OCR
Oxford Cambridge and RSA

Friday 5 June 2015 – Morning

AS GCE MATHEMATICS (MEI)

4771/01 Decision Mathematics 1

QUESTION PAPER

3167829333

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4771/01
- 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 inside 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 Printed Answer Book**. 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

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- 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

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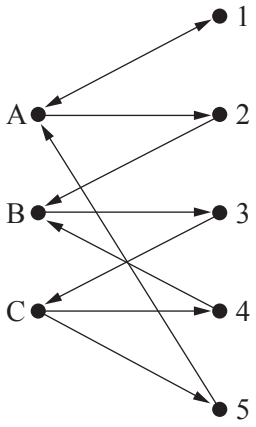
Section A (24 marks)

1 The directed bipartite graph represents links between chairlifts and ski runs in one part of a ski resort. Chairlifts are represented by capital letters, and ski runs are represented by numbers. For example, chairlift A takes skiers to the tops of ski runs 1 and 2, whereas ski run 2 takes skiers to the bottom of chairlift B.



(i) The incomplete map in your answer book represents the three chairlifts and ski run 2. Complete the map by drawing in the other 4 ski runs. **[2]**

Angus wants to ski all 5 ski runs, starting and finishing at the bottom of chairlift A.

(ii) Which chairlifts does Angus have to repeat, and why? **[3]**

(iii) Which ski runs does Angus have to repeat, and why? **[2]**

The chairlifts and ski runs shown above form only part of the resort. In fact, chairlift C also takes skiers to the bottom of chairlift D.

(iv) Why can this information not be represented in a bipartite graph? **[1]**

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2 The following algorithm operates on the equations of 3 straight lines, each in the form $y = m_i x + c_i$.

Step 1	Set $i = 1$
Step 2	Input m_i and c_i
Step 3	If $i = 3$ then go to Step 6
Step 4	Set $i = i + 1$
Step 5	Go to Step 2
Step 6	Set $j = 1$
Step 7	Set $a = j + 1$
Step 8	If $a > 3$ then set $a = a - 3$
Step 9	Set $b = j + 2$
Step 10	If $b > 3$ then set $b = b - 3$
Step 11	Set $d_j = m_b - m_a$
Step 12	If $d_j = 0$ then go to Step 20
Step 13	Set $x_j = \dfrac{c_a - c_b}{d_j}$
Step 14	Set $y_j = m_a \times x_j + c_a$
Step 15	Record (x_j , y_j) in the print area
Step 16	If $j = 3$ then go to Step 19
Step 17	Set $j = j + 1$
Step 18	Go to Step 7
Step 19	Stop
Step 20	Record "parallel" in the print area
Step 21	Go to Step 16

(i) Run the algorithm for the straight lines $y = 2x + 8$, $y = 2x + 5$ and $y = 4x + 3$ using the table given in your answer book. The first five steps have been completed, so you should continue from Step 6. **[7]**

(ii) Describe what the algorithm achieves. **[1]**

3 Mary takes over a small café. She will sell two types of hot drink: tea and coffee.

A coffee filter costs her £0.10, and makes one cup of coffee. A tea bag costs her £0.05 and makes one cup of tea. She has a total weekly budget of £50 to spend on coffee filters and tea bags.

She anticipates selling at least 500 cups of hot drink per week. She estimates that between 50% and 75% of her sales of cups of hot drink will be for cups of coffee.

Mary needs help to decide how many coffee filters and how many tea bags to buy per week.

(i) Explain why the number of tea bags which she buys should be no more than the number of coffee filters, and why it should be no less than one third of the number of coffee filters. **[2]**

(ii) Allocate appropriate variables, and draw a graph showing the feasible region for Mary's problem. **[5]**

Mary's partner suggests that she buys 375 coffee filters and 250 tea bags.

(iii) How does this suggestion relate to the estimated demand for coffee and tea? **[1]**

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Section B (48 marks)

4 The table defines a network on 6 nodes, the numbers representing distances between those nodes.

	A	B	C	D	E	F
A		3	2	7	8	3
B	3		4	5		
C	2	4			6	
D	7	5				
E	8		6			2
F	3				2	

(a) Use Dijkstra's algorithm to find the shortest routes from A to each of the other vertices. Give those routes and their lengths. **[6]**

(b) Jack wants to find a minimum spanning tree for the network.

