

1.4 DATA TYPES & STRUCTURES · 1.4.2

Graphs — Mark scheme

30 marks · spec 1.4.2(b)(c)

AO key: AO1 = knowledge · AO2 = application. Accept any valid alternative. Do not award the same point twice.

Q	ANSWER	AO	MARKS
1(a)	A set of nodes/vertices (1); connected by edges/arcs (no hierarchy, can have cycles) (1). (2)	AO1	2
1(b)	Directed: edges have a direction (arrow), one-way (1); undirected: edges have no direction, work both ways (1). (2)	AO1	2
1(c)	A graph where each edge has a value/weight (e.g. a cost or distance). (1)	AO1	1

Q	ANSWER	AO	MARKS																									
2(a)	<table><tr><td></td><td>P</td><td>Q</td><td>R</td><td>S</td></tr><tr><td>P</td><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>Q</td><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>R</td><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>S</td><td>0</td><td>1</td><td>1</td><td>0</td></tr></table> 1 mark per correct row (or ~per 2 correct edges, both directions). (4)		P	Q	R	S	P	0	1	1	0	Q	1	0	0	1	R	1	0	0	1	S	0	1	1	0	AO2	4
	P	Q	R	S																								
P	0	1	1	0																								
Q	1	0	0	1																								
R	1	0	0	1																								
S	0	1	1	0																								
2(b)	P → [Q, R] (1); Q → [P, S] and R → [P, S] (1); S → [Q, R] (1). (Order within a list not important.) (3)	AO2	3																									
2(c)	The graph is undirected, so every edge appears in both directions (A–B is also B–A), mirroring across the diagonal. (1)	AO2	1																									

Q	ANSWER	AO	MARKS
3(a)	Two differences, 2 marks each (point + contrast), max 4: a matrix is a 2-D grid storing every possible edge (1) while a list stores only existing edges (1); a matrix checks a connection by reading one cell (fast) (1) while a list must be searched (1); a matrix wastes memory on sparse graphs (1) while a list is memory-efficient (1). (4)	AO1	4
3(b)	Adjacency list (1); the graph is sparse (few edges relative to nodes), so a list avoids storing a huge mostly-empty matrix / saves memory (1). (2)	AO2	2

Q	ANSWER	AO	MARKS
4(a)	A directed graph (1); the streets are one-way, so each edge must have a direction (1). (2)	AO2	2
4(b)	It would not be symmetrical (1); an edge $A \rightarrow B$ fills one cell but the reverse $B \rightarrow A$ is not set unless that direction also exists (1). (2)	AO2	2
4(c)	A weighted (directed) graph (1); the road length (weight) is stored in the matrix cell instead of a 1 (1). (2)	AO2	2

Q	ANSWER	AO	MARKS
5(a)	Edges: A–B, A–C, B–C, C–D. All four correct (2); 2–3 correct (1). (2)	AO2	2
5(b)	4. (1)	AO2	1
5(c)	C, with 3 connections (A, B, D). (1)	AO2	1
5(d)	Undirected; the connections are mutual (e.g. A lists C and C lists A). (1)	AO2	1

Total for paper: 30 marks