

LEVEL 2

WJEC Level 2 Additional Mathematics

Approved by Qualifications Wales

Sample Assessment Materials

Unit 6: Discrete and Decision Mathematics

Teaching from 2026

For award from 2027



Contents

Question paper	1
Mark scheme	14
Mapping grid	19

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Surname	Centre number	Candidate number
First name(s)		0



Level 2

5322U6

**Additional Mathematics – Unit 6
Discrete and Decision Mathematics**

50 minutes

**SAMPLE ASSESSMENT
MATERIALS**

Additional materials

The use of a calculator will be required for this examination.

Instructions to candidates

Use black ink or black ball-point pen. Do **not** use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces provided at the top of this page.

Answer **all** the questions in the spaces provided.

Write your answers in the spaces provided in this booklet. If you need more space, use the additional page(s) at the back of this booklet, taking care to number the question(s) correctly.

Information for candidates

The number of marks is given in brackets at the end of each question or part-question.

In question **4(c)**, the assessment will take into account the quality of your mathematical organisation, communication and accuracy in writing.

For examiner's use only		
Question	Maximum mark	Mark awarded
1.	8	
2.	6	
3.	5	
4.	12	
5.	9	
Total	40	

Formula/Algorithm List – Unit 6 Discrete and Decision Mathematics

Bubble sort

Start at the beginning of the working list and move from left to right comparing adjacent items. If they are in order, leave them, if they are not, swap them.

When you get to the end of the working list, the last item will be in its final position. This item is no longer in the working list.

If you made some swaps on the last pass, repeat the first instruction.

When a pass is completed without any swaps, every item is in its final position and the list is in order, stop.

Quick sort

Choose the item at the midpoint of the list to be the first pivot. If the list has an even number of items, the pivot should be to the right of the middle.

Write down all the items that are less than the pivot, keeping their order, in a sub list.

Write down the pivot.

Write down the remaining items (greater than the pivot, keeping their order) in a sub list.

Repeat for each sub list of size greater than one.

When all items have been chosen as pivots or any subgroups only contain one item, stop.

Dijkstra's algorithm

Label the start vertex with a **final** label, 0.

Record a working value at each vertex that is connected to the vertex that has just received its final label.

- Working value is final label plus the weight of the edge.
- If there is already a working value, it is only replaced if the new value is smaller.
- Once a vertex has a final value, it is no longer revisited, and its working values are no longer considered.

Look at the working values at all vertices without final labels. Select the smallest working value. This now becomes the final label at that vertex. If two vertices have the same working value, choose either of them first.

Repeat the second and third steps until the destination vertex receives its final label.

To find the shortest path, trace back from the destination to the start.

Kruskal's algorithm

Sort all the edges into ascending order of weight.
Select the edge of least weight to start the tree.

Consider the next edge of least weight. If it would form a cycle with those edges already selected, reject it. If it does not form a cycle, add it to the tree. If there is a choice of equal edges, choose one of them at random consider each in turn.
Repeat the third step until all vertices are connected.

Prim's algorithm

Choose any vertex to start the tree.
Select an edge of least weight that joins a vertex already in the tree to a vertex not yet in the tree.

If there is a choice of edges of equal weight, choose any of them.
Repeat the second step until all the vertices are connected.

Answer **all** questions.

1. (a) Define the following graph theory terms:

Examiner
only

(i) Vertex

[1]

.....
.....

(ii) Subgraph

[1]

.....
.....

