OCR

SPECIMEN

Advanced Subsidiary GCE
QUANTITATIVE METHODS (MEI)

G246   Decision Mathematics 1

Specimen Question Paper

Candidates answer on the Printed Answer Book **OCR supplied materials:** • Printed answer book G246 • MEI Examination Formulae and Tables (MF2) **Other materials required:** • Scientific or graphical calculator	Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

•   The Question Paper will be found in the centre of the Printed Answer Book.
•   Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
•   **Write your answer to each question in the space provided in the Drinted 5 nswer 6 ook.** Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
•   Use black ink. HB pencil may be used for graphs and diagrams only.
•   Read each question carefully. Make sure you know what you have to do before starting your answer.
•   Answer **all** the questions.
•   Do **not** write in the bar codes.
•   You are permitted to use a scientific or graphical calculator in this paper.
•   Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

This information is the same on the Printed Answer Book and the Question Paper.

•   The number of marks is given in brackets **[ ]** at the end of each question or part question on the Question Paper.
•   You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
•   The total number of marks for this paper is **72**.
•   The Printed Answer Book consists of **12** pages. The Question Paper consists of **8** pages. Any blank pages are indicated.

INSTRUCTIONS TO EXAMS OFFICER/INVIGILATOR

•   Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

Turn over

Section A (24 marks)

1   Two students draw graphs to represent the numbers of pairs of shoes owned by members of their class. Andrew produces a bipartite graph, but gets it wrong. Barbara produces a completely correct frequency graph. Their graphs are shown below.
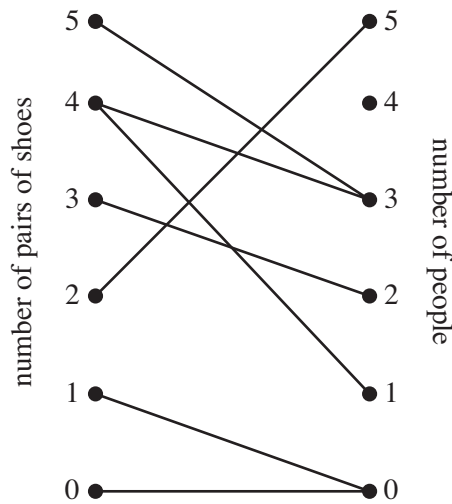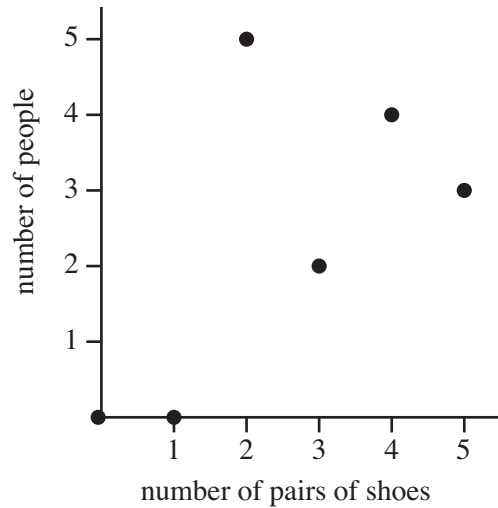
Andrew's graph   **Barbara's graph**

  (i)   Draw a correct bipartite graph.   **[3]**

 (ii)   How many people are in the class?   **[1]**

(iii)   How many pairs of shoes in total are owned by members of the class?   **[2]**

(iv)   Which points on Barbara's graph may be deleted without losing any information?   **[1]**

Charles produces the same frequency graph as Barbara, but joins consecutive points with straight lines.

 (v)   Criticise Charles's graph.   **[1]**

2 The algorithm gives a method for drawing two straight lines, if certain conditions are met.

Start with the equations of the two straight lines

Line 1 is $ax + by = c$, $\quad a, b, c > 0$
Line 2 is $dx + ey = f$, $\quad d, e, f > 0$

Let X = minimum of $\frac{c}{a}$ and $\frac{f}{d}$

Let Y = minimum of $\frac{c}{b}$ and $\frac{f}{e}$

If $X = \frac{c}{a}$ then $X^* = \frac{c - bY}{a}$ and $Y^* = \frac{f - dX}{e}$

If $X = \frac{f}{d}$ then $X^* = \frac{f - eY}{d}$ and $Y^* = \frac{c - aX}{b}$

Draw an x-axis labelled from 0 to X, and a y-axis labelled from 0 to Y
Join $(0, Y)$ to (X, Y^*) with a straight line
Join (X^*, Y) to $(X, 0)$ with a straight line

