Paper Reference(s)

6689/01

Edexcel GCE

Decision Mathematics D1

Advanced Subsidiary

Friday 18 May 2012 – Afternoon

Time: 1 hour 30 minutes

Materials required for examination
Nil

Items included with question papers
D1 Answer Book

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulas stored in them.

Instructions to Candidates

In the boxes on the answer book, write the name of the examining body (Edexcel), your centre number, candidate number, the unit title (Decision Mathematics D1), the paper reference (6689), your surname, other name and signature.
Values from the statistical tables should be quoted in full. When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information for Candidates

Full marks may be obtained for answers to ALL questions.
This paper has 7 questions.
The total mark for this paper is 75.

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 not gain full credit.

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

1. A carpet fitter needs the following lengths, in metres, of carpet.

20 33 19 24 31 22 27 18 25

He cuts them from rolls of length 50 m.

(*a*) Calculate a lower bound for the number of rolls he needs.
You must make your method clear.

(2)

(*b*) Use the first-fit bin packing algorithm to determine how these lengths can be cut from rolls of length 50 m.

(3)

(*c*) Carry out a bubble sort to produce a list of the lengths needed in **descending** order.
You need only give the state of the list after each pass.

(4)

(*d*) Apply the first-fit decreasing bin packing algorithm to show how these lengths may be cut from the rolls.

(3)

2.

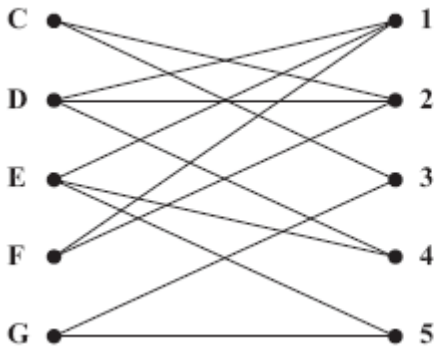

Figure 1

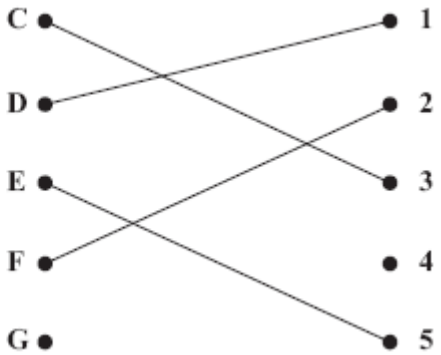

Figure 2

Figure 1 shows the possible allocations of five workers, Charles (**C**), David (**D**), Ellie (**E**), Freya (**F**) and Georgi (**G**), to five tasks, **1**, **2**, **3**, **4** and **5**.

Figure 2 shows an initial matching.

(*a*) Starting from this initial matching, use the maximum matching algorithm to find a complete matching. State clearly the alternating path that you use and list your final matching.

(4)

(*b*) Find another solution starting from the given initial matching. You should state the alternating path and list the complete matching it gives.

(3)

3.

	A	B	C	D	E	F	G
A	–	15	19	–	22	24	–
B	15	–	–	8	13	–	–
C	19	–	–	12	–	16	–
D	-	8	12	–	10	–	18
E	22	13	–	10	–	15	16
F	24	–	16	–	15	–	17
G	–	–	–	18	16	17	–

The table shows the lengths, in km, of a network of roads between seven villages, A, B, C, D, E, F and G.

(*a*) Complete the drawing of the network in Diagram 1 of the answer book by adding the necessary arcs from vertex D together with their weights.

(2)

(*b*) Use Kruskal's algorithm to find a minimum spanning tree for the network. You should list the arcs in the order that you consider them. In each case, state whether you are adding the arc to your minimum spanning tree.

(3)

(*c*) Draw the minimum spanning tree using the vertices provided in Diagram 2 in the answer book.

(1)

(*d*) State the weight of the minimum spanning tree.

(1)

4.