(iii) Path

[1]

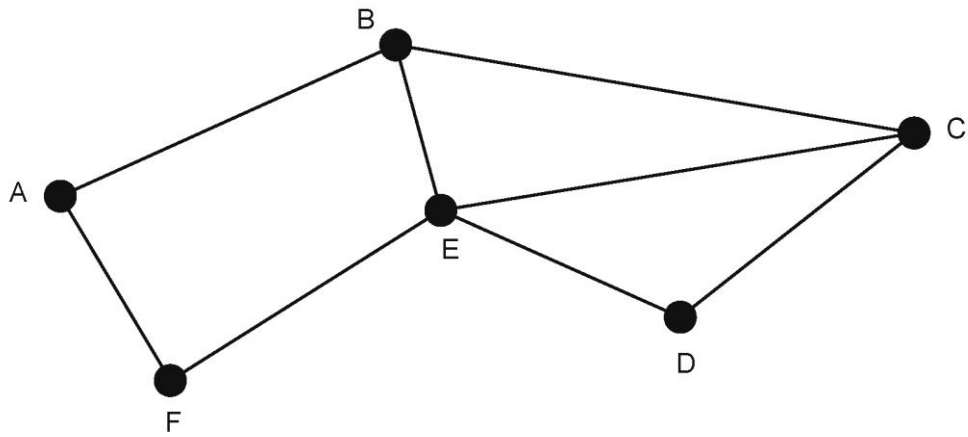
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(b) Draw a simple connected graph with exactly three vertices of degree 2, one vertex of degree 3 and one vertex of degree 1.

[2]

(c) Explain whether this graph is Eulerian, or semi-Eulerian.

[3] Examiner only



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2. (a) Sort the letters below into alphabetical order using the bubble sort algorithm, showing each pass. [3]

N H R K S C J E M

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- (b) Use the quick sort algorithm to sort the numbers below into descending order. You must show each pass. [3]

22 17 25 30 11 18 20 14

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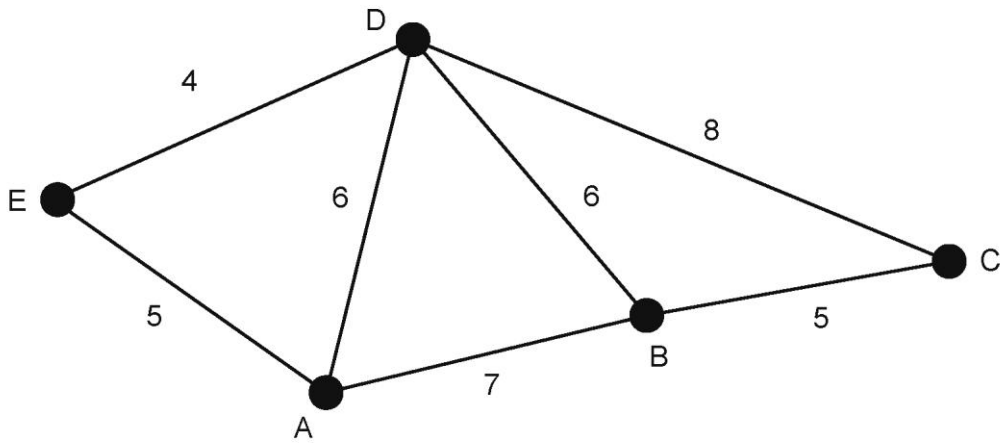
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3.



(a) Define the term minimum spanning tree.

[1]

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(b) Name and use an appropriate algorithm to find a minimum spanning tree for the above network. List the arcs in the order that you consider them. State the weight of your tree.

[4]

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Weight of tree

4. Gwenan, the manager of a hotel, is organising staff to act as servers at a wedding reception.

Gwenan will use x full-time workers from the hotel and call in y part-time workers to make up the number of servers who will be employed at the reception.

Note that $x \geq 0$ and $y \geq 0$.

Each full-time worker will earn £100, and each part-time worker will earn £50.

The selection of servers is subject to three additional restrictions.

Restriction 1: The total amount paid to servers must not exceed £1400.

- (a) Show that $2x + y \leq 28$. [2]

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Restriction 2: There must be at least one full-time worker for every two part-time workers.

