Question Number	Scheme	Marks
3. (a)	$\frac{132}{42} = 3.14...$ so lower bound is 4	M1 A1 **(2)**
(b)	Group 1: **8** **17** **9** 7 Group 2: **14** **18** 10 Group 3: **12** 22 Group 4: 15	M1 A1 **(2)**
(c)	e.g. middle right 8 17 9 14 18 12 22 10 15 7 17 14 18 22 15 **12** 8 9 10 7 22 **18** 17 14 15 **12** **10** 8 9 7 22 **18** 17 15 **14** **12** **10** **9** 8 7 22 **18** 17 **15** **14** **12** **10** **9** 8 **7** e.g. middle left 8 17 9 14 18 12 22 10 15 7 22 **18** 8 17 9 14 12 10 15 7 22 **18** 17 15 **14** 8 9 12 10 7 22 **18** **17** 15 **14** **12** 8 9 10 7 22 **18** **17** 15 **14** **12** 10 **9** 8 7 22 **18** **17** 15 **14** **12** 10 **9** **8** 7	M1 A1 A1ft A1 **(4)**
(d)	Group 1: **22** **18** Group 2: **17** **15** 10 Group 3: **14** **12** 9 7 Group 4: 8	M1 A1 **(2)**
(e)	B(E)C + G(I)H = (11.2 + 14.5) + (8.3 + 17.2) = 51.2* B(F)G + C(EJ)H = (10.3 + 15.2) + (14.5 + 7. 5 + 16.2) = 63.7 B(EJ)H + C(EF)G = (11.2 + 7.5 + 16.2) + (14.5 + 4. 3 + 15.2) = 68.9 Repeat arcs: BE, CE, GI, HI	M1 A1 A1 A1 **(4)**
(f)	Route e.g. ABEBFECEJIFGIGHIHJDCA Length = 227. 2 + 51.2 = 278.4 (m)	B1 B1ft **(2)**
(g)	Finishing vertex: C Reduction in lengths: 51.2 – (10.3 + 15.2) = 25.7 (m)	B1 B1 **(2)**
		18 marks

Notes for Question 3

PLEASE NOTE NO MISREADS IN THIS QUESTION – MARK ACCORDING TO THE SCHEME AND THE SPECIAL CASE FOR ASCENDING IN PART (c)

a1M1: Attempt to find the lower bound $(132 \pm 22)/42$ (a value of 3.14 (or better) seen with no working can imply this mark)
a1A1: CSO - correct calculation seen **or** 3.14 followed by 4 – accept 3.1 if correct calculation seen. An answer of 4 with no working scores M0A0

b1M1: First six items placed correctly and at least eight items placed in bins – condone cumulative totals for M1 only (the values in bold)
b1A1: CSO (so no additional/repeated values)

c1M1: Quick sort, pivot, p, chosen (must be choosing middle left or right – choosing first/last item as the pivot is M0). After the first pass the list must read (values greater than the pivot), pivot, (values less that the pivot). **If only choosing one pivot per iteration then M1 only**

c1A1: First pass correct **and** next pivots chosen correctly for the second pass (but the second pass does not need to be correct) – so they must be choosing (if middle right) a pivot values of 18 and 10 for the second pass or (if middle left) a pivot value of 14

Question Number	Scheme	Marks

c2A1ft: Second and third passes correct (follow through from their first pass and choice of pivots). They do not need to be choosing a pivot for the fourth pass for this mark
c3A1: CSO (correct solution only – all previous marks in this part **must** have been awarded) including if middle right a fourth pass with the 15 and 7 **used** as pivots **or** if middle left a fifth pass with the 8 used as a pivot

Sorting list into ascending order in (c)

- If the candidate sorts the list into ascending order and reverses the list in this part then this can score full marks in **(c)**
- If the list is not reversed in **(c)** but stated in ascending or descending order in **(d)** then remove the last two A marks earned in **(c)**. If the candidate says that the list needs reversing in **(c)** but does not actually show the reversed list in **(c)** then remove the last A mark earned
- **Note that if sorting into ascending order then a 'sort complete' statement is required – this could be shown by the final list being re-written or 'sorted' statement or each item being used as a pivot (which would therefore mean that the final list would have been written twice) BEFORE list is reversed**

Middle right ascending
(requires sort complete statement– see above)

8 17 9 14 18 12 22 10 15 7
8 9 10 7 **12** 17 14 18 22 15
8 9 7 **10** **12** 17 14 15 **18** 22
8 7 **9** **10** **12** **14** 17 15 **18** 22
7 8 **9** **10** **12** **14** **15** 17 **18** 22

Middle left ascending
(requires sort complete statement – see above)

8 17 9 14 18 12 22 10 15 7
8 17 9 14 12 10 15 7 **18** 22
8 9 12 10 7 **14** 17 15 **18** 22
8 9 10 7 **12** **14** 15 **17** **18** 22
8 7 **9** 10 **12** **14** 15 **17** **18** 22
7 **8** **9** 10 **12** **14** 15 **17** **18** 22

d1M1: First six items placed correctly and at least eight items placed in bins – condone cumulative totals for M1 only (the values in bold)
d1A1: CSO (so no additional/repeated values)

e1M1: Correct three pairings of the correct four odd nodes (B, C, G and H)
e1A1: Any one row correct including pairings **and** totals
e2A1: All three rows correct including pairings **and** totals
e3A1: CAO correct arcs clearly stated: BE, CE, GI and HI – must be these arcs and not e.g. BEC, GIH, or BC via E, etc.

f1B1: Any correct route (checks: 21 vertices, starting and ending at A, BE, CE, GI and HI appearing twice, A(2), B(2), C(2), D(1), E(3), F(2), G(2), H(2), I(3), J(2))
f2B1ft: For 227.2 + their smallest repeat out of a choice of at least **two** totals seen in **(e)** – this mark is dependent on M1 in (e)

g1B1: CAO (C)
g2B1: CAO (25.7) – note that the correct answer can come from incorrect working e.g. 11.2 + 14.5 = 25.7 is B0 (just adding BE and EC together) so this answer need to be checked carefully – correct method is 51.2 – (10.3 + 15.2) (subtracting BF and FG from 51.2) but give bod on a correct answer of 25.7 with no working