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Mark Scheme (Results)

January 2013

GCE Decision Mathematics D1 6689/01

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

  In some instances, the mark distributions (e.g. M1, B1 and A1) printed on the candidate's response may differ from the final mark scheme.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes.

- bod – benefit of doubt
- ft – follow through
- the symbol $\surd$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- $*$ The answer is printed on the paper
- $\lfloor$ The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but incorrect answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. If a candidate makes more than one attempt at any question:
   - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

8. The maximum mark allocation for each question/part question(item) is set out in the marking grid and you should allocate a score of '0' or '1' for each mark, or "trait", as shown:

	0	1
aM		●
aA	●	
bM1		●
bA1	●	
bB	●	
bM2		●
bA2		●

January 2013
6689 Decision Mathematics 1
Mark Scheme

Question Number	Scheme	Marks
1 (a)	<table><tr><td>N</td><td>E</td><td>R</td><td>Qn</td></tr><tr><td>72</td><td>8</td><td>8.5</td><td>N</td></tr><tr><td></td><td>8.5</td><td>8.485 294 118</td><td>N</td></tr><tr><td></td><td>8.485 294 118</td><td>8.485 281 374</td><td>N</td></tr><tr><td></td><td>8.485 281 374</td><td>8.485 281 374</td><td>Y</td></tr></table> Output is R = 8.485 281 4	M1 A1 A1 A1ft **(4)**
(b)	We would get a negative output for R/ We would get the negative square root	B1 **(1)**
(c)	E cannot be zero	B1 **(1)**
		Total 6 marks

Notes

a1M1: At least **two** rows of cells in just E and R completed.

a1A1: CAO first two rows correct giving exact values or awrt 7dp (the exact second value for R is $\frac{577}{68}$).

a2A1: CAO third and fourth rows awrt 7dp

a3A1ft: Output for R **must** follow through from **their** final value for R awrt 7dp – candidate **must** have answered 'yes' to score this mark. Output either on the answer line (or on the second page) or stated in the table but **must** be in the column for R below the row which contains 'yes'.

Condone N = 72 on each row and entries appearing on separate rows throughout for full marks. Allow e.g. ticks/crosses etc. for yes/no.

b1B1: Mention of 'negative' scores B1 however do not accept incorrect statements but bod that 'negative' only is implicitly describing the effect on the output. Accept 'other square root'.

c1B1: CAO (nothing/null etc. scores B0). Condone E = 0.

Question Number	Scheme	Marks
2 (a)	Pivot 1 = $\left[\frac{1+26}{2}\right] = [13.5] = 14$ letter N reject A – N	M1 A1
	Pivot 2 = $\left[\frac{15+26}{2}\right] = [20.5] = 21$ letter U reject U – Z	
	Pivot 3 = $\left[\frac{15+20}{2}\right] = [17.5] = 18$ letter R reject R – T	A1
	Pivot 4 = $\left[\frac{15+17}{2}\right] = 16$ letter P – located	A1 **(4)**
(b)	E.g. The maximum number of letters at the start of each iteration is 26, 13, 6, 3, 1	M1
	So a maximum of 5 iterations is necessary	A1 **(2)**
		Total 6 marks
	Notes a1M1: Choosing middle right pivot (choosing middle left is M0) + discarding/retaining half the list. M1 **only** for an 'incorrect' list - allow 1 error (e.g. two letters interchanged) or one omission or 1 extra letter. a1A1: First pass correct i.e. N found as pivot for a correct list and either using O to Z in 2nd pass or discarding A to N (so therefore no 'sticky' pivots – sticky is when the letter being considered is retained in the next pass) a2A1: Second and third passes correct i.e. U and R (no sticky pivots). **Special case**: Allow recovery for this mark if a sticky pivot is used in first pass but sticky pivots are not used in the 2nd and 3rd passes. So after retaining N incorrectly the 2nd pass would give T and the 3rd pass would give Q leaving a list with N O P. a3A1: CSO (correct solution only – all three previous marks must have been awarded to score this mark) search complete + 'found' (accept 'found', 'located', 'stop', etc. but not just the letter; must be convinced that P has been located). **If no alphabetical list seen then withhold the final A mark in part (a)**. If the alphabetical list is not given then bod that candidate is using the correct ordered list (which is implied by the correct passes). Listing the alphabet and then numbering the alphabet and referring to the corresponding numbers is fine for full marks. Candidates may renumber their list for each pass to calculate pivots. However, use of numbers and comparing to 16 without any reference to the alphabet is M0. b1M1: Numerical argument; listing size of list, using logs, etc. b1A1: Correct complete argument.	

