Free-Standing Mathematics Qualification
Specimen Unit
Advanced Level

USING AND APPLYING DECISION MATHEMATICS 6994/2
Unit 14

For this paper you must have:

- an 8-page answer book;
- a clean copy of the Data Sheet (enclosed);
- a scientific calculator;
- a ruler;
- an insert for use in Questions 1,2,3 and 5 (enclosed).

Time allowed: 1 hour 30 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 699X
- 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 calculators should normally be given to three significant figures.
- You may **not** refer to the copy of the Data Sheet that was available prior to this examination. A clean copy is available for your use.
- Fill in the boxes at the top of the insert. Make sure you attach the insert to your answer book.

Information

- The maximum mark for this paper is 60.
- Mark allocations are shown in brackets.

SECTION A

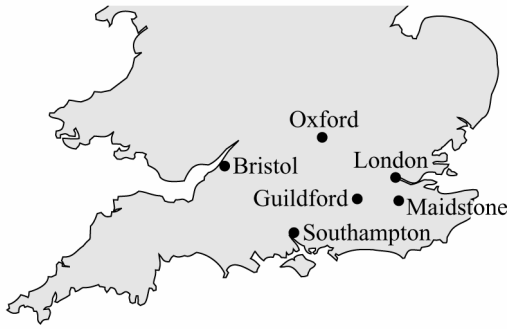
Answer **all** questions.

Use **Distances and Journey Times** *on page 2 of the Data Sheet.*

Some of the data are reproduced below. *Figure 1, printed on the insert, is provided for use in Question 1.*

1 A salesperson has to make a tour of six towns, before returning to his starting town. The distances (in miles) are shown below.

Distances in Miles		**B**	**G**	**L**	**M**	**O**	**S**
Bristol	B	–	106	120	167	73	106
Guildford	G	106	–	31	58	67	49
London	L	120	31	–	39	56	77
Maidstone	M	167	58	39	–	107	113
Oxford	O	73	67	56	107	–	67
Southampton	S	106	49	77	113	67	–



(a) Find the lengths of the tours obtained by using the nearest neighbour algorithm starting from:

(i) Bristol *(3 marks)*

(ii) London *(3 marks)*

(b) (i) By deleting L, find a lower bound for the length of a minimum tour. *(3 marks)*

(ii) By deleting B, find another lower bound. *(3 marks)*

(c) The length of a minimum tour is T kilometres.

Write down the smallest interval for T which can be obtained from your answers to parts (a) and (b). *(2 marks)*

(d) Use the map of Southern England to suggest an improved tour to that of part (a). Find its length. *(2 marks)*

2 **Figure 2**, *printed on the insert, is provided for use in Question 2.*

A local newspaper commissions an experienced driver to check the off-peak driving times along some of the AA-recommended routes connecting Birmingham, Cardiff, Carmarthen, Gloucester and Hereford.

(a) On Figure 2 of the insert, complete the network of journey times. *(2 marks)*

(b) Find the total of all the times on the network. *(1 mark)*

(c) Explain why the driver will need to drive more than is indicated by the answer to part (b). *(1 mark)*

(d) Showing all your working, find the minimum driving time the driver can expect to take to complete his task. (*5 marks)*

(e) Suggest a possible route for the driver, starting and finishing in Carmarthen, that corresponds to the minimum time. *(2 marks)*

(f) State **two** reasons why the times taken by the driver may differ from those given by the AA. *(3 marks)*

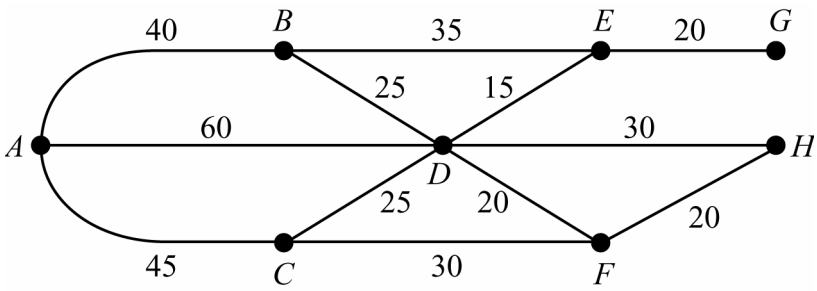
Turn over for the next question

SECTION B

Answer **all** questions.