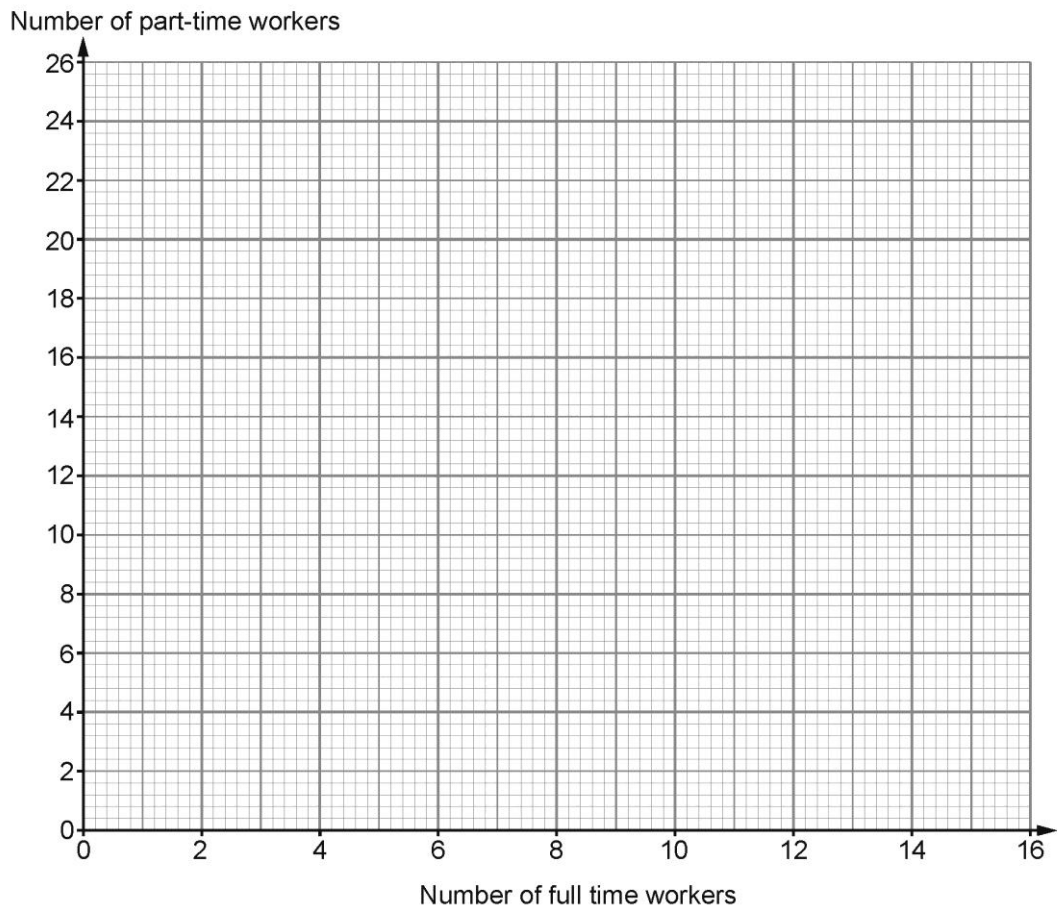
$$\text{So } x \geq \frac{y}{2}.$$

Restriction 3: No more than ten full-time workers will be available. So $x \leq 10$.

- (b) Show the three inequalities by drawing a suitable diagram on the graph below.
Identify with a letter **R** the region that satisfies all five inequalities.

Examiner
only

[4]



- (c) *In this part of the question, you will be assessed on the quality of your organisation, communication and accuracy in writing.*

Gwenan wants to maximise the number of servers for the reception.
You must use either the objective line method or the vertex testing method to identify the optimum number of workers and the total cost for employing these workers.

[4 + 2 OCW]

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Maximum total number of workers.....

Total cost £.....

5. Part of a building project consists of ten activities, labelled from A to J.

Activity A does not depend on any other activity.

Activities B, C and D all require that activity A is completed before they start.

Activities E and F depend on activity B.

Activity G cannot be started until activities C and E have been completed.

Activity H requires the completion of activity D, while activity I requires that both F and G are completed first.

Activity J requires the completion of all other activities before it can be started.

- (a) Complete the precedence table below to represent the project.