Question Number	Scheme	Marks
3 (a)	(i) C – 4 = N – 6 = J – 3 = R – 2 or (ii) O – 6 = J – 3 = R – 2 Change status to give (i) C = 4 – N = 6 – J = 3 – R = 2 or (ii) O = 6 – J = 3 – R = 2 Improved matching is: C G J N O R (i) 4 5 3 6 2 (ii) 5 3 4 6 2	M1 A1 A1 **(3)**
(b)	E.g. Tasks 1 and 5 can only be done by George E.g. Charlie can only do task 4 and Olivia can only do task 6 which means that Nurry can't be allocated a task as Nurry can only do tasks 4 and 6	B2, 1, 0 **(2)**
(c)	O – 6 = N – 4 = C – 5 = G – 1 or C – 5 = G – 1 Change status to give O = 6 – N = 4 – C = 5 – G = 1 or C = 5 – G = 1 Maximum matching is: C = 5, G = 1, J = 3, N = 4, O = 6, R = 2	M1 A1 A1 **(3)**
		Total 8 marks

Notes

a1M1: An alternating path (e.g. letter - number - letter - …) from C or O to 2 or vice versa.

a1A1: CAO – a correct path including change status **either** stated (only accept 'change (of) status' or 'c.s.') **or** shown (**all** symbols e.g. (... − ... = ...) **interchanged** (... = ... − ...)). Chosen path clear.

a2A1: CAO must follow from the correct stated path. Accept on a **clear** diagram (with five arcs only).

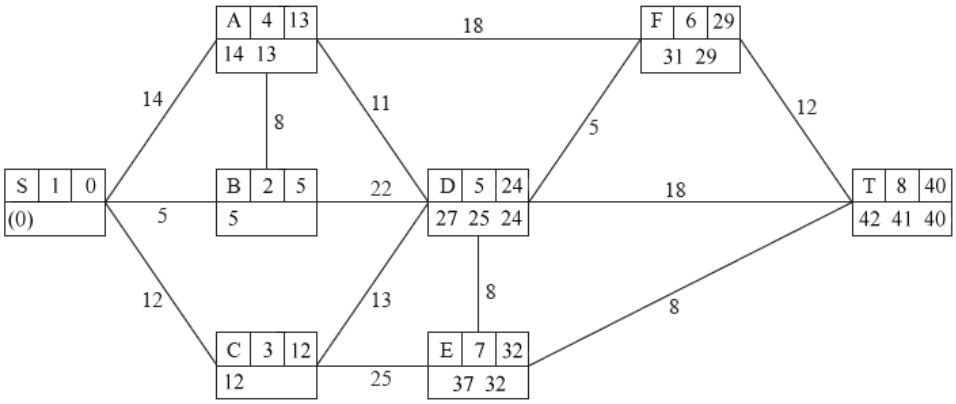
b1B1: Correct idea, may be imprecise or muddled (bod gets B1) all relevant nodes must be referred to and must be correct.

b2B1: Good, clear, complete, correct answer (this needs to be checked carefully e.g. G can only do tasks 1 and 5 is B1 only).

c1M1: A second alternating path from O or C to 1 (whichever letter (of O or C) that they didn't use before) or vice versa.

c1A1: CAO including change status (stated **or** shown), chosen path clear.

