

Version



**General Certificate of Education (A-level)
June 2012**

Mathematics

MD01

(Specification 6360)

Decision 1

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

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Key to mark scheme abbreviations

| | |
|--------------|--|
| M | mark is for method |
| m or dM | mark is dependent on one or more M marks and is for method |
| A | mark is dependent on M or m marks and is for accuracy |
| B | mark is independent of M or m marks and is for method and accuracy |
| E | mark is for explanation |
| ✓ or ft or F | follow through from previous incorrect result |
| CAO | correct answer only |
| CSO | correct solution only |
| AWFW | anything which falls within |
| AWRT | anything which rounds to |
| ACF | any correct form |
| AG | answer given |
| SC | special case |
| OE | or equivalent |
| A2,1 | 2 or 1 (or 0) accuracy marks |
| -x EE | deduct x marks for each error |
| NMS | no method shown |
| PI | possibly implied |
| SCA | substantially correct approach |
| c | candidate |
| sf | significant figure(s) |
| dp | decimal place(s) |

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

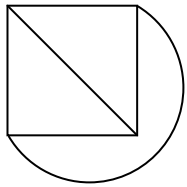
Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

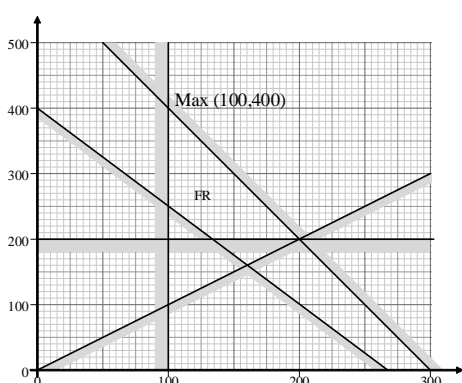
| Q | Solution | Marks | Total | Comments |
|--------------|--|-------|----------|---|
| 1(a) | $\begin{matrix} & 1 & 2 & 3 & 4 & 5 & 6 \\ A & 0 & 0 & 1 & 0 & 0 & 0 \\ B & 1 & 0 & 0 & 1 & 0 & 0 \\ C & 0 & 0 & 1 & 0 & 0 & 1 \\ D & 1 & 1 & 0 & 0 & 0 & 0 \\ E & 0 & 0 & 0 & 1 & 1 & 0 \\ F & 0 & 0 & 0 & 0 & 1 & 1 \end{matrix}$ | M1 | 2 | <p>6×6 matrix labelled with some 0, 1, ✓, ✗'s (at least 9 entries)</p> <p>All correct</p> |
| | <p>(b) $A - 3 + C$ or $2 - D + 1$</p> <p>$A - 3 + C - 6 + F - 5 + E - 4 + B - 1 + D - 2$ or $2 - D + 1 - B + 4 - E + 5 - F + 6 - C + 3 - A$</p> <p>Match A3, B1, C6, D2, E4, F5</p> | M1 | | |
| | | A1 | | |
| | | B1 | 3 | |
| Total | | | 5 | |
| 2(a) | $\left. \begin{matrix} \text{1st} & 1 \\ \text{2nd} & 2 \\ \text{3rd} & 1 \end{matrix} \right\}$ | B2 | 2 | <p>All correct</p> <p>2 correct</p> |
| | $\left. \begin{matrix} \text{1st} & 1 \\ \text{2nd} & 2 \\ \text{3rd} & 0 \end{matrix} \right\}$ | (B1) | | |
| | | | | |
| (b) | | B2 | | All correct |
| | | (B1) | 2 | 2 correct |
| (c) | No, has to check 23 (and 26) | E1 | 1 | No, (at least) one more pass needed etc |
| Total | | | 5 | |