[3]

Activity	Depends on
A	--
B	A
C	A
D	A
E	
F	
G	
H	
I	
J	

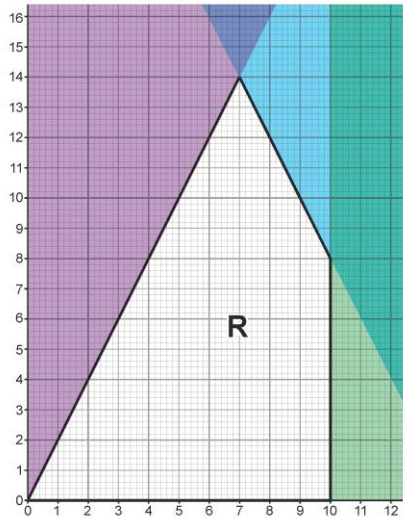
(b) Use your precedence table to draw the corresponding activity network.

[6] Examiner
only

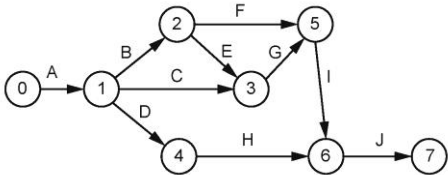
END OF QUESTIONS

MARK SCHEME

Level 2 Additional Mathematics Unit 6: Discrete and Decision Mathematics SAMs		Mark	Comments
1 (a) (i)	A point which may be connected to other vertices by edges.	B1	
1 (a) (ii)	A graph G' , each of whose vertices and edges belong to G .	B1	
1 (a) (iii)	A walk in which no vertex is visited more than once.	B1	
1 (b)		C2	1 mark for a partial graph showing the order three vertex and two other vertices. 2 marks for a fully correct diagram. Note that there are alternatives that are in effect reflections or rotations of this image.
1 (c)	This graph is semi-Eulerian, as it has a pair of vertices of degree 3 and all the other vertices are of even degree.	E3	E1 for semi-Eulerian E1 for noting the pair of odd vertices E1 even number of even vertices
2 (a)	start NHRKSCJEM pass 1 HNKRCJEMS pass 2 HKNCJEMRS pass 3 HKCJEMNRS pass 4 HCJEKMNRS pass 5 CHEJKMNRS pass 6 CEHJKMNRS pass 7 CEHJKMNRS	M1 A1 A1	For at least one correct pass For three or more correct CAO
2 (b)	start 22 17 25 30 11 18 20 14 pass 1 22 17 25 30 18 20 14 <u>11</u> pass 2 <u>30</u> 22 17 25 18 20 14 <u>11</u> pass 3 <u>30</u> 22 25 20 <u>18</u> 17 14 <u>11</u> pass 4 <u>30</u> <u>25</u> 22 20 <u>18</u> 17 <u>14</u> <u>11</u> pass 5 <u>30</u> <u>25</u> 22 <u>20</u> <u>18</u> 17 <u>14</u> <u>11</u>	M1 A1 A1	For the correct choice of the first pivot and one pass, allow ascending order for M mark Correctly finding pass 3 CAO Note: active pivots shown in bold , previous pivots are <u>underlined</u> .
3 (a)	A spanning tree such that the total length of its edges is as small as possible.	B1	

3 (b)	<p>Kruskal's: Order of edges is DE4, AE5, BC5, AD6, BD6, AB7, CD8. Start with DE Add AE Add BC Reject AD (forms a cycle) Add BD</p> <p>Weight of MST is $5+4+6+5=20$</p>	<p>M1 M1 A1 A1</p>	<p>For choice and listing</p> <p>Note AE and BC are interchangeable as are AD and BD</p> <p>Seen or implied</p> <p>CAO</p>
	<p><u>Alternative Solution:</u></p> <p>Prim's</p> <p>Start at A, choose AE (5), ED (4), reject DA as it forms a cycle</p> <p>DB (6), BC (5)</p> <p>Weight of MST is $5+4+6+5=20$</p>	<p>M1 M1 A1 A1</p>	<p>For choice, starting point and first edge</p> <p>Note other starting vertices are acceptable that will result in the same MST</p>
4 (a)	$100x + 50y \leq 1400$ $2x + y \leq 28$	<p>M1 A1</p>	<p>Given answer, so division by 50 to be seen or implied.</p>
4 (b)	<p>3 correct lines with shading to show the region not required for each line and the letter R identified.</p> 	<p>G3 B1</p>	<p>Deduct G1 once if any line is not showing shading. For labelling the region R.</p>