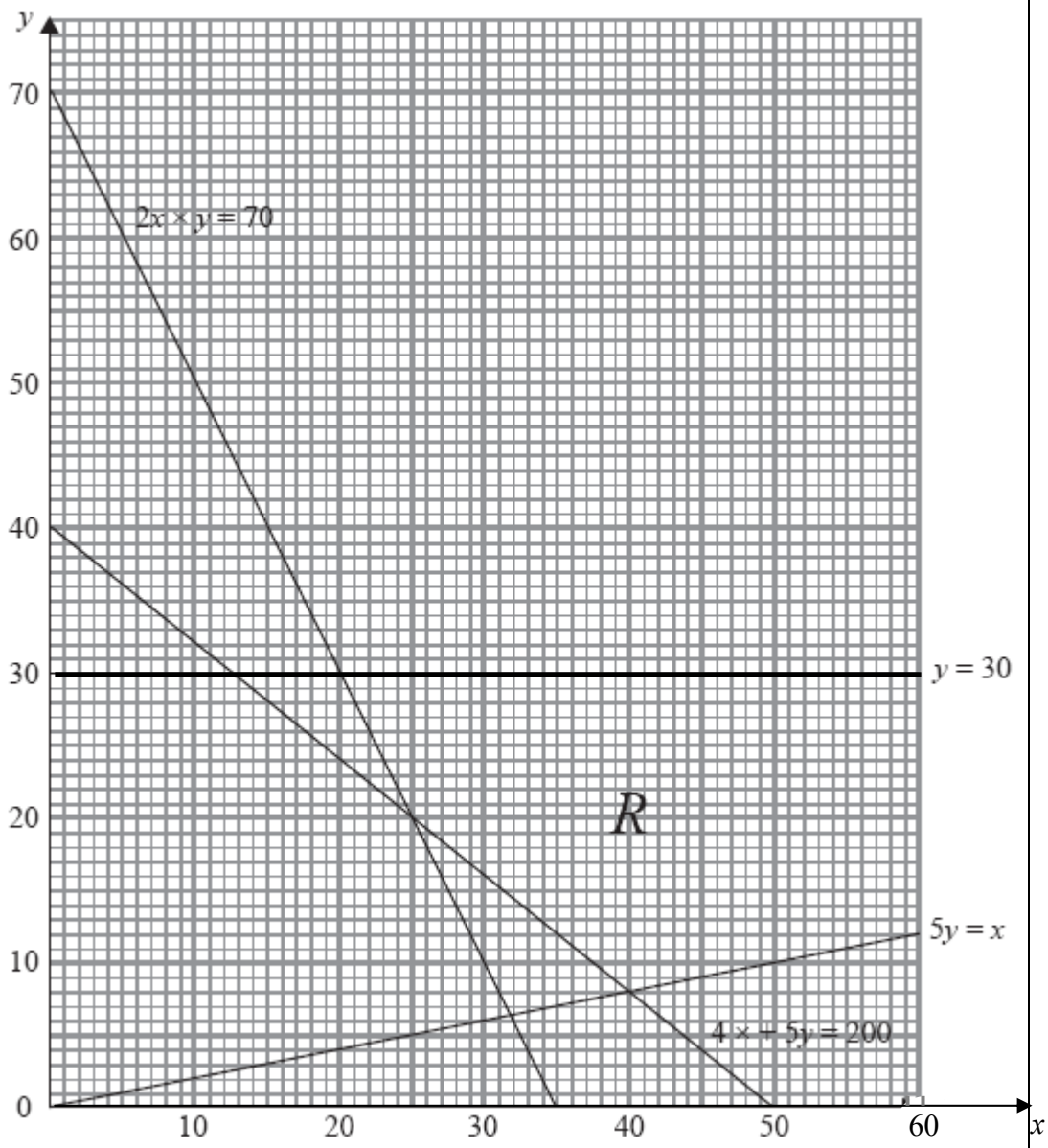
c2A1: CAO must follow from **two correct** stated paths (so both previous M marks must have been awarded). Accept on a **clear** diagram (with six arcs only).

