<table>
<tr><th>Question Number</th><th>Scheme</th><th>Marks</th></tr>
<tr><td>4. (a)</td><td>
<table>
<tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td></tr>
<tr><td>A</td><td>-</td><td>21</td><td>42</td><td>17</td><td>25</td><td>31</td><td>41</td></tr>
<tr><td>B</td><td>21</td><td>-</td><td>26</td><td>27</td><td>12</td><td>15</td><td>20</td></tr>
<tr><td>C</td><td>42</td><td>26</td><td>-</td><td>32</td><td>17</td><td>11</td><td>46</td></tr>
<tr><td>D</td><td>17</td><td>27</td><td>32</td><td>-</td><td>15</td><td>21</td><td>47</td></tr>
<tr><td>E</td><td>25</td><td>12</td><td>17</td><td>15</td><td>-</td><td>6</td><td>32</td></tr>
<tr><td>F</td><td>31</td><td>15</td><td>11</td><td>21</td><td>6</td><td>-</td><td>35</td></tr>
<tr><td>G</td><td>41</td><td>20</td><td>46</td><td>47</td><td>32</td><td>35</td><td>-</td></tr>
</table>
</td><td>B2, 1, 0 (2)</td></tr>
<tr><td>(b)</td><td>NNA starting at A: A – D – E – F – C – B – G – A
17 + 15 + 6 + 11 + 26 + 20 + 41 = 136 (km)</td><td>M1
A1 (2)</td></tr>
<tr><td>(c)</td><td>A – D – E – F – C – F – B – G – B – A</td><td>B1 (1)</td></tr>
<tr><td>(d)</td><td>RMST weight = 12 + 6 + 11 + 15 + 20 = 64</td><td>B1</td></tr>
<tr><td></td><td>64 + 17 (AD) + 21 (AB) = 102 (km)</td><td>M1 A1 (3)</td></tr>
<tr><td>(e)</td><td>AC + EG = 42 + 32 = 74</td><td>M1</td></tr>
<tr><td></td><td>AE + CG = 25 + 46 = 71</td><td>A1</td></tr>
<tr><td></td><td>AG + CE = 41 + 17 = 58*</td><td>A1</td></tr>
<tr><td></td><td>Repeat arcs: AB, BG, CF, EF</td><td>A1</td></tr>
<tr><td></td><td>Length: 291 + 58 = 349 (km)</td><td>A1ft (5)</td></tr>
<tr><td></td><td></td><td>13 marks</td></tr>
</table>

Notes for Question 4

Condone lack of, or incorrect units throughout this question

a1B1: At least two of the six values correct (in either table) – these are the bold values. The two values can be the same (for example, 42 in both cells AC and CA would score this mark)

a2B1: Fully correct (the six bold values in both tables)

b1M1: Nearest neighbour route starting at A – must have at least A – D – E – F – C – B – …
Allow if stated in terms of arcs (AD, DE, EF, FC, CB,…) rather than nodes (note that arcs AD and DA are equivalent and so therefore AD, ED, EF, FC, CB,… is acceptable)

b1A1: CAO on length (136) **and** route (must return to A and can be stated in terms of arcs rather than nodes)

c1B1: CAO (ADEFCFBGBA or in terms of arcs, e.g., AD, DE, EF, FC, CF, FB, BG, GB, BA)

d1B1: CAO on the weight of the RMST (using arcs BE, EF, CF, DE, BG) – accept either 64 **or** 12 + 6 + 11 + 15 + 20 – could be seen or implied by later working as part of the lower bound calculation

d1M1: Adding correct two least weighted arcs from A (17(AD) + 21(AB)) to their RMST length where their RMST length x is $58 \leq x \leq 70$

d1A1: CAO (102). If this answer is stated with no working then award B0M1A1

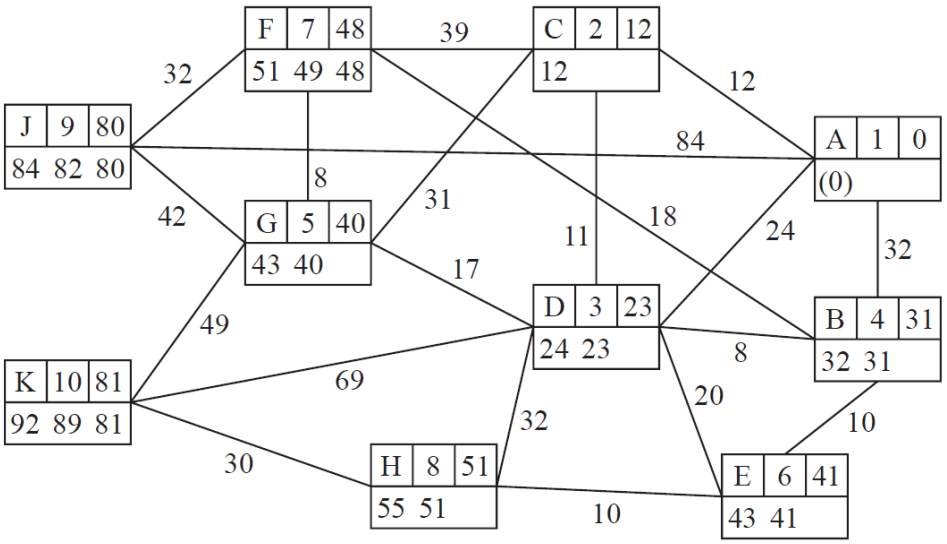
e1M1: Correct three distinct pairings of the correct four odd nodes (A, C, E and G)

e1A1: Any two rows correct including pairings **and** totals

e2A1: All three rows correct including pairings **and** totals

e3A1: CAO correct edges clearly stated and not just in their working as AB, BG, CF and EF – must be these arcs. Do not accept AG, ABG or AG via B (and similarly for CE)

e4A1ft: Follow through their value of their smallest pairing total + 291

Question Number	Scheme	Marks
5.(a)	Start at A e.g. we would be able to find the shortest distance from A to every other vertex e.g. A appears in both required routes	B1 B1dep **(2)**
(b)	 Shortest path to J: A C D G F J Length: 80 (miles) Shortest path to K: A C D B E H K Length: 81 (miles)	M1 A1 (ACDBG) A1 (EFH) A1ft (JK) A1 A1 A1ft **(7)**
(c)	Route from F to H via A: F G D C A C D B E H	B1 **(1)**
		10 marks
Notes for Question 5		