   (i) Apply the algorithm with $a = 1, b = 5, c = 25, d = 10, e = 2, f = 85$.   **[7]**

   (ii) Why might this algorithm be useful in an LP question?   **[1]**

3 John has a standard die in his pocket (ie a cube with its six faces labelled from 1 to 6).

   (i) Describe how John can use the die to obtain realisations of the random variable X, defined below.

x	1	2	3
Probability$(X = x)$	$\frac{1}{2}$	$\frac{1}{6}$	$\frac{1}{3}$

    [3]

   (ii) Describe how John can use the die to obtain realisations of the random variable Y, defined below.

y	1	2	3
Probability$(Y = y)$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{4}$

    [3]

   (iii) John attempts to use the die to obtain a realisation of a uniformly distributed 2-digit random number. He throws the die 20 times. Each time he records one less than the number showing. He then adds together his 20 recorded numbers.

     Criticise John's methodology.   **[2]**

Section B (48 marks)

4   An eco-village is to be constructed consisting of large houses and standard houses.

Each large house has 4 bedrooms, needs a plot size of $200\,m^2$ and costs £60 000 to build.

Each standard house has 3 bedrooms, needs a plot size of $120\,m^2$ and costs £50 000 to build.

The area of land available for houses is $120 000\,m^2$. The project has been allocated a construction budget of £42.4 million.

The market will not sustain more than half as many large houses as standard houses. So, for instance, if there are 500 standard houses then there must be no more than 250 large houses.

 (i)   Define two variables so that the three constraints can be formulated in terms of your variables. Formulate the three constraints in terms of your variables. **[5]**

 (ii)   Graph your three inequalities from part **(i)**, indicating the feasible region. **[4]**

 (iii)   Find the maximum number of bedrooms which can be provided, and the corresponding numbers of each type of house. **[2]**

 (iv)   Modify your solution if the construction budget is increased to £45 million. **[5]**

5 The activity network and table together show the tasks involved in constructing a house extension, their durations and precedences.
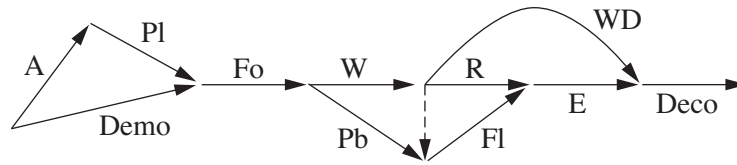
Activity	Description	Duration (days)
A	Architect produces plans	10
Pl	Obtain planning permission	14
Demo	Demolish existing structure	3
Fo	Excavate foundations	4
W	Build walls	3
Pb	Install plumbing	2
R	Construct roof	3
Fl	Lay floor	2
E	Fit electrics	2
WD	Install windows and doors	1
Deco	Decorate	5

(i) Show the immediate predecessors for each activity. **[2]**

(ii) Perform a forward pass and a backward pass to find the early time and the late time for each event. **[4]**

(iii) Give the critical activities, the project duration, and the total float for each activity. **[4]**

(iv) The activity network includes one dummy activity. Explain why this dummy activity is needed. **[2]**

Whilst the foundations are being dug the customer negotiates the installation of a decorative corbel. This will take one day. It must be done after the walls have been built, and before the roof is constructed. The windows and doors cannot be installed until it is completed. It will not have any effect on the construction of the floor.

(v) Redraw the activity network incorporating this extra activity. **[3]**

(vi) Find the revised critical activities and the revised project duration. **[1]**

6 The table shows the distances in miles, where direct rail connections are possible, between 11 cities in a country. The government is proposing to construct a high-speed rail network to connect the cities.

	P	S	F	Ln	Br	Nr	Bm	Ld	Nc	Lv	M
P	–	150	–	240	125	–	–	–	–	–	–
S	150	–	150	80	105	–	135	–	–	–	–
F	–	150	–	80	–	–	–	–	–	–	–
Ln	240	80	80	–	120	115	120	–	–	–	–
Br	125	105	–	120	–	230	90	–	–	–	–
Nr	–	–	–	115	230	–	160	175	255	–	–
Bm	–	135	–	120	90	160	–	120	–	–	90
Ld	–	–	–	–	–	175	120	–	210	100	90
Nc	–	–	–	–	–	255	–	210	–	175	–
Lv	–	–	–	–	–	–	–	100	175	–	35
M	–	–	–	–	–	–	90	90	–	35	–

(i) Use the tabular form of Prim's algorithm, starting at vertex P, to find a minimum connector for the network. Draw your minimum connector and give its total length. **[6]**

(ii) Give one advantage and two disadvantages of constructing a rail network using only the arcs of a minimum connector. **[3]**

(iii) Use Dijkstra's algorithm on the diagram in the Printed Answer Book, to find the shortest route and distance from P to Nr in the original network. **[6]**

(iv) Give the shortest distance from P to Nr using only arcs in your minimum connector. **[1]**

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Advanced Subsidiary GCE

QUANTITATIVE METHODS (MEI)

G246   Decision Mathematics 1

Specimen Printed Answer Book

<table>
<tr><td>

Candidates answer on this Printed Answer Book.