(i) Apply Prim's algorithm to the network, draw the minimum spanning tree and give its length. **[3]**

Jill suggests the following algorithm is easier.

Step 1 Remove an arc of longest length which does not disconnect the network
Step 2 If there is an arc which can be removed without disconnecting the network then go to Step 1
Step 3 Stop

(ii) Show the order in which arcs are removed when Jill's algorithm is applied to the network. **[2]**

(iii) Explain why Jill's algorithm always produces a minimum spanning tree for a connected network. **[3]**

(iv) In a complete network on n vertices there are $\frac{n(n-1)}{2}$ arcs. There are $n - 1$ arcs to include when using Prim's algorithm. How many arcs are there to remove using Jill's algorithm?

For what values of n does Jill have more arcs to remove than Prim has to include? **[2]**

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5 The table lists activities which are involved in framing a picture. The table also lists their durations and their immediate predecessors. Except for activities C and H, each activity is undertaken by one person. Activities C and H require no people.

Activity		Duration (mins)	Immediate predecessor(s)
A	select mounting	5	–
B	glue picture to mounting	5	A
C	allow mounting glue to dry	20	B
D	measure for frame	5	A
E	select type of frame	10	A
F	cut four frame pieces	5	D, E
G	pin and glue frame pieces together	5	F
H	allow frame glue to dry	20	G
I	cut and bevel glass	30	D
J	fit glass to frame	5	H, I
K	fit mounted picture to frame	5	C, J

(i) Draw an activity on arc network for these activities. **[5]**

(ii) Mark on your diagram the early time and the late time for each event. Give the minimum completion time and the critical activities. **[6]**

A picture is to be framed as quickly as possible. Two people are available to do the job.

(iii) Produce a schedule to show how two people can complete the picture framing in the minimum time. **[3]**

To reduce the completion time an instant glue is to be used. This will reduce the time for activities C and H to 0 minutes.

(iv) Produce a schedule for two people to complete the framing in the new minimum completion time, and give that time. **[2]**

Question 6 begins on page 6

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6 Adrian and Kleo like to go out for meals, sometimes to a French restaurant, and sometimes to a Greek restaurant. If their last meal out was at the French restaurant, then the probability of their next meal out being at the Greek restaurant is 0.7, whilst the probability of it being at the French restaurant is 0.3. If their last meal out was at the Greek restaurant, then the probability of their next meal out being at the French restaurant is 0.6, whilst the probability of it being at the Greek restaurant is 0.4.

(i) Construct two simulation rules, each using single-digit random numbers, to model their choices of where to eat. **[3]**

(ii) Their last meal out was at the Greek restaurant. Use the random digits printed in your answer book to simulate their choices for the next 10 of their meals out. Hence estimate the proportion of their meals out which are at the French restaurant, and the proportion which are at the Greek restaurant. **[4]**

Adrian and Kleo find a Hungarian restaurant which they like. The probabilities of where they eat next are now given in the following table.

last meal out \ next meal out	French	Greek	Hungarian
French	$\frac{1}{5}$	$\frac{3}{5}$	$\frac{1}{5}$
Greek	$\frac{1}{2}$	$\frac{3}{10}$	$\frac{1}{5}$
Hungarian	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$

(iii) Construct simulation rules, each using single-digit random numbers, to model this new situation. **[5]**

(iv) Their last meal out was at the Greek restaurant. Use the random digits printed in your answer book to simulate their choices for the next 10 of their meals out. Hence estimate the proportion of their meals out which are at each restaurant. **[4]**

END OF QUESTION PAPER

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Friday 5 June 2015 – Morning

AS GCE MATHEMATICS (MEI)

4771/01 Decision Mathematics 1

PRINTED ANSWER BOOK

3168033498

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- MEI Examination Formulae and Tables (MF2)