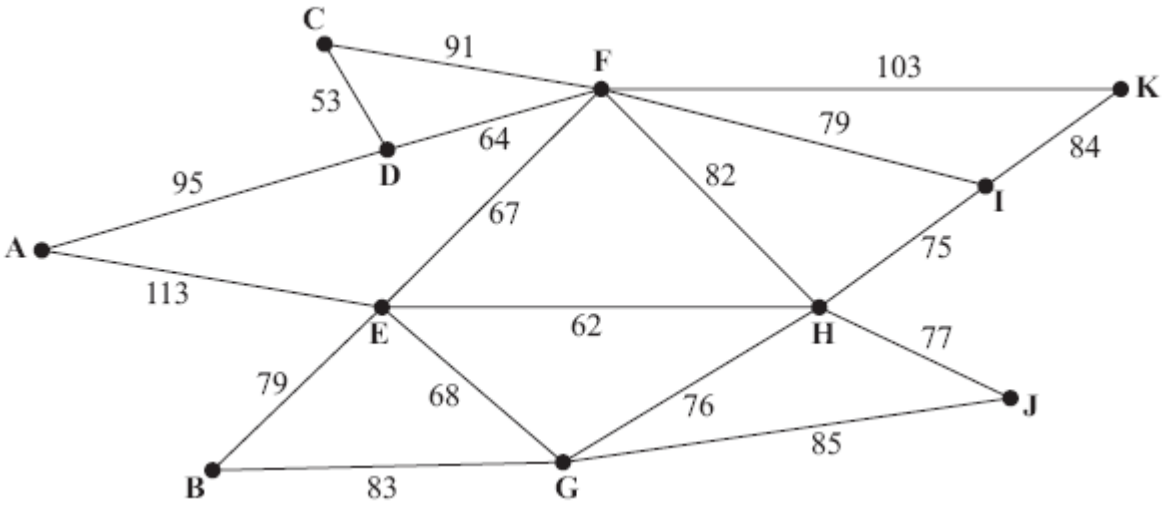

Figure 3

[*The total weight of the network is 1436 m.*]

(*a*) Explain the term **valency**.

(2)

Figure 3 models a system of underground pipes. The number on each arc represents the length, in metres, of that pipe.

Pressure readings indicate that there is a leak in the system and an electronic device is to be used to inspect the system to locate the leak. The device will start and finish at **A** and travel along each pipe at least once. The length of this inspection route needs to be minimised.

(*b*) Use the route inspection algorithm to find the pipes that will need to be traversed twice. You should make your method and working clear.

(5)

(*c*) Find the length of the inspection route.

(1)

Pipe **HI** is now found to be blocked; it is sealed and will not be replaced. An inspection route is now required that excludes pipe **HI**. The length of the inspection route must be minimised.

(*d*) Find the length of the minimum inspection route excluding **HI**. Justify your answer.

(2)

(*e*) Given that the device may now start at any vertex and finish at any vertex, find a minimum inspection route, excluding **HI**.

(2)

5.

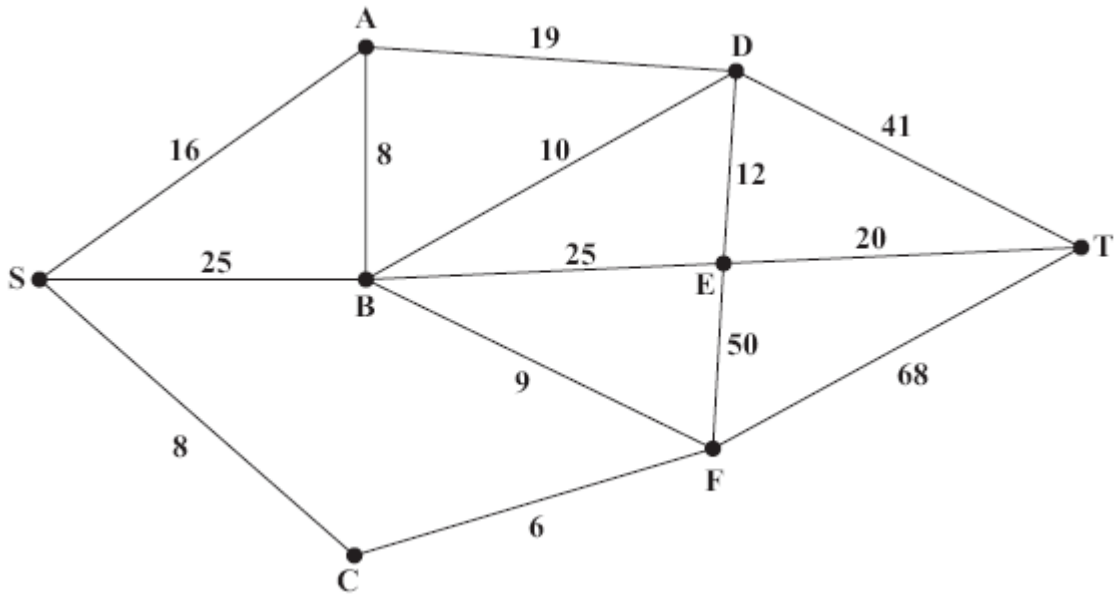

Figure 4

Figure 4 shows a network of roads. The number on each arc represents the length, in miles, of the corresponding road.