Use **Pipelines** *on page 3 of the Data Sheet.*

3 The relevant parts of the data are reproduced below. Figure 3, printed on the insert, is provided for use in Question 3.



Distance in miles

(a) On **Figure 3** of the insert, complete the matrix that represents the pipelines connecting A, B, C, D, E, F, G and H. *(2 marks)*

(b) Apply Prim's algorithm to your matrix, starting by crossing out row A, to find a minimum connector and its total length.
Show all your working clearly, and indicate the order in which you build up your minimum connector. *(5 marks)*

(c) Draw a tree representing your minimum connector. *(2 marks)*

(d) Using only the pipelines of your minimum connector, what is the maximum distance between two points on the network? *(2 marks)*

(e) Suggest why the actual pipe network consists of more pipelines than those on the minimum connector. *(2 marks)*

(f) State **two** features of an actual pipe network which are **not** represented on the network shown above. *(2 marks)*

SECTION C

Answer **all** questions.

4 The owners of a holiday resort intend to improve wheelchair access. The costs (in £1000's) of installing lifts or ramps to connect different parts of the resort are shown in the table. X means that a direct connection is impractical.

	Reception	A	B	C	D	E
Reception	–	6	4	7	X	X
A	6	–	1	5	7	3
B	4	1	–	X	9	X
C	7	5	X	–	5	4
D	X	7	9	5	–	3
E	X	3	X	4	3	–

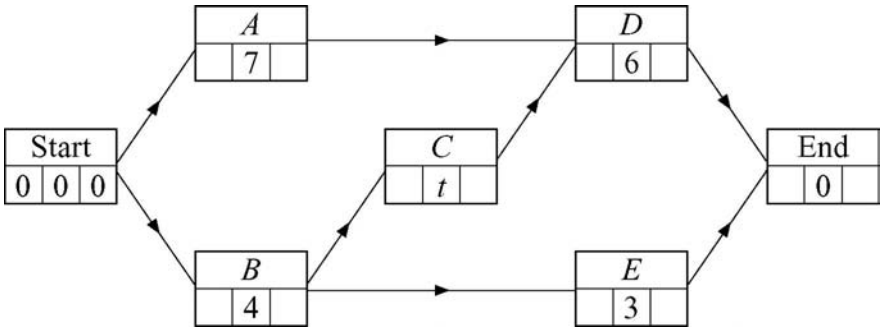
(a) Draw a network to represent the data in the table. *(3 marks)*

(b) Apply Dijkstra's algorithm to find the cheapest cost of making D accessible from the Reception and give the route corresponding to the minimum cost. Show your working clearly and indicate the order in which you assign permanent labels. *(6 marks)*

Turn over for the next question

5 **Figure 4**, *printed on the insert, is provided for use in Question 5.*

A small construction project has an activity network as shown.



(a) On figure 4 of the insert, complete the early and late times for the network when the duration of activity C is $t = 2$. *(4 marks)*

(b) For what range of values of t is activity C critical? *(2 marks)*

END OF QUESTIONS

Free-Standing Mathematics Qualification
Specimen Unit
Advanced Level

ASSESSMENT and QUALIFICATIONS ALLIANCE

USING AND APPLYING DECISION MATHEMATICS 6994/2PM
Unit 14

PRELIMINARY MATERIAL

DATA SHEET

REMINDER TO CANDIDATES

YOU MUST **NOT** BRING THIS DATA SHEET
WITH YOU WHEN YOU SIT THE EXAMINATION.
A CLEAN COPY WILL BE MADE AVAILABLE.