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Duration: 1 hour 30 minutes

4771 01

Candidate forename		Candidate surname	

Centre number						Candidate number				

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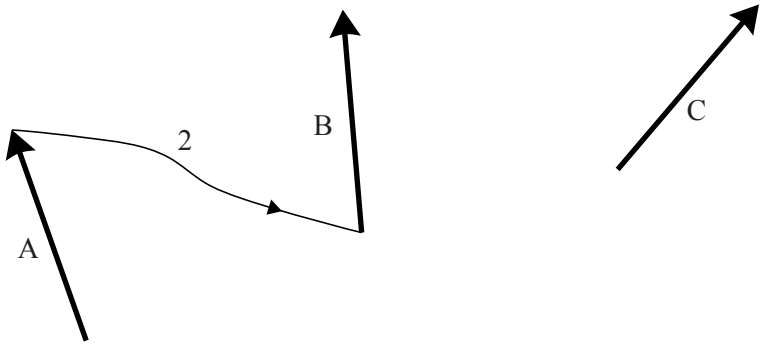
Section A (24 marks)

1 (i)



1 (ii)

1 (iii)

1 (iv)

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2 (i)

i	1	2	3						
m_1	2								
c_1	8								
m_2		2							
c_2		5							
m_3			4						
c_3			3						
j									
a									
b									
d_1									
x_1									
y_1									
d_2									
x_2									
y_2									
d_3									
x_3									
y_3									

Print area

2 (ii)

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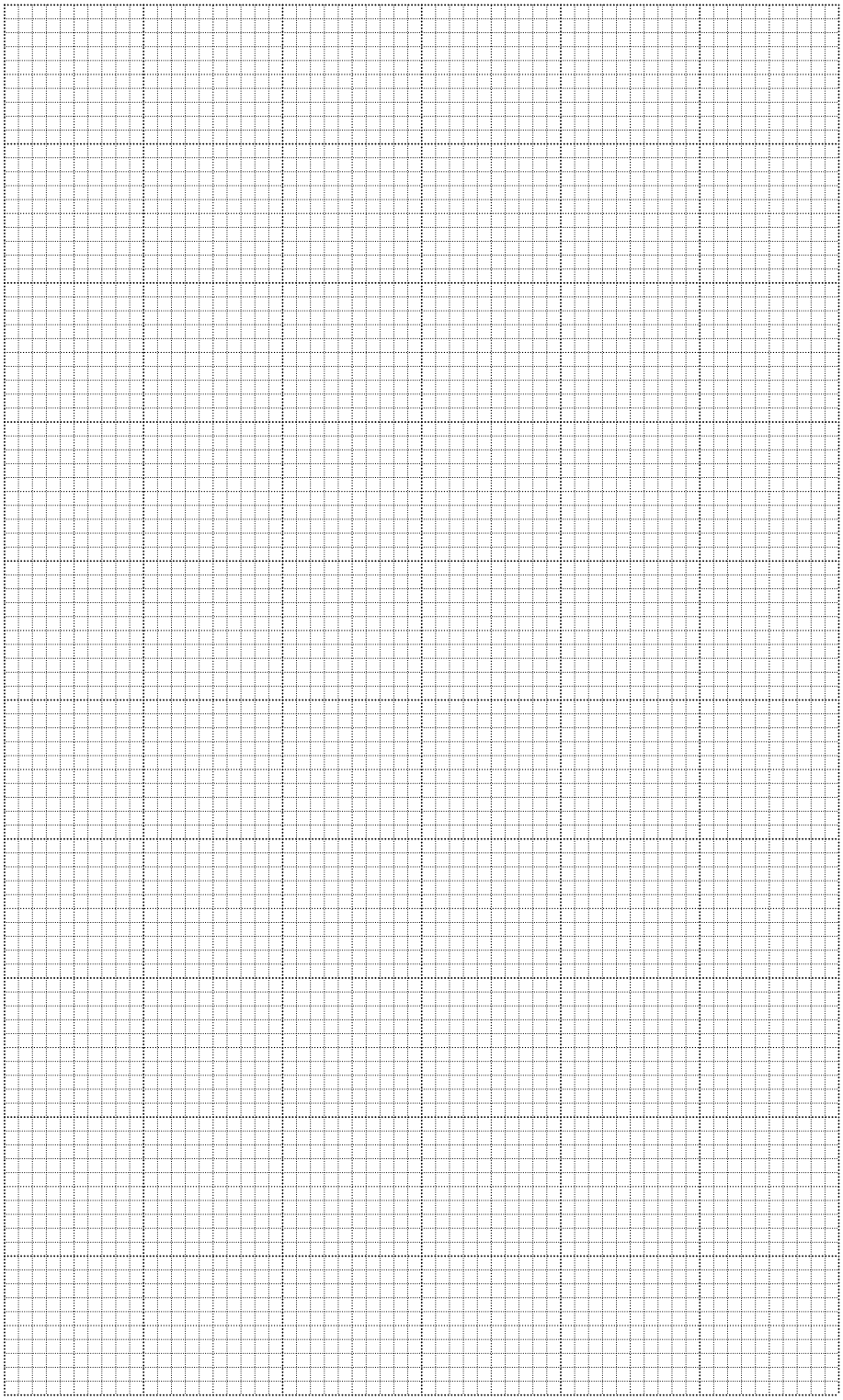
3 (ii) **(continued)** **A spare copy of this graph can be found on page 11**