OCR supplied materials:
*   Question paper G246 (inserted)
*   MEI Examination Formulae and Tables (MF2)

Other materials required:
*   Scientific or graphical calculator

</td><td>

Duration: 1 hour 30 minutes

</td></tr>
</table>

Candidate forename		Candidate surname	

Centre number						Candidate number				

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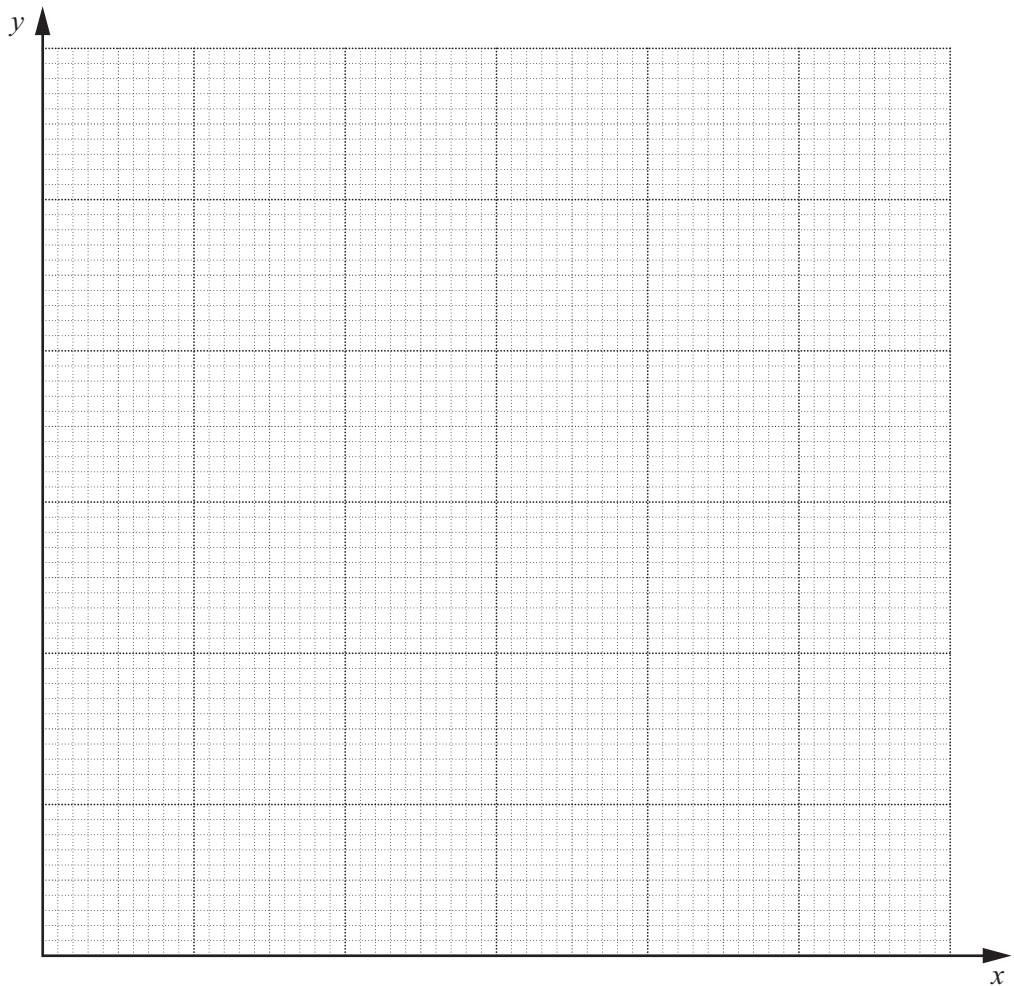
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Turn over

Section A (24 marks)

1 (i)

number of pairs of shoes

```
5 ●              ● 5

4 ●              ● 4

3 ●              ● 3

2 ●              ● 2

1 ●              ● 1


0 ●              ● 0
```

number of people

1 (ii)

1 (iii)

1 (iv)

1 (v)