(*a*) Use Dijkstra's algorithm to find the shortest route from **S** to **T**. State your shortest route and its length.

(6)

(*b*) Explain how you determined your shortest route from your labelled diagram.

(2)

Due to flooding, the roads in and out of **D** are closed.

(*c*) Find the shortest route from **S** to **T** avoiding **D**. State your shortest route and its length.

(2)

6.

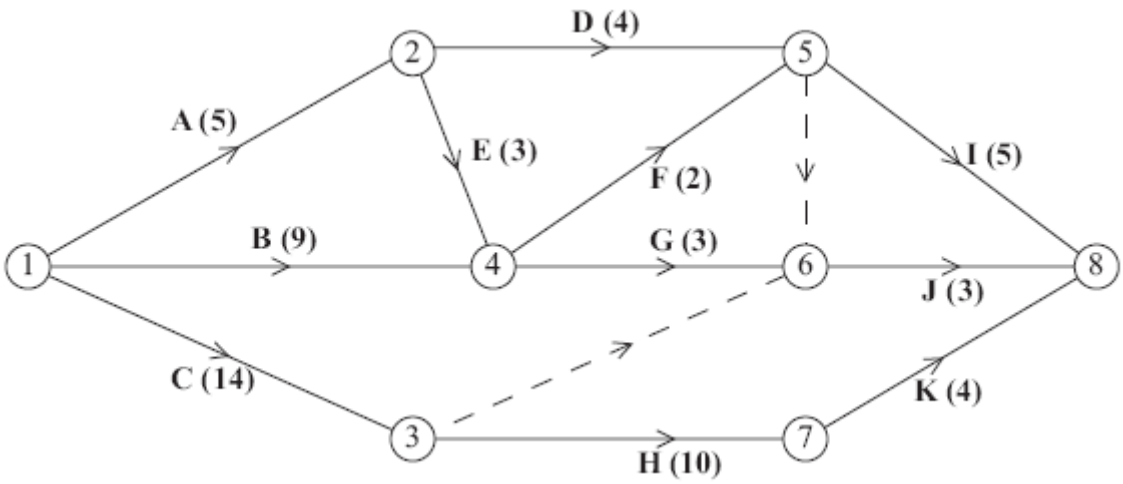

Figure 5

Figure 5 is the activity network relating to a development project. The activities are represented by the arcs. The number in brackets on each arc gives the time, in days, to complete the activity. Each activity requires one worker. The project is to be completed in the shortest possible time.

(*a*) Complete the precedence table in the answer book.

(2)

(*b*) Complete Diagram 1 in the answer book to show the early event times and late event times.

(4)

(*c*) Calculate the total float for activity **E**. You **must** make the numbers you use in your calculation clear.

(2)

(*d*) Calculate a lower bound for the number of workers needed to complete the project in the minimum time. You must show your working.

(2)

(*e*) Schedule the activities using the minimum number of workers so that the project is completed in the minimum time.

(4)

7.