4 (c)	<p><i>Objective line method</i></p> <p>Max(imise) ($P =$) $x + y$ Use of any line of form $x + y = k$</p> <p>Clear evidence of using at least one repeat of a line of the same form and selecting the relevant integer point</p> <p>Total number of workers=21</p> <p>Total cost =£1400</p>	<p>M1</p> <p>m1</p> <p>A1</p> <p>A1</p>	<p>si</p> <p>Accept (7,14) or equivalent.</p>
	<p><u>Alternative Solution:</u> <i>Vertex testing method</i></p> <p>Max(imise) ($P =$) $x + y$ Consider one of the vertices of the region R</p> <p>Use of at least a second vertex</p> <p>Total number of workers=21</p> <p>Total cost =£1400</p>	<p>M1</p> <p>m1</p> <p>A1</p> <p>A1</p>	<p>si</p> <p>Accept (7,14) or equivalent</p>
	<p>Organisation and communication</p> <p>Writing</p>	<p>OC1</p> <p>W1</p>	<p>For OC1, candidates will be expected to:</p> <ul style="list-style-type: none"> • present their response in a structured way • explain to the reader what they are doing at each step of their response • lay out their explanations and working in a way that is clear and logical • write a conclusion that draws together their results and explains what their answer means. <p>For W1, candidates will be expected to:</p> <ul style="list-style-type: none"> • show all their working • use correct mathematical form in their working • use appropriate terminology, units, etc.

5 (a)	Activity	Depends on	B1 B1 B1	For any two correct dependencies For three or more correct CAO
	A	--		
	B	A		
	C	A		
	D	A		
	E	B		
	F	B		
	G	C, E		
	H	D		
	I	F, G		
J	H, I			
5 (b)	Diagram of activity network – note that there are alternative orientations for the network. For example:		M1	For drawing an activity network with at least 3 nodes and two activities
			A1	For directional arrows
			A1	For order in or close to nodes, accept 0-7 or 1-8
			M1A2	CAO.

How to read the mark scheme

- 'M' marks are awarded for any correct method applied to appropriate working, even though a numerical error may be involved. Once earned they cannot be lost.
- 'm' marks are dependant method marks. They are only given if the relevant previous 'M' mark has been earned.
- 'A' marks are given for a numerically correct stage, for a correct result or for an answer lying within a specified range. They are only given if the relevant M/m mark has been earned either explicitly or by inference from the correct answer.
- 'B' marks are independent of method and are usually awarded for an accurate result or statement.
- 'S' marks are awarded for strategy
- 'E' marks are awarded for explanation
- 'U' marks are awarded for units
- 'P' marks are awarded for plotting points
- 'C' marks are awarded for drawing curves
- 'OC' marks are awarded for 'organising and communicating', a strand of OCW (organising, communicating and writing accurately)
- 'W' marks are awarded for 'writing accurately', a strand of OCW (organising, communicating and writing accurately)
- 'SC' marks are awards for special cases
- CAO: correct answer only
- ISW: ignore subsequent working
- FT: follow through

Mapping grid

Question	Marks	Assessment objective			OCW
		AO1	AO2	AO3	
1a	3	3			
1b	2		2		
1c	3	3			
2a	3	3			
2b	3	3			
3a	1	1			
3b	4		4		
4a	2	2			
4b	4	4			
4c	6			6	*
5a	3	3			
5b	6			6	
Total	40	22	6	12	