6690/01

Edexcel GCE

Decision Mathematics

Unit D2 Mock paper

Advanced Subsidiary / Advanced

Time: 1 hour 30 minutes

Materials required for the examination	Items included with these question papers
Answer Book (AB04) Graph Paper (GP02)	Nil

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

Instructions to Candidates

In the boxes on the Answer Book provided, write the name of the Examining Body (Edexcel), your Centre Number, Candidate Number, the Unit Title (Mechanics M1), the Paper Reference (6677), your surname, other names and signature.

When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information for Candidates

A booklet 'Mathematical Formulae including Statistical Formulae and Tables' is provided.

Full marks may be obtained for answers to ALL questions.

This paper has 6 questions. Pages 6, 7 and 8 are blank.

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 will gain no credit.

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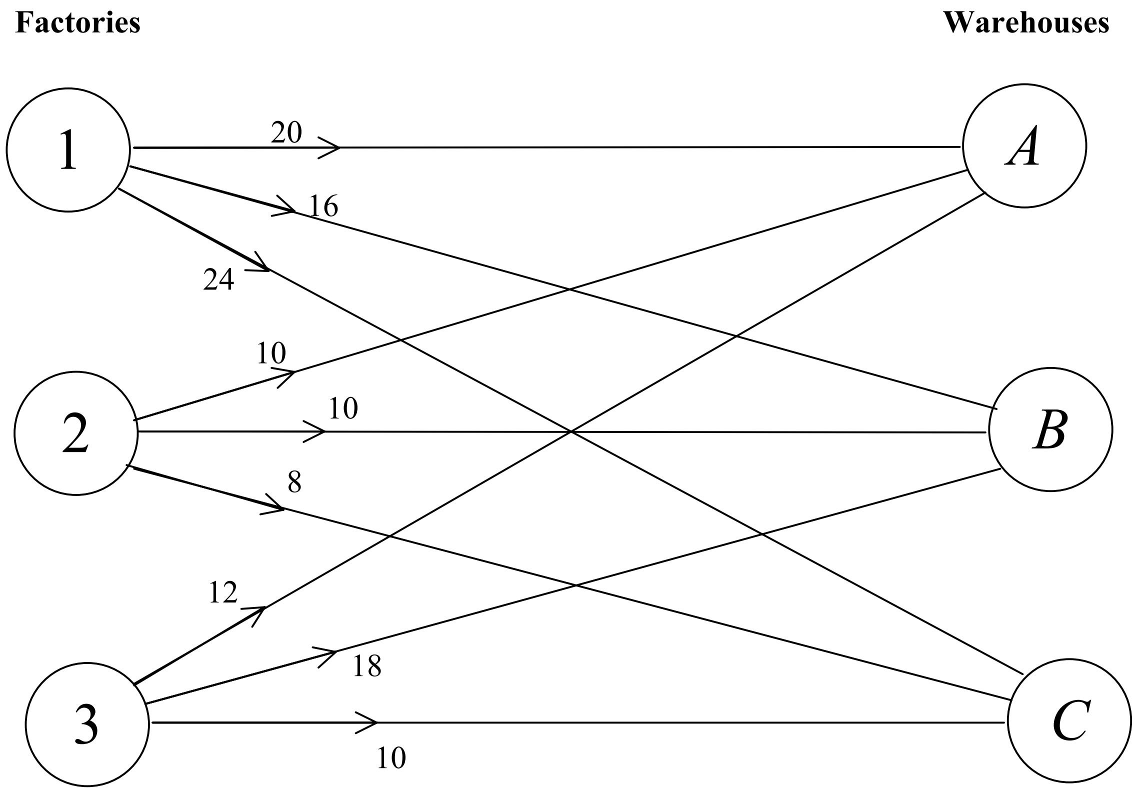
1. **Figure 1**



A product is produced at three factories 1, 2 and 3 and shipped to three warehouses A, B and C. The transportation costs, in £ per unit, on the possible routes are shown in Fig. 1. The capacities of the factories and the demands of the warehouses are shown in the tables below.

Factory	Capacity
1	300
2	500
3	100

Warehouse	Demand
A	200
B	400
C	300

Formulate, as a linear programming problem, the above situation when the total overall cost is to be minimised. Give reasons for your equations. **(7 marks)**

2.

	A	B	C	D	E	F	G
A	–	165	195	280	130	200	150
B	165	–	90	155	150	235	230
C	195	90	–	170	110	175	190
D	280	155	170	–	150	105	163
E	130	150	110	150	–	90	82
F	200	235	175	105	90	–	63
G	150	230	190	163	82	63	–

An area manager has to visit branches of his company in 7 towns A, B, C, D, E, F and G. The table shows the distances, in km, between these 7 towns. The manager lives in town A and plans a route starting and finishing at this town. She wishes to visit each town and drive the minimum distance.

(*a*) Starting from A, use Prim's algorithm to find a minimum connector and draw the minimum spanning tree. State the order in which you selected the arcs. **(5 marks)**

(*b*) (i) Hence determine an initial upper bound for the length of the route planned by the manager.