3 (iii)

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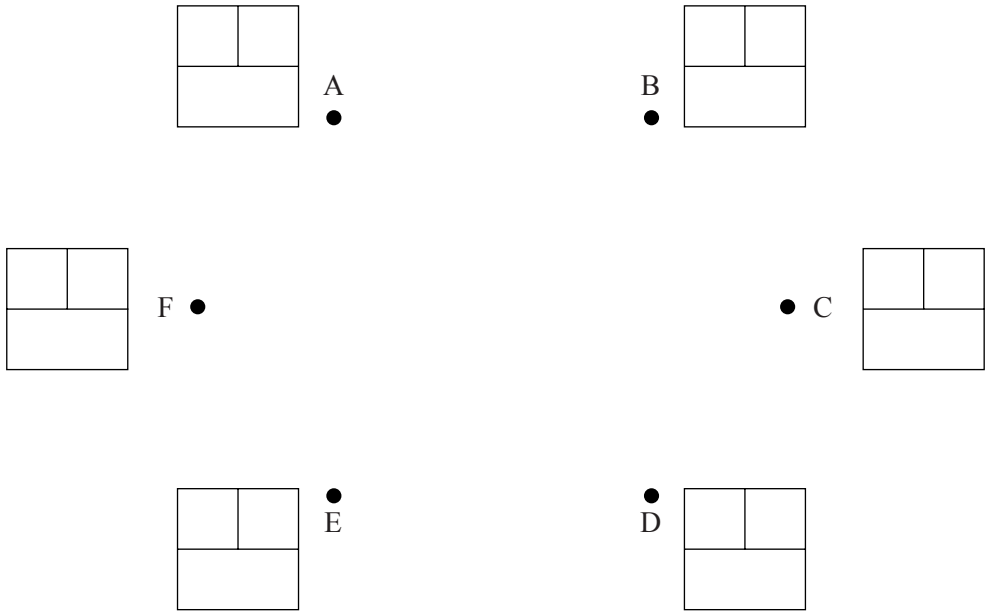
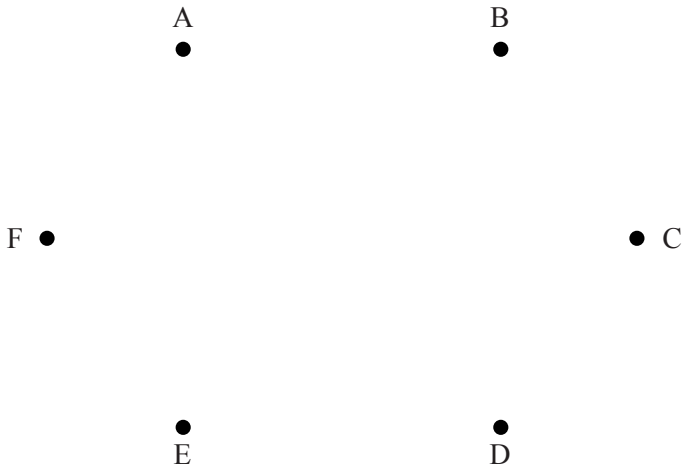
Section B (48 marks)

4 (a)



4 (b) (i)