2 (i)

2 (ii)

3 (i)

x	1	2	3
Probability$(X = x)$	$\frac{1}{2}$	$\frac{1}{6}$	$\frac{1}{3}$

3 (ii)

y	1	2	3
Probability$(Y = y)$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{4}$
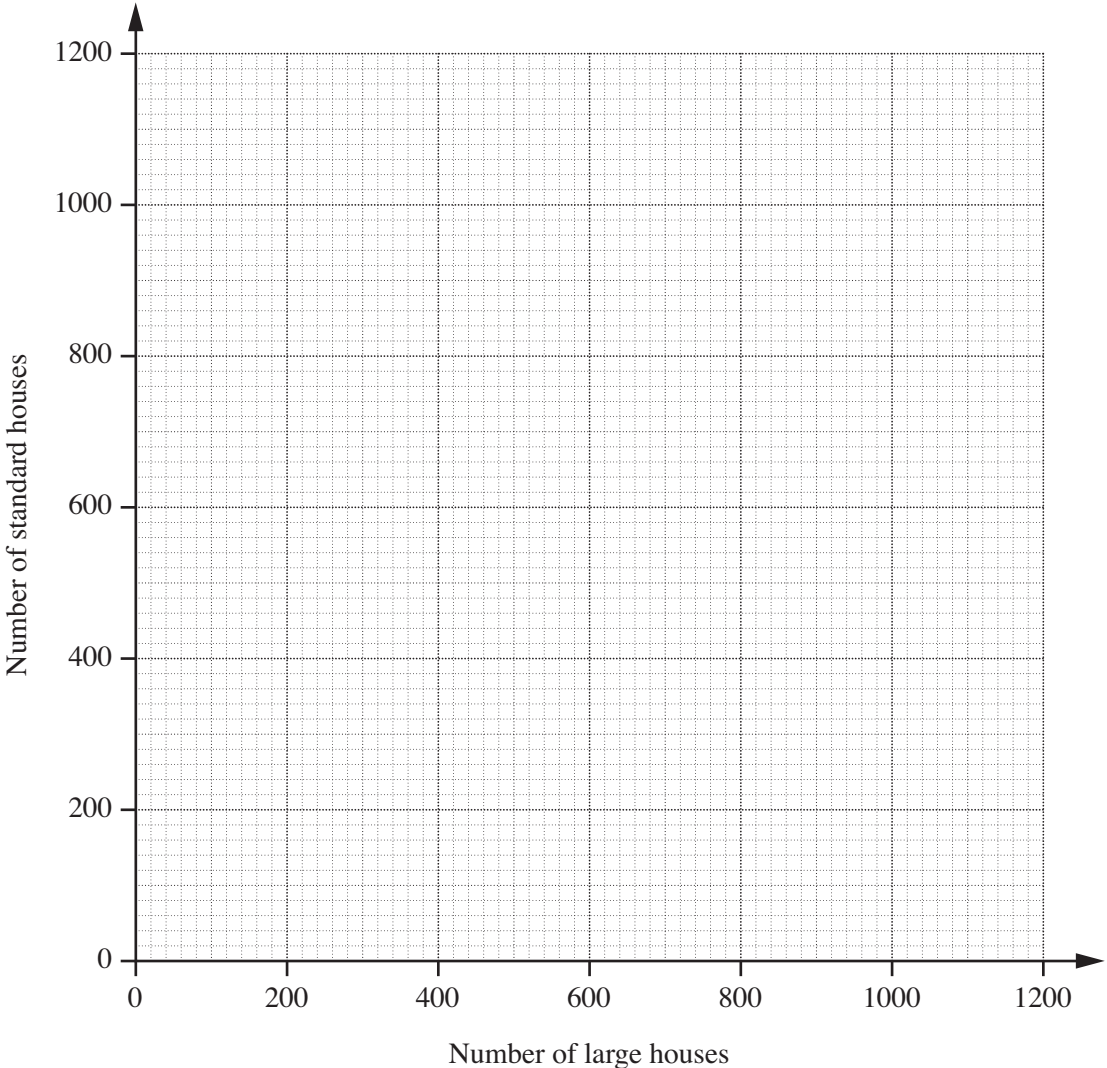
3 (iii)

PLEASE DO NOT WRITE ON THIS SPACE

 Turn over

Section B (48 marks)

4 (i)

4 (ii)

Number of standard houses (y-axis): 0, 200, 400, 600, 800, 1000, 1200

Number of large houses (x-axis): 0, 200, 400, 600, 800, 1000, 1200

4 (iii)

4 (iv)