Question Number	Scheme	Marks
4 (a)	A path is a (i) finite sequence of edges, such that (ii) the end vertex of one edge in the sequence is the start vertex of the next, and in which (iii) no vertex appears more than once.	B2, 1, 0 **(2)**
(b)		M1 A1 (S,A, B, C) A1ft (D, F) A1 (E, T)
	Shortest path: SBADET Length: 40 (miles)	B1 B1ft **(6)**
(c)	Shortest distance S to F = 29 (miles)	B1ft **(1)**
(d)	SADET or SCDET; of length 41 (miles)	B1 B1 **(2)**
		Total 11 marks
	Notes a1B1: One of the three points made clearly or two suggested. Arcs (edges)/ vertices (nodes) must be referred to correctly. Do not condone incorrect technical language e.g. point for vertex. a2B1: All three points made clearly. b1M1: A larger value replaced by a smaller value at least once at A or D or E or F or T. b1A1: **All** values in S, A, B and C correct. The working values at A must be in the correct order. Condone lack of 0 in S's working value. b2A1ft: All values in D and F ft correctly and working values in the correct order. F must be labelled before E but penalise order of labelling only once per question. b3A1: All values in E and T correct and working values in the correct order. Penalise order of labelling only once per question. b1B1:Route CAO b2B1ft: Their final value ft (if answer is not 40 ft their final value at T) c1B1ft: Their final value ft (if answer is not 29 ft their final value at F) d1B1: Either route CAO d2B1: Length CAO (condone lack of (or incorrect) units throughout)	

Question Number	Scheme	Marks
5 (a)	AC (32) CF (14) DF (12) EF (17); BE (15) FI(18); IJ (10) GJ (9) DH (19)	M1 A1; A1 **(3)**
(b)	146 x 80 = (£) 11 680	M1 A1 **(2)**
(c)	BF + GH = 32 + 40 = 72 BG + FH = 39 + 25 = 64* BH + FG = 57 + 37 = 94 Roads BE, EG and FH need repeating	M1 A3,2,1,0 A1ft A1 **(6)**
(d)	379 + 64 = 443 (km)	B1ft (**1**)
(e)	Ben should choose to repeat FH (25) since this is the shortest. He should choose B and G as his start and finish vertices Route length is 379 + 25 = 404 (km)	M1 A1 A1 **(3)**
		Total 15 marks
	Notes Accept the **weight** of each arc to represent the arcs (as each value is unique). a1M1: First four arcs correctly chosen **or** first five nodes correctly chosen (A, C, F, D, E, …). Any rejections seen during selection scores **M0**. Order of nodes may be seen at the top of a matrix. a1A1: First six arcs correctly chosen **or** all nodes correctly chosen (A, C, F, D, E, B, I, J, G, H). Order of nodes may be seen at the top of a matrix. a2A1: CSO (must be considering arcs for this final mark). b1M1: $80\times$ their MST weight. Accept a value in the interval $[114,178]\times 80$ for this mark. If no working is seen then M0 unless answer is correct. b1A1: CAO (11680 with no working scores both marks). c1M1: Three distinct pairings of **their** four odd nodes. c1A1: Any one row correct including pairing **and** total. c2A1: Any two rows correct including pairing **and** total. c3A1: All three rows correct including pairing **and** total. c4A1ft: Their smallest **arcs** repeated (e.g. accept BEG or BG via E but **not** just BG). BEG (or e.g. BG via E) could appear in their working. c5A1: CAO BE, EG and FH. Accept BEG or BG via E (could appear in working) but not just BG. d1B1ft: correct answer of 443 **or** 379 + their least out of a choice of at least **two** totals given in part (c). e1M1: FH (or 25) specifically identified as **least**. e1A1: B and G identified as the start and finish nodes. e2A1: 404 CAO (condone lack of (or incorrect) units throughout).	