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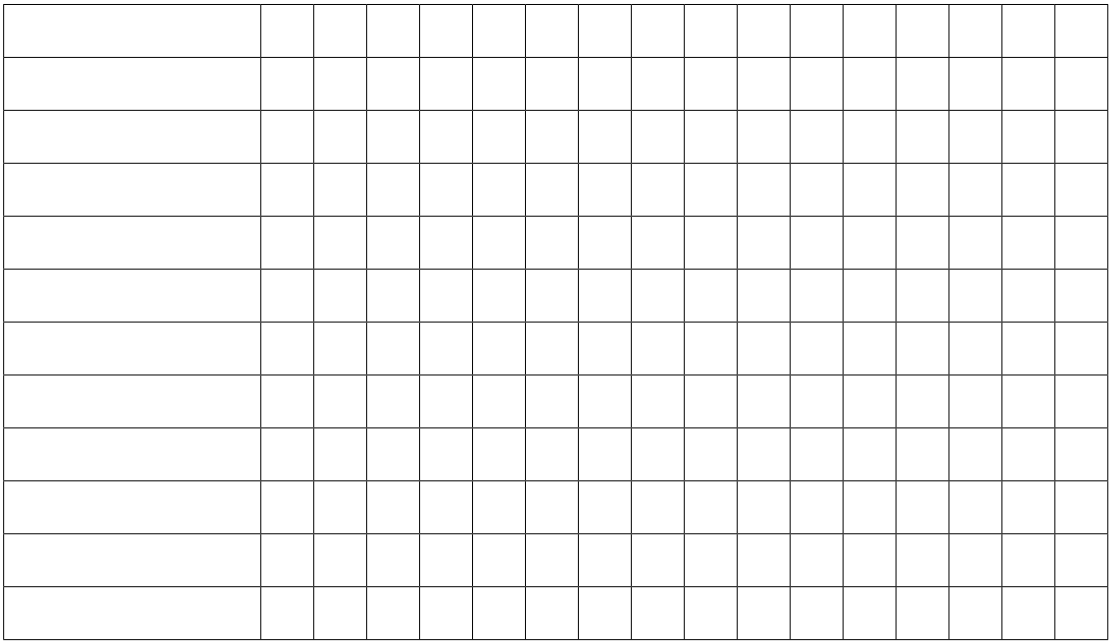
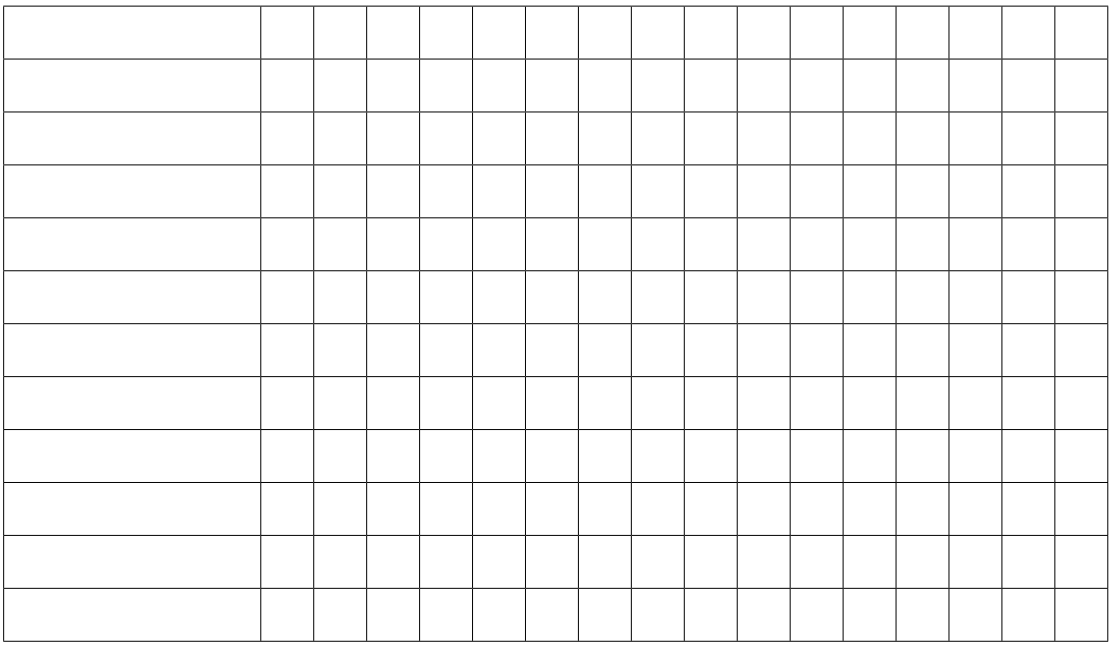
5 (iii)