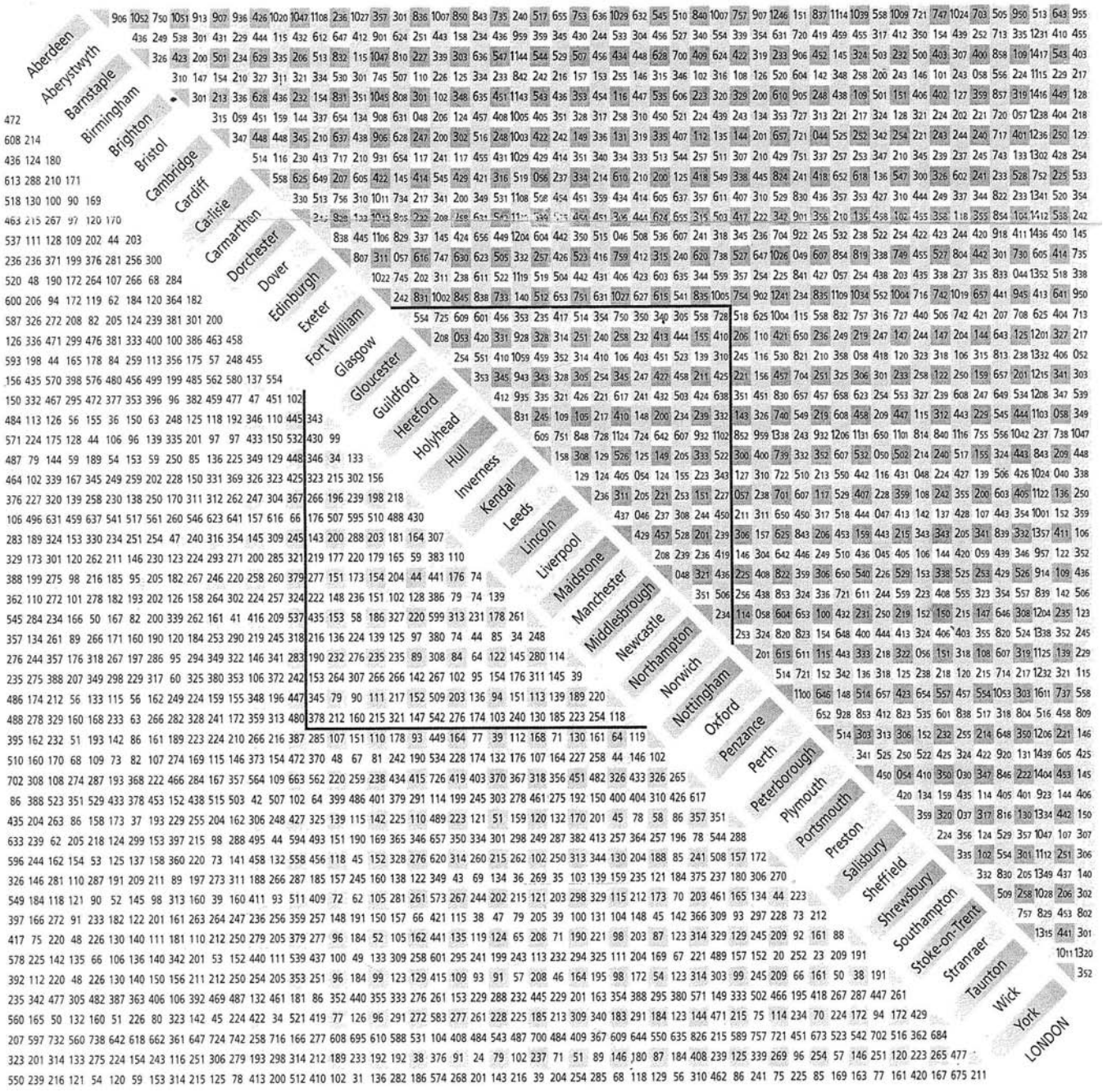
Distances and journey times

The mileage chart opposite shows distances in miles between two towns along AA-recommended routes. Using motorways and other main roads this is normally the fastest route, though not necessarily the shortest.

The journey times, shown in hours and minutes, are average off-peak driving times along AA-recommended routes. These times should be used as a guide only and do not allow for unforeseen traffic delays, rest breaks or fuel stops.

For example, the 378 mile (608 km) journey between Glasgow and Norwich should take approximately 7 hours 28 minutes.