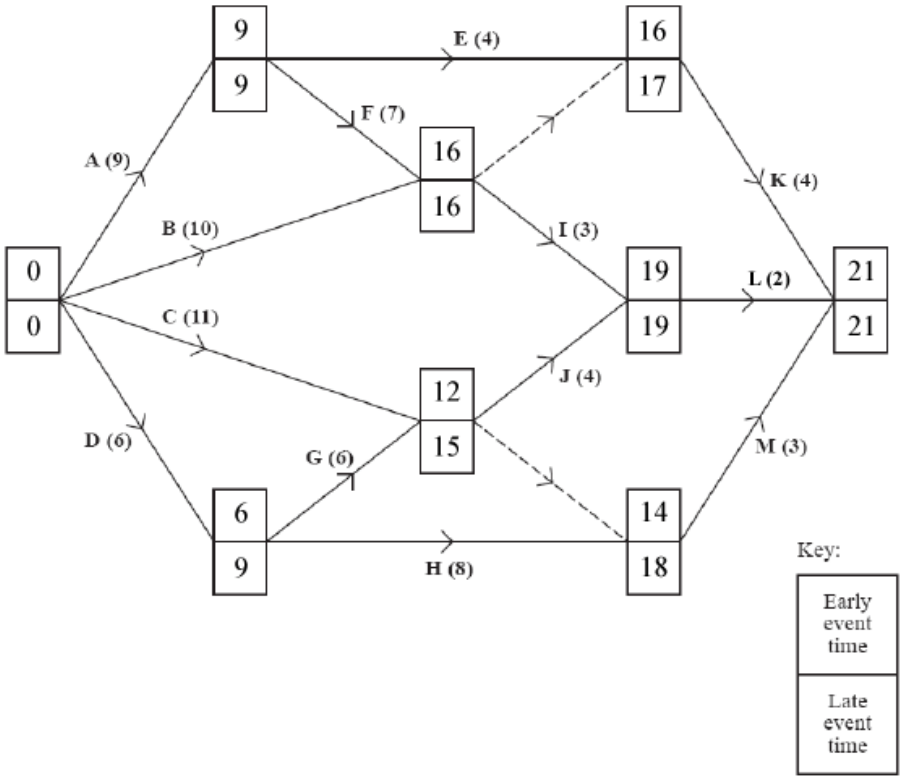
Question Number	Scheme	Marks
	Misread in (a): Starting at a node other than A scores **M1 only** – **must** have the first four arcs (or five nodes or numbers) correct.	

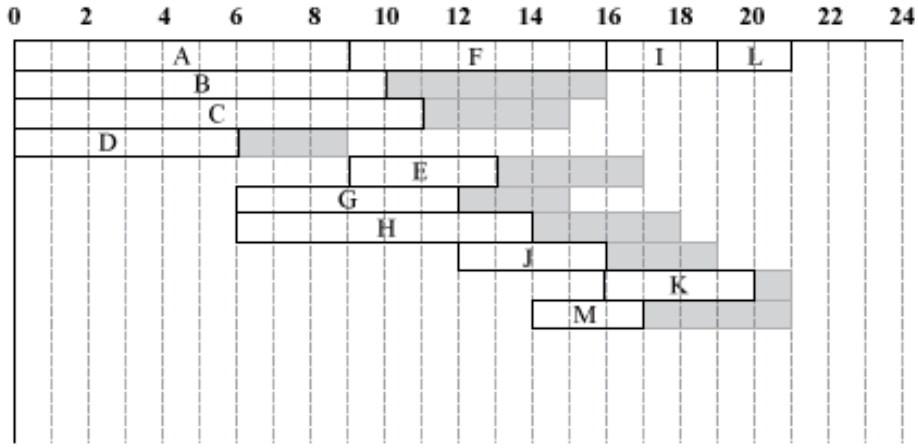
Starting at	Minimum Arcs required for M1 only	Nodes	Order
B	BE,EF,DF,CF	B, E, F, D, C	(10)15423(8967)
C	CF,DF,EF,BE	C, F, D, E, B	(10)51342(8967)
D	DF,CF,EF,BE	D, F, C, E, B	(10)53142(8967)
E	BE,EF,DF,CF	E, B, F, D, C	(10)25413(8967)
F	DF,CF,EF,BE	F, D, C, E, B	(10)53241(8967)
G	GJ,IJ,FI,DF	G, J, I, F, D	(10)(86)5(7)41(9)32
H	DH,DF,CF,EF	H, D, F, C, E	(10)(6)4253(9)1(78)
I	IJ,GJ,FI,DF	I, J, G, F, D	(10)(86)5(7)43(9)12
J	GJ,IJ,FI,DF	J, G, I, F, D	(10)(86)5(7)42(9)31

Question Number	Scheme	Marks
6.		