A spare copy of this diagram can be found on page 12

5 (iv)



A spare copy of this diagram can be found on page 12

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6 (i)	
6 (ii)	**Random digits: 3 0 8 6 0 0 1 2 8 6**
6 (iii)	
6 (iv)	**Random digits: 2 0 8 9 1 7 9 1 2 3 0 6 5 2 6**

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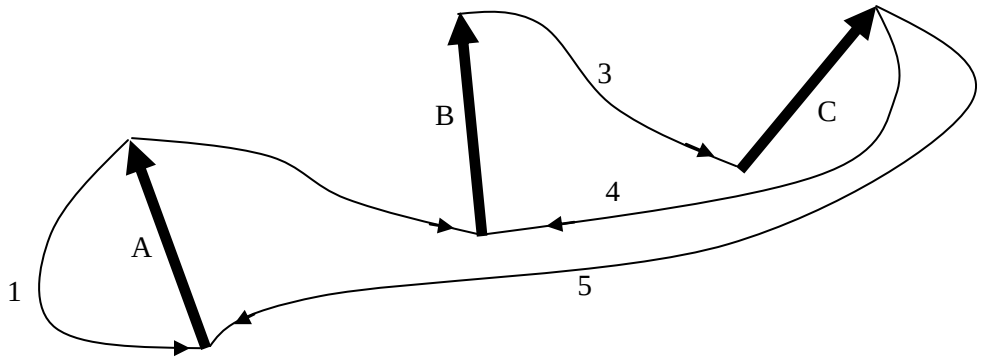
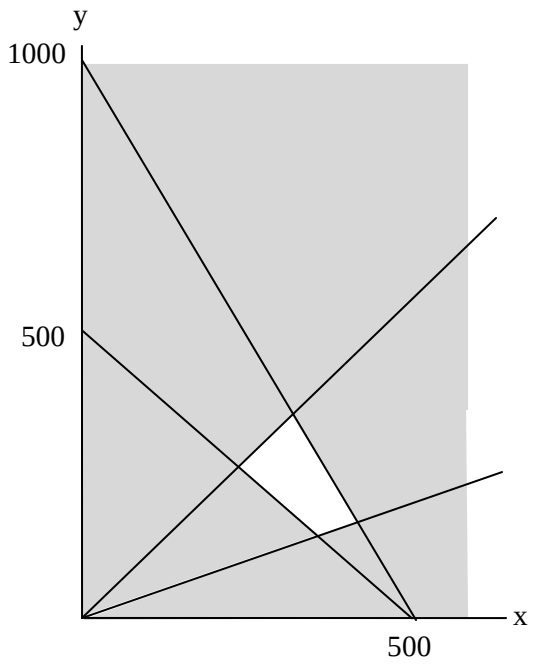
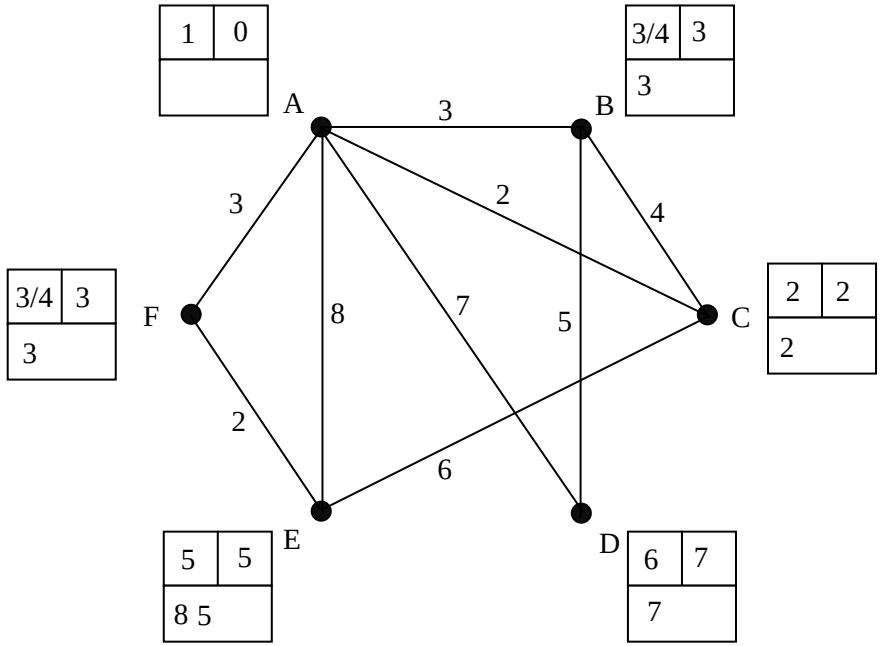
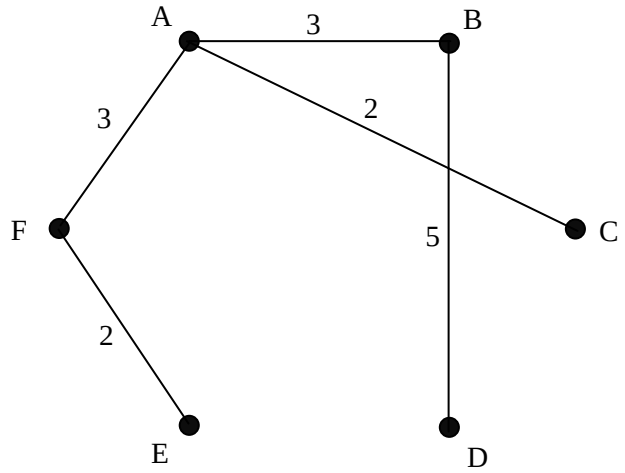
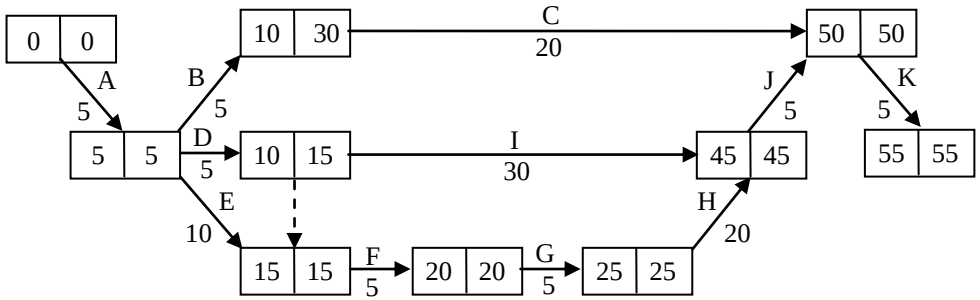
Question			Answer	Marks	Guidance
1	(i)			M1 A1 [2]	At least two directed arcs, each from the top of a lift to the bottom all 4 correct
1	(ii)		(Angus has to repeat all of the chairlifts.) He has to repeat A either because two ski runs deliver skiers to it, or because it serves two ski runs. He has to repeat B and C … … either because two ski runs deliver skiers to them, or because they serve two ski runs or because of ski run 4.	 B1 M1 A1 [3]	
1	(iii)		Angus has to repeat ski run 3 because he has to repeat chairlifts B and/or C (or runs 4 and 5).	M1 A1 [2]	run 3 for explanation
1	(iv)		This would have to be represented by an arc from chairlift C to chairlift D, but in a bipartite graph an arc can only connect two elements which are not in the same set. In this case the sets are chairlifts and ski runs.	B1 [1]	needs to be contextualised

Question			Answer	Marks	Guidance
2	(i)		i 1 2 3 m_1 2 c_1 8 m_2 2 c_2 5 m_3 4 c_3 3 j 1 2 3 a 2 3 4 1 b 3 4 1 5 2 d_1 2 x_1 1 y_1 7 d_2 -2 x_2 2.5 y_2 13 d_3 0 x_3 y_3 Print area (1, 7) (2.5, 13) parallel	M1 A1 B1 B1 B1 M1 A1√ **[7]**	j 1 a 2 b 3 as and bs (4's and 5's not essential) for 1 and 7 for 2.5 and 13 for 0 use of print area 3 copied, inc "parallel"
2	(ii)		Finds the line intersections	B1 **[1]**	