| Q | Solution | Marks | Total | Comments | |
|--------------|--|----------------------|----------|---|--|
| 3(a) | (i) $\begin{matrix} AD & 4 \\ AB & 6 \\ AC & 16 \\ DE & 19 \\ EG & 10 \\ GI & 12 \\ IH & 13 \\ IF & 17 \end{matrix}$ | M1 B1 A1 A1 | 4 | Using Prim's, first 3 edges correct, 6+ edges, no cycles, must have edges not lengths 8 edges <i>GI</i> 6 th All correct | |
| | (ii) 97 | B1 | 1 | | |
| | (iii) | M1 A1 | 2 | ST with 6+ edges All correct including labels | |
| | (b)(i) <i>IF</i> | B1 | 1 | | |
| | (ii) <i>AC</i> | B1 | 1 | | |
| Total | | | 9 | | |
| 4(a) | (i) | M1 A1 m1 A1 | 5 | Dijkstra, 2+ values at <i>C</i> and 1 value at <i>B</i> and <i>D</i> Sight of 10, 9, 8 (only) at <i>C</i> 3 values at <i>E</i> and 2 values at <i>G</i> or <i>I</i> All correct, including crossing out, boxing (condone omission of 0 at <i>A</i>) | |
| | (ii) Route <i>A D C E F H I J</i> | B1 | 1 | 39 at <i>J</i> (final value) or reverse | |
| | (b) (Time = 39 min) (Dist =) $\frac{\text{their } 39}{60} \times 90$ OE = 58.5 km CAO | M1 A1 | 2 | Must see km, or 58500 m SC 58.5 with no working scores M1A0, but 58.5 km with no working scores 2/2 | |
| | Total | | | 8 | |

| Q | Solution | Marks | Total | Comments |
|--------------|--|------------------------|----------|--|
| 5(a) | $BD+FH = \begin{bmatrix} 210+210 \\ 200+180 \\ 260+340 \end{bmatrix} = \begin{bmatrix} 420 \\ 380 \\ 600 \end{bmatrix}$ $(\text{MIN}) = 2430 + 380$ $= 2810$ | M1 A2,1 m1 A1 | 5 | These 3 sets of pairs 3 correct totals, 2 correct totals 2430 + their smallest of three pair totals CSO |
| (b) | $2430 + 340$ (<i>DF</i>) $= 2770$ | B1F | 1 | 2430 + their <i>DF</i> |
| (c)(i) | $2430 + 180$ (<i>DH</i>) $= 2610$ | B1F | 1 | 2430 + their min (must have scored M1) |
| (ii) | <i>B, F</i> only | B1 | 1 | |
| Total | | | 8 | |
| 6(a) |  | E1 | 1 | |
| (b)(i) | 28 | B1 | | |
| (ii) | Odd number of edges at (all) vertices | E1 | 2 | Must see the word odd, not just 7 |
| (c)(i) | $\frac{n(n-1)}{2}$ OE | B1 | | |
| (ii) | $n - 1$ | B1 | | |
| (iii) | n must be odd | E1 | | Must have n in their answer |
| (iv) | $n = 3$ | B1 | 4 | Must have n in their answer |
| Total | | | 7 | |

| Q | Solution | Marks | Total | Comments |
|------|--|----------------------------------|-----------|--|
| 7(a) | $\begin{pmatrix} A & C & F & D & E & B & A \\ 10 & 31 & 32 & 11 & 18 & 16 & \end{pmatrix}$ $= 118$ | B1 | 1 | |
| (b) | $\begin{matrix} A & C & D & E & B & F & A \\ [10 & 14 & 11 & 18 & 50 & 40] \end{matrix}$ $= 143$ | M1 m1 A1 B1 | 4 | Tour from A visiting at least 4 vertices Visits all vertices Correct order from A |
| (c) | $= 100$ | M1 A1 A1 B1 | 4 | Spanning tree + 2 different edges from A (ST must be edges using B, C, D, E, F not lengths, but condone two lengths from A, or 26) Diagram is not necessary in part (c) Correct minimum spanning tree Correct edges (not lengths) from A |
| (d) | <p>Lower bound does not make a cycle OE } AND tour > 100 }</p> | B1 E1 | 2 | Correctly labelled diagram Both, must be strict inequality |
| | Total | | 11 | |