4 (ii) **SPARE COPY OF GRAPH PAPER**

Number of standard houses (y-axis, 0 to 1200)

Number of large houses (x-axis, 0 to 1200)

5 (i)

Activity	Immediate predecessor(s)
A	
Pl	
Demo	
Fo	
W	
Pb	
R	
Fl	
E	
WD	
Deco	

5 (ii)
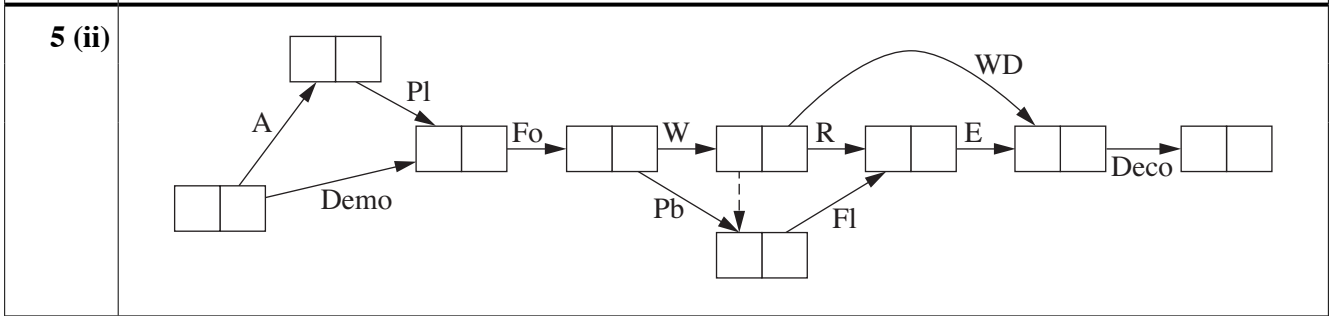
5 (iii)

task: A   Pl   Demo Fo   W   Pb   R   Fl   E   WD   Deco

float:

5 (iv)

5 (v)

5 (vi)

5 (ii) **SPARE COPY OF ACTIVITY NETWORK**

6 (i)

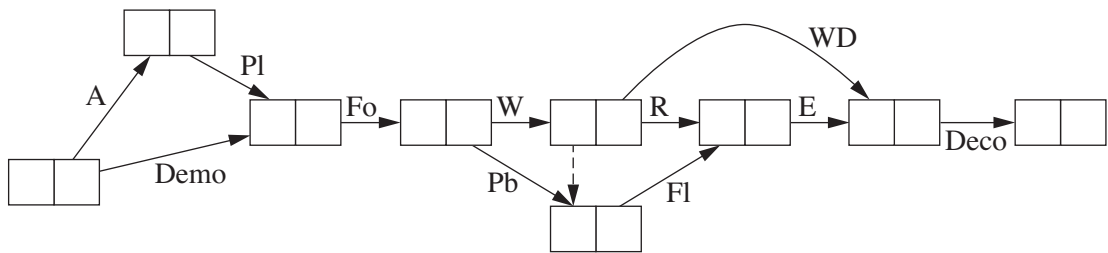|	P	S	F	Ln	Br	Nr	Bm	Ld	Nc	Lv	M
P	–	150	–	240	125	–	–	–	–	–	–
S	150	–	150	80	105	–	135	–	–	–	–
F	–	150	–	80	–	–	–	–	–	–	–
Ln	240	80	80	–	120	115	120	–	–	–	–
Br	125	105	–	120	–	230	90	–	–	–	–
Nr	–	–	–	115	230	–	160	175	255	–	–
Bm	–	135	–	120	90	160	–	120	–	–	90
Ld	–	–	–	–	–	175	120	–	210	100	90
Nc	–	–	–	–	–	255	–	210	–	175	–
Lv	–	–	–	–	–	–	–	100	175	–	35
M	–	–	–	–	–	–	90	90	–	35	–

Min connector
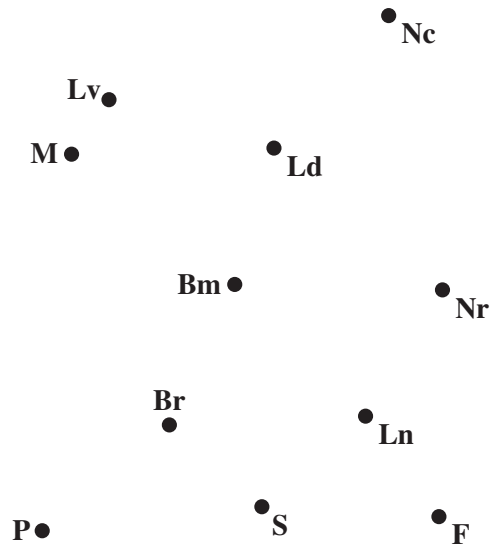
6 (ii)