Question Number	Scheme	Marks
6(a)	$5y \geq x$	B1 B1 **(2)**
(b)	$2x + y \geq 70$ and $4x + 5y \geq 200$	B3,2,1 **(3)**
(c)	Two lines correctly added	B1 B1 **(2)**
(d)	R correctly labelled	B1 **(1)**
(e)	(T =) $10x + 4y$	B1 **(1)**
(f)	<table><tr><th>Vertex</th><th>Time (mins)</th></tr><tr><td>(20,30)</td><td>320</td></tr><tr><td>(25, 20)</td><td>330</td></tr><tr><td>(40, 8)</td><td>432</td></tr><tr><td>(60,12)</td><td>648</td></tr><tr><td>(60,30)</td><td>720</td></tr></table>	M1 A1 A1
	So produce 20 celebration arrangements, 30 party arrangements taking 320 (minutes)	A1 **(4)**
		Total 13 marks
	Notes a1B1: Ratio of coefficients correct (i.e. **equation** of line correct) a2B1: Inequality correct way round ($ay \geq bx$ o.e.) do not accept a strict inequality b1B1: One equation correct b2B1: One constraint correct, including inequality (but accept strict inequality here) b3B1: Both constraints correct, including correct inequalities c1B1: One line drawn correctly. Must pass within one small square of (25, 20) and if line extended must go from axis to axis through the points of intersection with the axes within one small square. Line must be long enough to form the feasible region. Check using length measurement tool if required. Ignore shading. c2B1: Both lines drawn correctly. See above for accuracy. Ignore shading. d1B1: R labelled (not just implied by shading) – must have scored **both** marks in (c). e1B1: CAO (isw if $(T =)10x + 4y$ 'simplified' to $k(10x + 4y)$ but if $(T =)10x + 4y$ not stated then B0)	

Question Number	Scheme	Marks
	f1M1: At least three of **their** (**or** the correct) R vertices found (by either reading off their graph or using simultaneous equations) **and** tested using **their** T (or the correct T). Objective line method (only) is **M0**. f1A1: Three vertices found and tested correctly CAO (must be using three of the **correct** vertices (see table above) and the values for T must be correct). f2A1: All five vertices found and tested correctly CAO (**all** values of T must be correct). f3A1: CAO number of each **and** time, both correct and it must be clear that $x = 20$ and $y = 30$ (accept as coordinates). If values appear in e.g. a table it must be clear that (20, 30) and 320 has been selected (condone lack of/incorrect units on the time).	

Question Number	Scheme	Marks
7 (a)	Activity K depends on activities E, F and B, but activity I depends on F and B only.	B2, 1, 0 **(2)**
(b)		M1 A1 M1 A1 **(4)**
(c)	Critical activities are: A, F, I, L	B1 **(1)**
(d)	Total float on G = 15 – 6 – 6 = 3	M1 A1 **(2)**

Question Number	Scheme	Marks
(e)		M1 A1 A1 A1 **(4)**
(f)	Activities A, C and D must be happening at time 5.5	B1 **(1)**
(g)	E.g. Activities F, B, C and G together with 9< time<10 stated So 4 workers are needed	M1 A1 **(2)**
		Total 16 marks
	Notes a1B1: K, I, E and at least one of B or F referred to. Correct statement but may be incomplete give bod here. a2B1: Clear correct statement no bod (at least one of only B or F referred to can score this mark). b1M1: All top boxes complete, values generally increasing left to right, condone one 'rogue' (if values do not increase from left to right then if one value is ignored and then the values do increase from left to right then this is considered to be only one rogue value). b2A1: CAO b2M1: All bottom boxes complete, values generally decreasing right to left, condone one rogue. Condone missing 0 **or** 21 for the M only. b2A1: CAO c1B1: CAO d1M1: Correct calculation seen, all three numbers correct (ft), float ≥ 0 d1A1: CAO (no ft on this mark) e1M1: At least 9 activities including at least 5 floats. Scheduling diagram scores M0.	

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