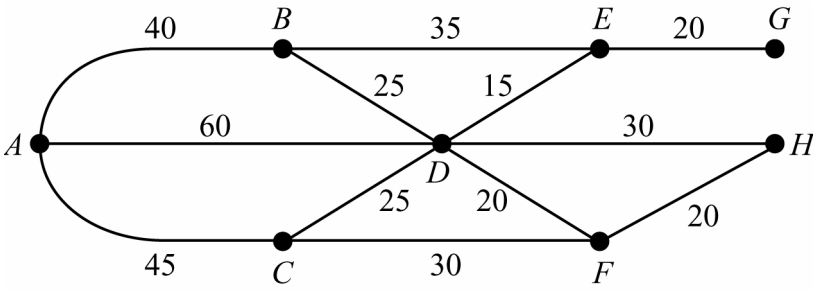
Journey Times



Distances in miles (one mile equals 1.6093km)

Pipelines

The lengths of pipelines between various pumping stations are as shown.



Distance in miles

Free-Standing Mathematics Qualification
Specimen Unit
Advanced Level

USING AND APPLYING DECISION MATHEMATICS
Unit 14

Insert for use in Questions 1, 2, 3 and 5.

Figure 1

Distances in Miles		**B**	**G**	**L**	**M**	**O**	**S**
Bristol	B	–	106	120	167	73	106
Guildford	G	106	–	31	58	67	49
London	L	120	31	–	39	56	77
Maidstone	M	167	58	39	–	107	113
Oxford	O	73	67	56	107	–	67
Southampton	S	106	49	77	113	67	–

Figure 2

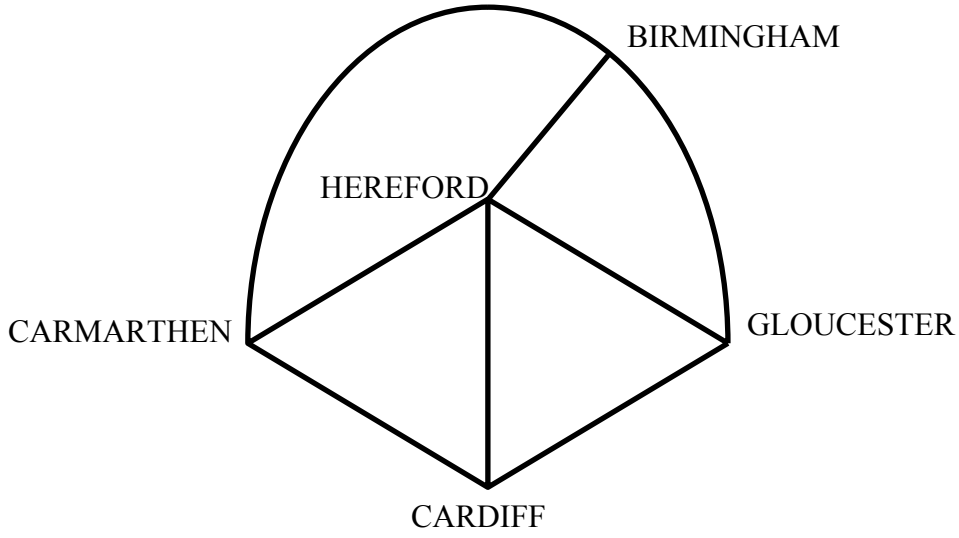
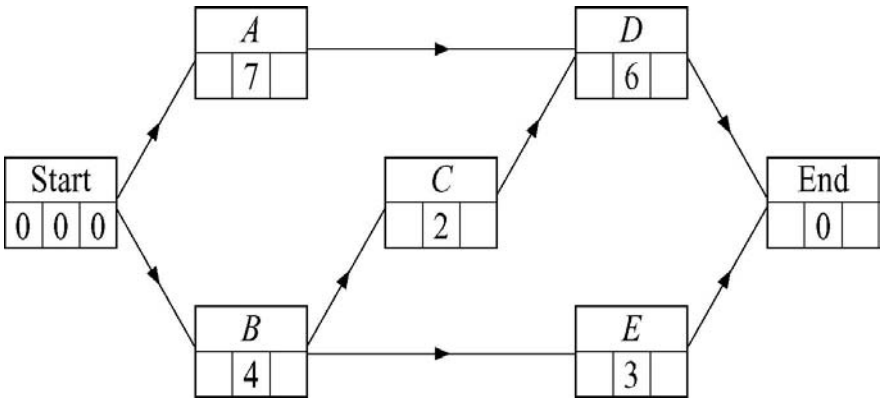