6 (iii)
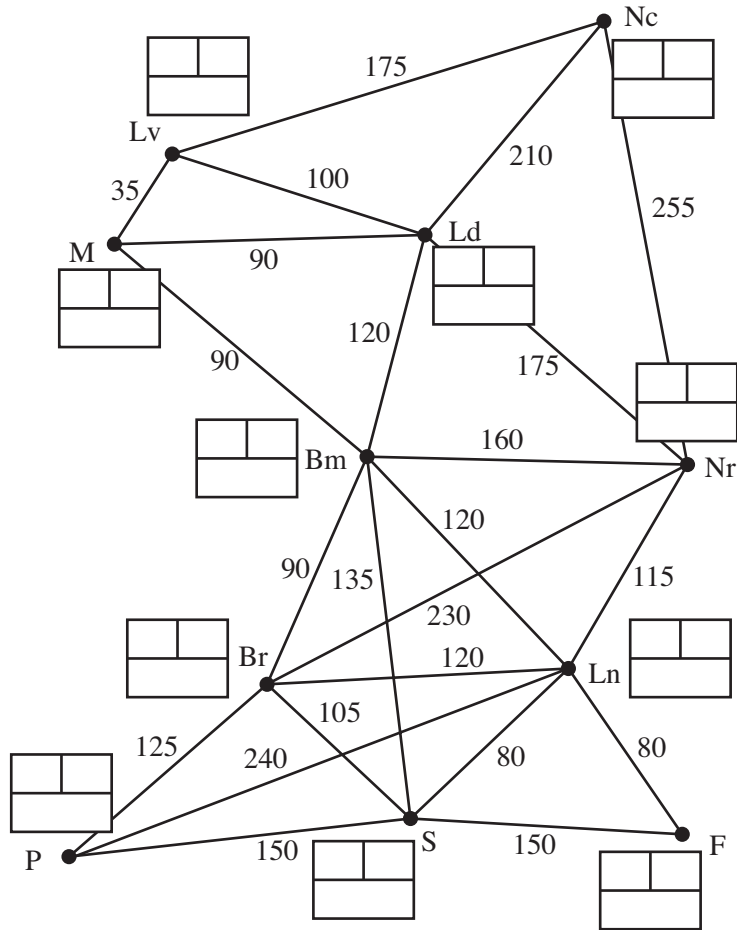
THERE IS A SPARE COPY OF THIS NETWORK ON PAGE 12.

6 (iv)

6 (iii) **SPARE COPY OF NETWORK**

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Advanced Subsidiary GCE
QUANTITATIVE METHODS (MEI)
G246 Decision Mathematics 1 (D1)

Specimen Mark Scheme

The maximum mark for this paper is 72.

GENERIC MARKING INSTRUCTIONS

1.   Mark strictly to the mark scheme.

2.   Marks awarded must relate directly to the marking criteria.

3.   The schedule of dates is very important. It is essential that you meet the scoris 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4.   If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or the scoris messaging system, or by email.

5.   Work crossed out:
     a.   where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks
     b.   if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.

6.   Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7.   There is a NR (No Response) option. Award NR (No Response):
   - if there is nothing written at all in the answer space
   - OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
   - OR if there is a mark (e.g. a dash, a question mark) which is not an attempt at the question.

   Note: Award 0 marks - for an attempt that earns no credit (including copying out the question).

8.   The scoris **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

   If you have any questions or comments for your Team Leader, use the phone, the scoris messaging system, or email.

9.   Assistant Examiners will send a brief report on the performance of candidates to your Team Leader (Supervisor) by the end of the marking period. The Assistant Examiner's Report Form (AERF) can be found on the RM Cambridge Assessment Support Portal (and for traditional marking it is in the *Instructions for Examiners*). Your report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10.   **Annotations and abbreviations**

Annotation in scoris	Meaning
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
Highlighting	
Other abbreviations in mark scheme	**Meaning**
E1	Mark for explaining
U1	Mark for correct units
G1	Mark for a correct feature on a graph
M1 dep*	Method mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working

SUBJECT-SPECIFIC MARKING INSTRUCTIONS

A   Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

B   An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

C   The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

E

A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

D   When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep *' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

E   The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only – differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow-through questions candidate-by-candidate rather than question-by-question.

