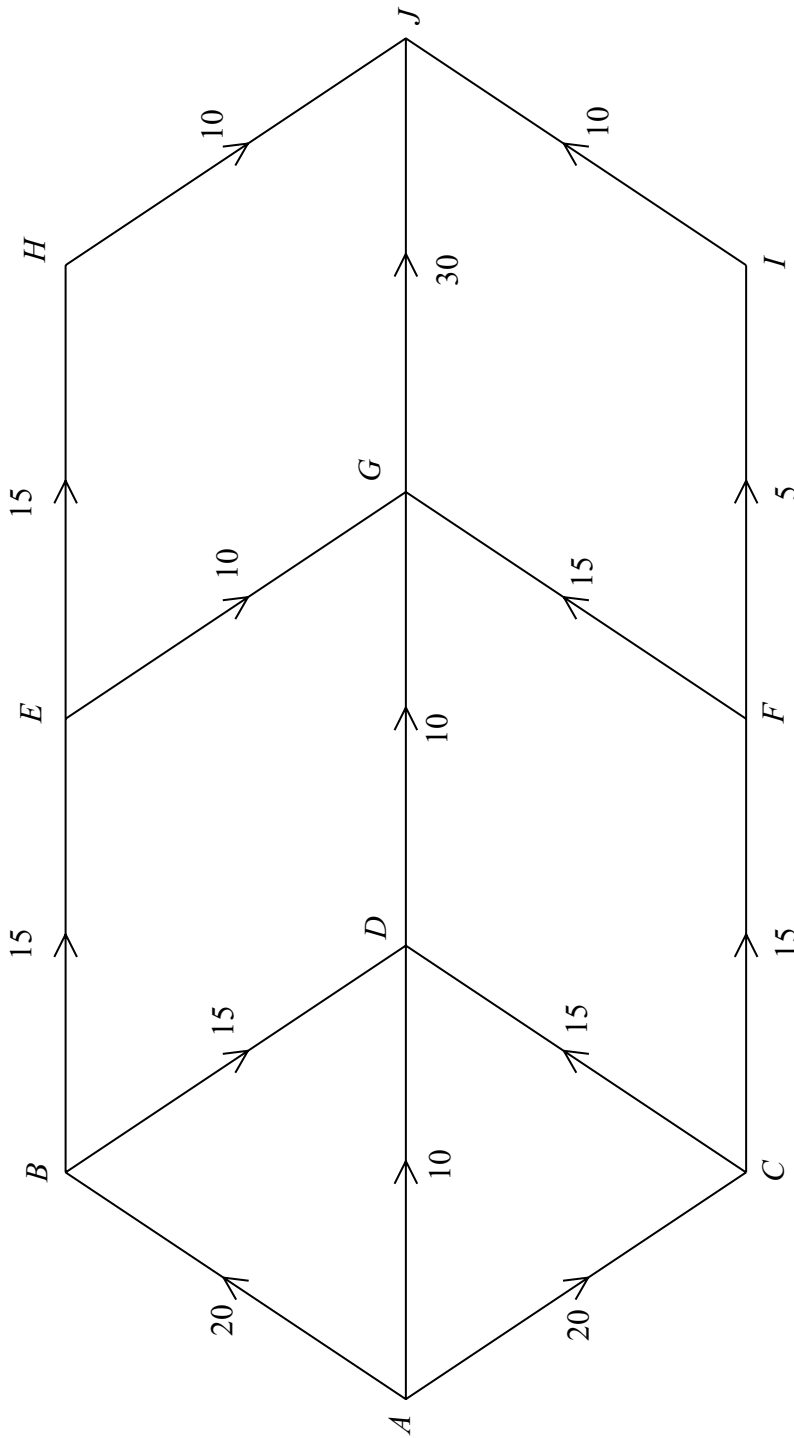


Figure 3 (for Question 4)