Figure 3

	A	B	C	D	E	F	G	H
A								
B								
C								
D								
E								
F								
G								
H								

Figure 4



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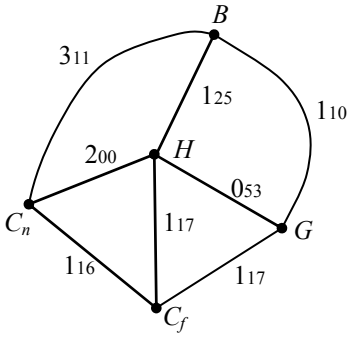
Free-Standing Mathematics Qualification

Using and Applying Decision Mathematics

Question 1

(a)(i)	$B_{73}\ O_{56}\ L_{31} G_{49}\ S_{113}\ M_{167} B$ 489 miles	B1 M1 A1	B–0 Visits all vertices
(ii)	$L_{31}\ G_{49}\ S_{67}\ O_{73}\ B_{167}\ M_{39}\ L$ 426 miles	B1 M1 A1	L–G Visits all vertices
(b)(i)	$L < \begin{matrix}31\\39\end{matrix}$ $M_{58}\ G_{49}\ S_{67}\ O_{73}\ B$ 317 miles	 B1 M1 A1	 Can be implied MST with 4 edges
(b)(ii)	$B < \begin{matrix}73\\106\end{matrix}$ $O_{56}\ L_{31}\ G_{49}\ S$ M_{39} 354 miles	 B1 M1 A1	
(c)	$354 \leq T \leq 426$	B1F,BIF	FT on answers to (a) and (b)
(d)	$B_{73}\ O_{56}\ L_{39}\ M_{58}\ G_{49}\ S_{106}\ B$ 381 miles	M1 A1	Any tour Improving on (a)
	TOTAL	**16**	

Question 2

(a)			
(b)	12 hours 29 minutes	B1	
(c)	There are odd nodes so an Enlerian trail is impossible	B1	
(d)	$B - C_n$, $C_f - G$ 4+ $B - G$, $C_f - C_n$ 2_{26} $B - C_f$,, $C - C_G$ 4+ The least pairing is B - G, C_f - C_n $12_{29} + 2_{26} = 14_{55}$	M1 A1 M1 M1 A1	One pair considered All three
(e)	E.g. $C_nHBGHC_fGBC_nC_fC_n$	M1 A1	
(f)	E.g. Traffic delays The AA times are only averages	B2 B1	1st reason 2nd reason
	Total	**14**	

Question 3

<table>
<tr><td>(a)</td><td>
<table>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>G</th><th>H</th></tr>
<tr><td>A</td><td>/</td><td>40</td><td>45</td><td>60</td><td>/</td><td>/</td><td>/</td><td>/</td></tr>
<tr><td>B</td><td>40</td><td>/</td><td>/</td><td>25</td><td>35</td><td>/</td><td>/</td><td>/</td></tr>
<tr><td>C</td><td>45</td><td>/</td><td>/</td><td>25</td><td>/</td><td>30</td><td>/</td><td>/</td></tr>
<tr><td>D</td><td>60</td><td>25</td><td>25</td><td>/</td><td>15</td><td>20</td><td>/</td><td>30</td></tr>
<tr><td>E</td><td>/</td><td>35</td><td>/</td><td>15</td><td>/</td><td>/</td><td>20</td><td>/</td></tr>
<tr><td>F</td><td>/</td><td>/</td><td>30</td><td>20</td><td>/</td><td>/</td><td>/</td><td>/</td></tr>
<tr><td>G</td><td>/</td><td>/</td><td>/</td><td>/</td><td>20</td><td>/</td><td>/</td><td>/</td></tr>
<tr><td>H</td><td>/</td><td>/</td><td>/</td><td>30</td><td>/</td><td>20</td><td>/</td><td>/</td></tr>
</table>
</td><td>M1