F   Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise. Candidates are expected to give numerical answers to an appropriate degree of accuracy, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

G   Rules for replaced work

If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

H   For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question.

Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

Question			Answer	Marks		Guidance
1	**(i)**			B1	3 to 4 deleted	-1 for each arc in error
				B1	1 to 4 deleted	
				B1	4 to 4 added	
				[3]		
1	**(ii)**		14	B1 **[1]**		
1	**(iii)**		47	M1		Award method mark if answer correct, or if wrong but with a sum of products shown.
				A1 **[2]**	cao	
1	**(iv)**		(0, 0) and (1, 0)	B1 **[1]**		Award only if correct **points** are specified in some way.
1	**(v)**		Explanation should recognise that a line is a set of points − not appropriate in this context	B1 **[1]**		e.g. "Intermediate points have no meaning." e.g. "Can't have one and a half pairs of shoes." (sic)

Question			Answer	Marks		Guidance
2	**(i)**		$X = \min(25, 8.5) = 8.5$ or equivalent $Y = \min(5, 42.5) = 5$ oe $X^* = (85–10)/10 = 7.5$ oe $Y^* = (25–8.5)/5 = 3.3$ oe (graph with points $(0, 5)$, $(7.5, 5)$, $(8.5, 3.3)$, $(8.5, 0)$)	B1 B1 B1 B1 B1 B1 B1 **[7]**	cao cao cao cao allow ft cao cao	OK if only seen once or more on graph OK if only seen once or more on graph OK if only seen on graph OK if only seen on graph sensibly scaled for their X and Y e.g. disallow if either of the lines in the question could intersect both axes. lines – can extend to beyond segment condone minor errors in plotting (e.g. 8.5 plotted at 9)
2	**(ii)**		Avoids tiny feasible regions	B1 **[1]**		need comment on size of region

3	**(i)**		e.g.
			    $1, 2, 3 \to 1$
			        $4 \to 2$
			      $5, 6 \to 3$
				M1
				
				A1
				A1
				[3]
						function with domain {1,2,3,4,5,6} and range {1,2,3}(special cases are possible – if correct!)
						proportions 3:2:1
						all OK

3	**(ii)**		e.g.
			    $1, 2 \to 1$
			       $3 \to 2$
			       $4 \to 3$
			  $(5, 6 \to$ reject and throw again$)$
				M1
				
				A1
				
				A1
				
				[3]
					reject some
					
					reject two
					
					rest
						(Special cases are possible – if correct! e.g. allow throwing die twice and allocating correct proportions of 36)

3	**(iii)**		non uniform allows 100	B1 B1 **[2]**		 '101 values' OK no credit for, e.g. '3 is not a two-digit number'

Question			Answer	Marks		Guidance
4	**(i)**		e.g. x = number of large houses y = number of standard houses	M1A1		M1 for variables for large and for standard A1 for 'number'
			land: $200x + 120y \leq 120000$ oe	B1		use 'isw' for incorrect simplifications
			cash: $60x + 50y \leq 42400$ oe	B1		-1 once only for any ' $<$ '
			market: $x \leq 0.5y$ oe	B1		
				[5]		
4	**(ii)**			B1	line 1, allow ft	for instance, if $x \leq 2y$ in part (i), then allow correct graph of $x \leq 0.5$ or ft graph of $x \leq 2y$
				B1	line 2, allow ft	plotting tolerance on axis intersection points – within correct small square
				B1	line 3, allow ft	
				B1	feasible region	must consider 3 lines ft if region includes y-axis interval from origin upwards allow any clear indication of feasible region ignore any indication(s) of boundary lines included or excluded
				[4]		
4	**(iii)**		intersection of $y = 2x$ and $6x + 5y = 4240$, (265, 530)	M1	correct point, cao	identification only – coordinates not required here
			2650	A1		their $4x + 3y$ from (260–280, 520–540)
				[2]		
4	**(iv)**		their $60x + 50y \leq 45000$ or line from their (0, 900) to (750, 0)	B1	ft	can be implied from final M1 working

Question	Answer	Marks		Guidance
	Best point is at the intersection of the land constraint and the new cash constraint, and not on y=2x	M1	comparison of two (or more) points	not just ringing points
		A1		their identified best point is not on $y = 2x$ or an axis
	(214, 643)	M1	Correct point, cao	identification, coordinates not required here
	2785	A1		bedrooms − their $4x + 3y$ from (200−220, 620−660)
		[5]		
5 (i)				

Table for question 5(i):

Activity	Immediate predecessors
A	−
Pl	A
Demo	−
Fo	Pl; Demo
W	Fo
Pb	Fo
R	W
Fl	Pb; W
E	R; Fl
WD	W
Deco	WD; E