Question			Answer	Marks	Guidance
3	(i)		At least 50% coffee (allow more than) (so number of coffee filters ≥ number of tea bags, so number tea bags ≤ number of coffee filters.) At most 75% coffee (allow less than) so number of coffee filters ≤ 3× number of tea bags, so number of tea bags ≥ 1/3× number of coffee filters.	B1 B1 **[2]**	referral to sales info to get ≤ (allow <) referral to sales info + explanation of 1/3 to get ≥ (allow >)
3	(ii)		Let x be the number of coffee filters. Let y be the number of tea bags ... or vice versa.  	B1 B1 B1 B1cao **[5]**	"number of" essential "500" line £50 line lines from (i) shading
3	(iii)		Coffee – 75% of 500. Tea – 50% of 500.	B1cao **[1]**	

Question			Answer	Marks	Guidance
4	(a)		 AB 3 AC 2 AD 7 AFE 5 AF 3	B1 B1 B1 B1 B1 **[6]**	Dijkstra award only if correct at E other working values order of labelling labels routes lengths

Question			Answer	Marks	Guidance
4	(b)	(i)	 Length = 15	M1 A1 B1 **[3]**	tree or attempt at Prim
4	(b)	(ii)	Removes AE, AD, CE then BC	M1 A1 **[2]**	AE, AD, CE (in order) BC only
4	(b)	(iii)	It will remain connected. There will be no cycles left. Removing a largest possible arc at each stage guarantees a minimum spanning tree.	B1 B1 B1 **[3]**	
4	(b)	(iv)	$(n^2-3n+2)/2$ (or equivalent) arcs for Jill to remove. More than Prim if n is 5 or more	B1 B1 **[2]**	algebraic simplification not needed

Question			Answer	Marks	Guidance
5	(i)&(ii)		 minimum completion time = 55 minutes critical activities – A, E, F, G, H, J, K	M1 A1 A1 A1 A1 **[5]** M1A1√ M1A1√ B1cao B1cao **[6]**	activity on arc F & I J K rest forward pass backward pass time critical activities
5	(iii)		e.g. (each cell represents 5 minutes) 1st person: A E E F G 2nd person: B D I I I I I I other activities: C C C C H H H H	M1 A1 B1 **[3]**	A, E, F, G allocated OK B, D, I, J, K OK C and H correctly timed
5	(iv)		e.g. 1st person: A D I I I I I I J K 2nd person: B E E F G 50 minutes	B1 B1 **[2]**	a correct schedule for two people 50 minutes seen

Question			Answer	Marks	Guidance
6	(i)		e.g. French 0, 1, 2, 3, 4, 5, 6 → Greek 7, 8, 9 → French Greek 0, 1, 2, 3, 4, 5 → French 6, 7, 8, 9 → Greek	 B1 M1 A1 **[3]**	 French proportions efficient
6	(ii)		Using Greek rule Using French rule e.g. F G G G F G F G G G Computing observed probabilities e.g. P(F)=0.3 and P(G)=0.7 (Long run probabilities are 6/13 French and 7/13 Greek.)	M1 M1 A1√ B1√ **[4]**	Greek French
6	(iii)		e.g. French 0, 1 → French 2, 3, 4, 5, 6, 7 → Greek 8, 9 → Hungarian Greek 0, 1, 2, 3, 4 → French 5, 6, 7 → Greek 8, 9 → Hungarian Hungarian 0, 1, 2 → French 3, 4, 5 → Greek 6, 7, 8 → Hungarian 9 → reject and redraw	 B1 B1 M1 A1 A1 **[5]**	 reject one (or more) proportions efficient

6	**(iv)**		Greek rule applied in correct circumstances and correctly French rule applied in correct circumstances and correctly Hungarian rule applied in correct circumstances and correctly e.g. F F H F G H F G F F so P(F)=0.6, P(G)=0.2, P(H)=0.2 (Long run proportions are 56/169, 74/169 and 39/169.)	B1 B1 B1 B1√ **[4]**	