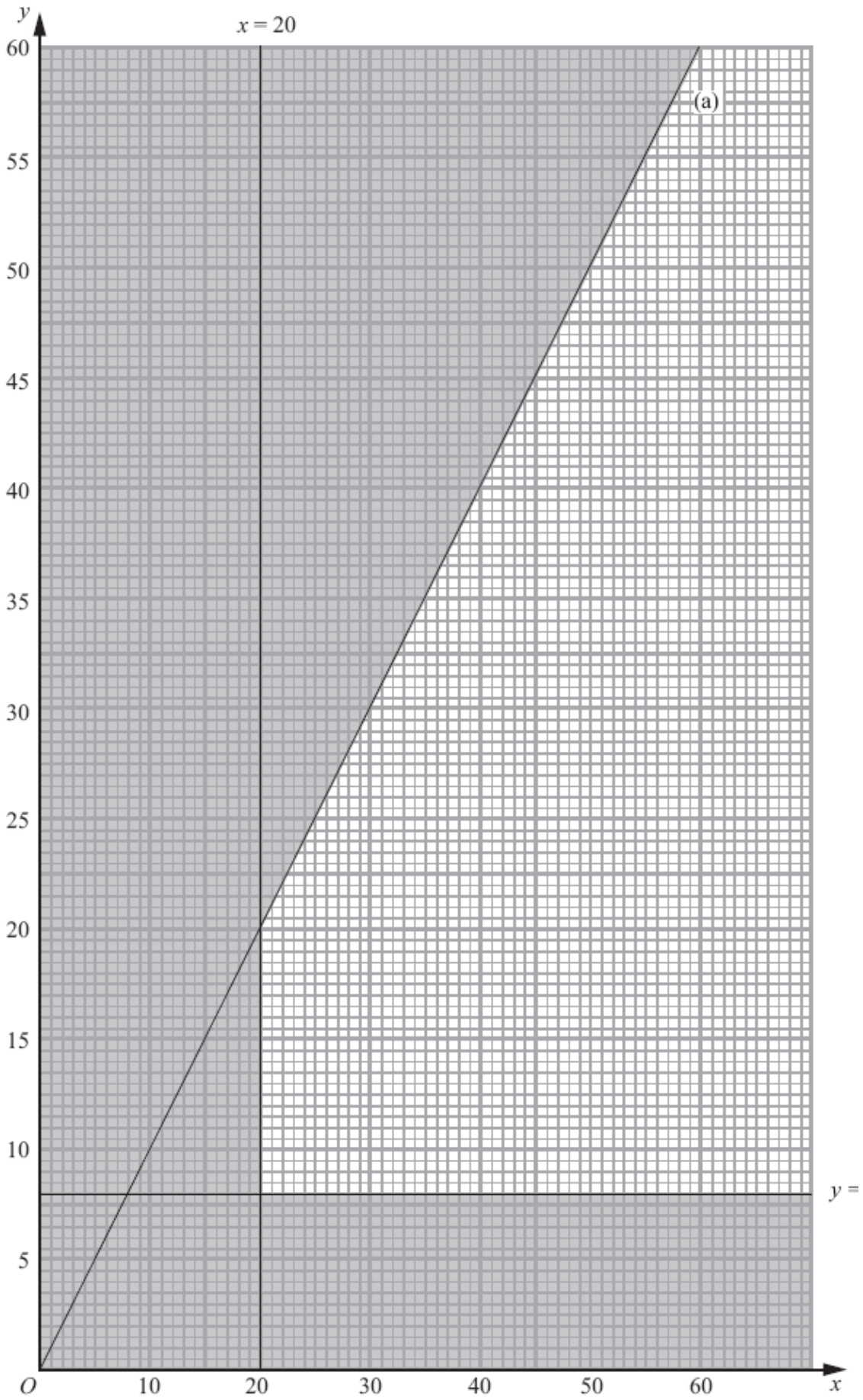

Figure 6

A company is going to hire out two types of car, standard and luxury.

Let x be the number of standard cars it should buy.
Let y be the number of luxury cars it should buy.

Figure 6 shows three constraints, other than $x, y \geq 0$.
Two of these are $x \geq 20$ and $y \geq 8$.

(*a*) Write, as an inequality, the third constraint shown in Figure 6.

(1)

The company decides that at least $\frac{1}{6}$ of the cars must be luxury cars.

(*b*) Express this information as an inequality and show that it simplifies to

$$5y \geq x.$$

You must make the steps in your working clear.

(2)

Each time the cars are hired they need to be prepared. It takes 5 hours to prepare a standard car and it takes 6 hours to prepare a luxury car. There are 300 hours available each week to prepare the cars.

(*c*) Express this information as an inequality.

(1)

(*d*) Add two lines and shading to Diagram 1 in the answer book to illustrate the constraints found in parts (*b*) and (*c*).

(2)

(*e*) Hence determine the feasible region and label it *R*.

(1)

The company expects to make £80 profit per week on each car.
It therefore wishes to maximise $P = 80x + 80y$, where P is the profit per week.

(*f*) Use the objective line (ruler) method to find the optimal vertex, V, of the feasible region.
You must clearly draw and label your objective line and the vertex V.

(3)

(*g*) Given that P is the expected profit, in pounds, per week, find the number of each type of car that the company should buy and the maximum expected profit.

(3)

TOTAL FOR PAPER: 75 MARKS

END