	Marks	Guidance
	M1	Fl correct
	A1	rest
	[2]	

Question			Answer	Marks		Guidance
5	**(ii)**			M1 A1 M1 A1 **[4]**	at least one correct nontrivial join forward pass at least one correct nontrivial burst backward pass	excluding start node
5	**(iii)**		critical activities: A; Pl; Fo; W; R; E; Deco project duration = 41 days	B1 B1 B1 B1 **[4]**	cao cao A,Pl,Dm,Fo,W rest	cao cao – most zeros, dashes or empty spaces won't do
5	**(iv)**		Fl has both W and Pb as immediate predecessors. R and WD have only W as immediate predecessor.	B1 B1 **[2]**	one of R/WD	SC1 for a convincing but not specific answer, e.g. 'A dummy is needed to cater for both joint and separate precedences'.

Table in 5(iii):

act	A	Pl	Dm	Fo	W	Pb	R	Fl	E	WD	Dc
float	0	0	21	0	0	2	0	1	0	4	0

Question			Answer	Marks		Guidance
5	(v)			M1 A1 A1 **[3]**	C between W and R Fl + dummy OK WD OK	
5	(vi)		new duration = 42 days critical activities: A; Pl; Fo; W; C; R; E; Deco	B1 **[1]**	both needed	

Question	Answer	Marks	Guidance
6 (**i**)	(see table and diagram below)	M1 tabular Prim	125 in P column and 90 in Br column ringed, with both rows crossed

	1	7	9	8	2	10	3	6	11	5	4
	P	S	F	Ln	Br	Nr	Bm	Ld	Nc	Lv	M
P	—	150	—	240	125	—	—	—	—	—	—
S	150	—	150	80	(105)	—	135	—	—	—	—
F	—	150	—	(80)	—	—	—	—	—	—	—
Ln	240	(80)	80	—	120	115	120	—	—	—	—
Br	(125)	105	—	120	—	230	90	—	—	—	—
Nr				(115)	230	—	160	175	255	—	—
Bm	—	135	—	120	(90)	160	—	120	—	—	90
Ld	—	—	—	—	—	175	120	—	210	100	(90)
Nc	—	—	—	—	—	255	—	210	—	(175)	—
Lv	—	—	—	—	—	—	—	100	175	—	(35)
M	—	—	—	—	—	—	(90)	90	—	35	—

A2 choosings — all circles in correct place; -1 each error (watch for one error making two changes to a row)

A1 crossings — all rows crossed out except, possibly, Nc row.

accept convincing transpose

Length = 985 miles

B1 cao

B1 cao

[6]

Question			Answer	Marks		Guidance
6	**(ii)**		Advantage: shortest length of track	B1	cao	allow cost minimisation
			Disadvantage: tree, no redundancy ≡ fragility (breakdown et al)	B1		could say 'no cycles'
			Disadvantage: some journeys are not shortest paths	B1		disallow comments relating to direct connectivity, or relating to more stops; 'longer journeys' or 'takes longer' allowed
						allow 'min connector arcs may be more expensive' oe
				[3]		don't allow two marks for the same point described differently. e.g. longer journeys/more time/more upkeep

Question	Answer	Marks	Guidance
6 (iii)		M1 Dijkstra	correct working values (no extras) at Ln and Nr, and working values only superseded at Ln and Nr (ignore Nc for this M)
		A1 working values	(need to check Nc here)
		B1 labels	
		B1 order of labelling	
	Route: P S Ln Nr	B1 cao	
	Distance: 345 miles	B1 cao	
		[6]	
6 (iv)	Distance by min connector = 425 miles	B1	ft their mc
		[1]	

Assessment Objectives (AO) Grid

Question	AO1	AO2	AO3	AO4	AO5	Total
1(i)			3			3
1(ii)				1		1
1(iii)				1	1	2
1(iv)				1		1
1(v)	1					1
2(i)	2	2	2		1	7
2(ii)			1			1
3(i)	3					3
3(ii)	1		2			3
3 (iii)				2		2
4(i)	2		3			5
4(ii)		4				4
4(iii)				1	1	2
4(iv)	1	1	2	1		5
5(i)	1	1				2
5(ii)	2	2				4
5(iii)			2	2		4
5(iv)				2		2
5(v)	1	2				3
5(vi)			1			1
6(i)	3	1	1	1		6
6(ii)			3			3
6(iii)		4	2			6
6(iv)					1	1
Totals	**17**	**17**	**22**	**12**	**4**	**72**

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