(ii) Starting from your initial upper bound and using a short cut, obtain a route with length less than 870 km.

(iii) Find a further cut which produces a route which visits each vertex exactly once and has a length less than 810 km. **(7 marks)**

3. Jenny wishes to travel from S to T. There are several routes available. She wishes to choose the route on which the maximum altitude, above sea level, is as small as possible. This is called the minimax route.

Figure 2

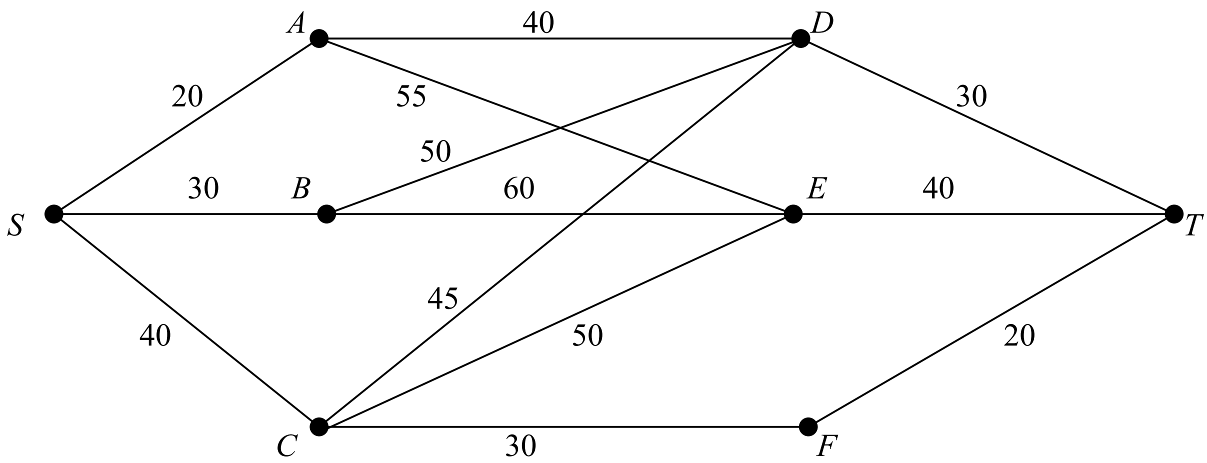


Figure 2 gives the possible routes and the weights on the edges give the maximum altitude on the road (in units of 100 feet).

Use dynamic programming, carefully defining the stages and states, to determine the route or routes Jenny should take. You should show your calculations in tabular form, using a table with columns labelled as shown below.

Stage	Initial State	Action	Final State	Value

(12 marks)

4. A builder owns three areas of land on which he wishes to build. The planning authority decides that each area of land must have a different type of building. Once the type of building has been chosen, every building in that area must be of the same design. The profit made by the builder depends on the area of land and the type of building.

	Area of Land		
Type of Building	**1**	**2**	**3**
Detached House (D)	60	56	50
Semi-detached House (S)	50	45	35
Bungalow (B)	60	50	45

The table shows the profits in units of £1000.

The builder wishes to *maximise* his overall profit. Use the Hungarian algorithm to decide which type of building should be allocated to which area of land. State the maximum profit.

(13 marks)

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5. Members of a string quartet have been playing together for 20 years. At their concerts they sometimes play mostly "old music", sometimes they play mainly "new music" and sometimes they play a mixture of both old and new. The choice of music depends on the age of the audience, provided this is known in advance. Young audiences prefer new music and older audiences prefer old music.

The table shows the audience reaction, as a score out of 10, for each of the possible combinations.

		Audience		
		Young	**Mixture**	**Old**
Music	**Old**	1	3	8
	Mixture	4	2	3
	New	7	5	3

(*a*) Explain why the quartet should never choose to play a mixture of old and new music.

(2 marks)

Generally, the quartet does not know in advance whether their audience will be mostly young, mostly old or a mixture.

If they choose to play old music with a probability p and new music with a probability $(1 - p)$,

(*b*) calculate the expected reaction, as a score out of 10, from each of the three types of audience. **(3 marks)**

(*c*) Use a graphical method to decide what value p should take to maximise the minimum expected reaction from part (*b*). Explain your method carefully. **(9 marks)**

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6. A clothing group owns a factory in each of three towns P, Q and S which distribute their products to three retail shops A, B and C. Factory availabilities, projected store demands and unit shipping costs are given in the table below.

To / From	***A***	***B***	***C***	**Factory Availability**
P	3	3	9	35
Q	6	7	6	60
S	5	2	8	30
Store Demand	20	35	70	

The group wishes to transport its products from factories to shops at minimum total cost.

(*a*) Write down the transportation pattern obtained by using the North-West corner rule. **(3 marks)**

(*b*) By calculating improvement indices I_{ij} , show that this pattern is not optimal. **(5 marks)**

(*c*) Use the stepping stone method to obtain an improved solution. **(3 marks)**

(*d*) Show that the transportation pattern obtained in part (*c*) is optimal and find the cost of this transportation pattern. **(6 marks)**

END