A1</td><td></td></tr>
<tr><td>(b)</td><td>Clear method
AB 40
BD 25

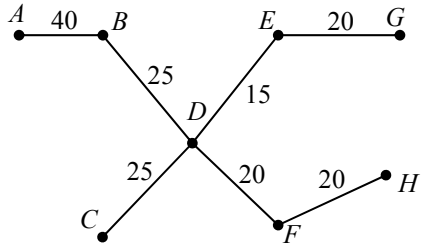
DE 15

DF 20, EG 20, FH 20
CD 25
165 miles</td><td>M1

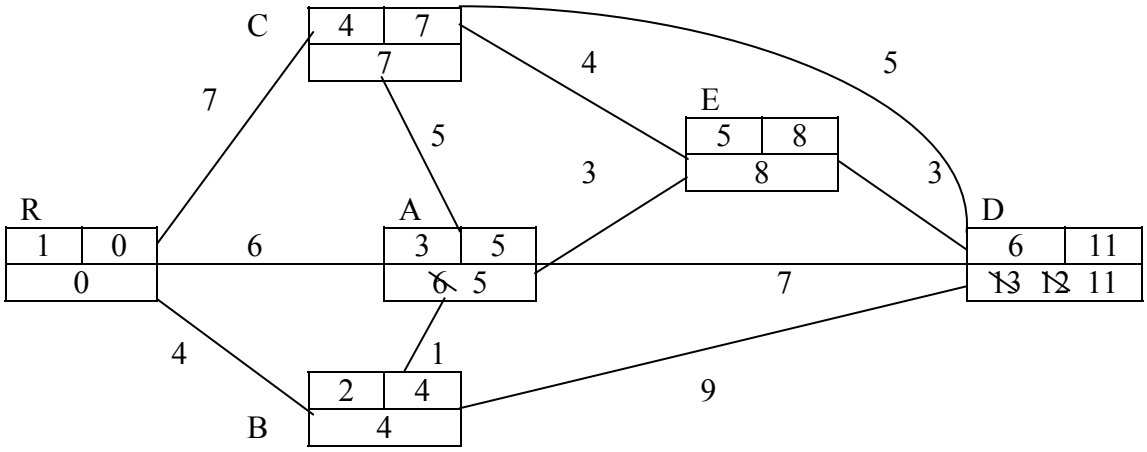
A1

B1

M1
A1</td><td>

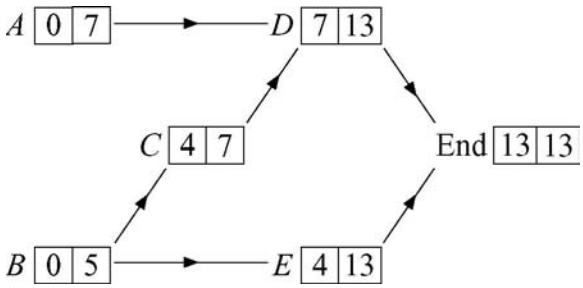
SC B2 no working</td></tr>
<tr><td>(c)</td><td> 
</td><td>M1
A1</td><td></td></tr>
<tr><td>(d)</td><td>105 miles (AH)</td><td>M1A1</td><td></td></tr>
<tr><td>(e)</td><td>Answers relating to either:-
Increasing the capacity of the network
Or
Maintaining flow when pipelines are either damaged or being maintained</td><td>B2</td><td></td></tr>
<tr><td>(f)</td><td>E.g. Direction of flow
Capacities</td><td>B1
B1</td><td></td></tr>
<tr><td></td><td>Total</td><td>15</td><td></td></tr>
</table>

Question 4



(a)	Networks Costs	M1 A1 A1	
(b)	Evidence of Dijkstra Correct at B and C Correct at A and D R B A E D £11, 000	M1 A1 M1 A1 B1 B1F	6 ft on route
	Total	**9**	

Question 5



(a)	Early times All correct Late times All correct	M1 A1 M1 A1	at least 4 correct at least 4 correct, following through from the final early time
(b)	'3' obtained $t \geq 3$	B1 B1	
	Total	**6**	