| Q | Solution | Marks | Total | Comments | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------|---|----------------|----------|--|---|---|---|---|--|--|--|--|---|--|--|---|---|---|--|---|--|--|--|--|-----|---|--|---|--|--|--|--|------|---|--|----|--|--|--|--|------|----------|--|--|
| 8(a) | <table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>C</th> <th>D</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>1</td> <td>1</td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td>1</td> </tr> <tr> <td></td> <td></td> <td>1</td> <td>2</td> </tr> <tr> <td>2</td> <td></td> <td>2</td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td>2.5</td> </tr> <tr> <td>3</td> <td></td> <td>6</td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td>2.67</td> </tr> <tr> <td>4</td> <td></td> <td>24</td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td>2.71</td> </tr> </tbody> </table> | A | B | C | D | 1 | 1 | 1 | | | | | 1 | | | 1 | 2 | 2 | | 2 | | | | | 2.5 | 3 | | 6 | | | | | 2.67 | 4 | | 24 | | | | | 2.71 | M1 A1 | | At least 3 evaluated values for D 3 rd value of D as 2.5 |
| | A | B | C | D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 2.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 2.67 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | 24 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 2.71 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | An estimate of e is 2.71 AWRT | B1 m1 A1 | | Values of (1), 1, 2, 6, 24 (only) seen for C Exactly 5 evaluated values for D Correct 5 values for D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (b) | Never-ending (loop) (A,) B (, C) always reset to 1 OE | A1 CSO | 6 | All correct values seen (1 for A , 4 for B , 5 for C and D) <u>and</u> correct final statement | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | B2,1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Total | | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Q | Solution | Marks | Total | Comments |
|--------|--|----------------------------|-----------|---|
| 9(a) | $\left. \begin{array}{l} x \geq 100, y \geq 200 \\ x + y + z \geq 400 \end{array} \right\} \text{OE}$ $4x + 3y + 4z \leq 1800 \text{ OE}$ $y \geq \frac{40}{100} (x + y + z) \text{ OE}$ | B1 B1 B1 | 3 | |
| (b)(i) | $(x = 2z)$ $\left. \begin{array}{l} x + y + \frac{1}{2}x \geq 400 \\ \Rightarrow 3x + 2y \geq 800 \end{array} \right\}$ $\left. \begin{array}{l} 4x + 3y + 2x \leq 1800 \\ 6x + 3y \leq 1800 \\ 2x + y \leq 600 \end{array} \right\}$ $\left. \begin{array}{l} 5y \geq 2x + 2y + x \\ 3y \geq 3x \\ y \geq x \end{array} \right\}$ | M1 A1 A1 | 3 | <p>Correct substitution and fully simplifying 1 inequality (must see evidence: either replacing z or multiplying inequality)</p> <p>As above 'in 2nd inequality'</p> <p>As above 'in 3rd inequality'</p> |
| (ii) |  | B1 B1 B1 B1 B1 | 5 | <p>Each line must be straight to have the B mark available. For all lines, must be correct to half square horizontal and vertical at the indicated vertices.</p> <p>$x = 100, y = 200$</p> <p>$y = x$ line through (100, 100) and (200, 200)</p> <p>$2x + y = 600$ line through (100, 400) and (200, 200)</p> <p>$3x + 2y = 800$ line through (100, 250) and (200, 100)</p> <p>Feasible Region, all lines correct and region labelled (condone no shading, ignore 'poor' shading)</p> |
| (iii) | $\text{(Max) } y + \frac{3}{2}x$ $= 400 + 150 = 550$ | M1 A1 | 2 | PI by objective line with gradient -1.5 |
| (iv) | <p>Buys 100 soft 400 medium 50 firm</p> | B1 | 1 | |
| | Total | | 14 | |
| | TOTAL | | 75 | |