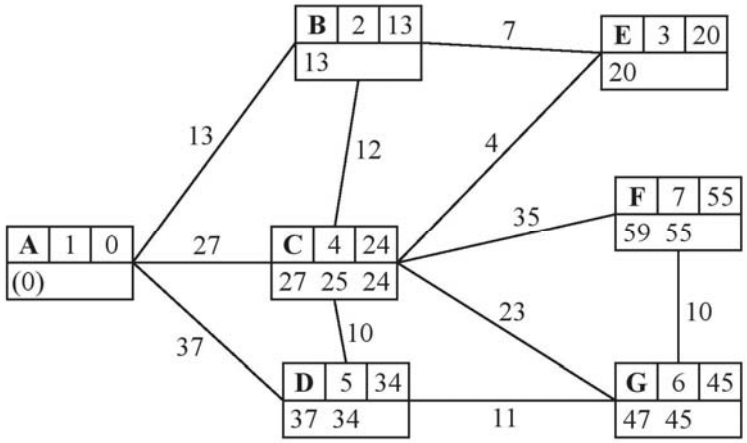
## Paper 2 Option K

### Decision Mathematics 1 Mark Scheme (Section A)

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| 1(a) |  | M1<br>A1<br>A1 | 1.1b<br>1.1b<br>1.1b |
| | Path: ABECDGF | A1 | 1.1b |
| | Length: 55 (metres) | A1ft | 1.1b |
| | | **(5)** | |
| (b) | AB + DG = 13 + 11 = 24 ← | M1 | 1.1b |
| | A(BEC)D + B(ECD)G = 34 + 32 = 66 | A1 | 1.1b |
| | A(BECD)G + B(EC)D = 45 + 21 = 66 | A1 | 1.1b |
| | Repeat arcs: AB, DG | A1ft | 2.2a |
| | | **(4)** | |
| (c) | Length = 189 + 24 = 213 (metres) | B1ft | 1.1b |
| | | **(1)** | |
| (d) | $189 + x + 34 = 213 + 2x$ | M1 | 3.1b |
| | $x = 10$ so BG is 10 m | A1 | 1.1b |
| | | **(2)** | |
| | | | **(12 marks)** |

**Notes:**

**(a)**
**M1:** For a larger number replaced by a smaller one in the working values boxes at C, D, F or G
**A1:** For all values correct (and in correct order) at A, B, C and D
**A1:** For all values correct (and in correct order) at E, F & G
**A1:** For the correct path
**A1ft:** For 55 or ft their final value at F

**(b)**
**M1:** For 3 correct pairings of the four odd nodes (A,B, D & G)
**A1:** At least two pairings and totals correct
**A2:** All three pairings and totals correct
**A3ft:** Selecting their shortest pairing, and stating that these arcs should be repeated

| **Question 1 notes continued:** |
| --- |
| **(c)**<br>**B1ft:** For 213 or 189 + their shortest repeat<br>**M1:** For translating the information in the question in to an equation involving $x$, $2x$ and 34<br>**A1:** For a correct equation leading to BG = 10 (m) |

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| **2** | Objective line drawn or at least two vertices tested | M1 | 3.1a |
| | For solving y = 4$x$ and 8$x$ + 7$y$ = 560 to find the exact co-ordinate of the optimal point, must reach either $x$ = or $y$ = | M1 | 1.1a |
| | $x = 15\frac{5}{9}$ and $y = 62\frac{2}{9}$ | A1 | 1.1b |
| | Finding at least two points with integer co-ordinates from (15 ± 1, 63 ± 2) | M1 | 1.1b |
| | Testing at least two points with integer co-ordinates | M1 | 1.1b |
| | $x$ = 15 and $y$ = 63 | A1 | 2.2a |
| | So the teacher should buy 15 pens and 63 pencils | A1ft | 3.2a |
| | | | **(7 marks)** |

**Notes:**

**M1:** Selecting an appropriate mathematical process to solve the problem – either drawing an objective line with the correct gradient (or reciprocal gradient), or testing at least two vertices in C

**M1:** Solving simultaneous equations

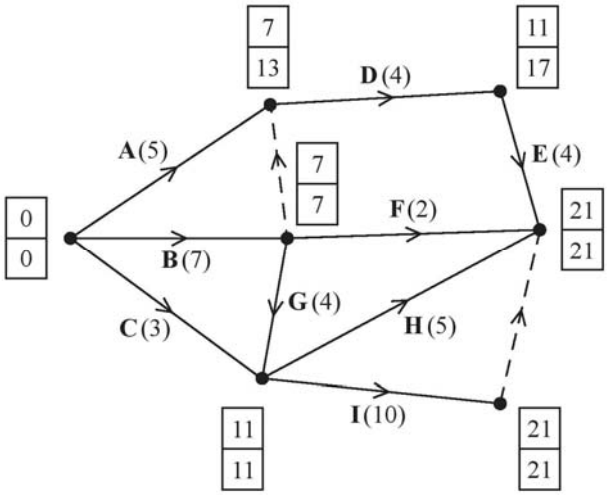
**A1:** cao

**M1:** Recognition that outcome from this model is non-integer and integer solutions are required – testing two points with integer co-ordinates in at least one of $y \geq 4x$ and $8x + 7y \geq 560$

**M1:** Testing at least two integer solutions in $y \geq 4x$ or $8x + 7y \geq 560$ and C

**A1:** cao – deducing from tests which integer solution is both valid and optimal

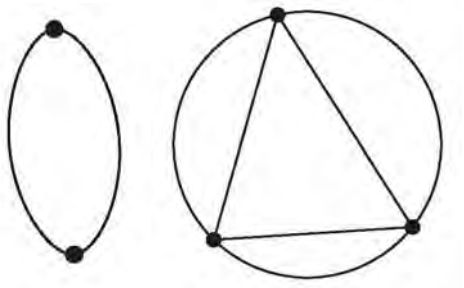
**A1ft:** Interpreting solution in the context of the question – gives their integer values for x and y in the context of pens and pencils

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| **3(a)(b)** |  | M1<br>A1<br>A1 | 1.1b<br>1.1b<br>1.1b |
| | | **(3)** | |
| | | M1<br>A1 | 2.1<br>1.1b |
| | The number(s) at the end of activity E indicate this project can be completed in 21 days | A1ft | 2.2a |
| | Critical activities: B, G, I | A1 | 1.1b |
| | | **(4)** | |
| | | | **(7 marks)** |

**Notes:**

**M1:** At least 5 activities and one dummy, one start
**A1:** A,B,C,D,F,G and first dummy correct
**A1:** E,H,I correct, second dummy correct and one finish

**M1:** All boxes completed, number generally increasing L to R (condone one "rogue")
**A1:** All values cao
**A1:** Deduction that result in diagram indicates that project can be completed in 21 days (all boxes completed, numbers generally increasing in the direction of the arrows for the top boxes and generally decreasing in the opposite direction of the arrow for the bottom boxes)
**A1:** Critical activities correct

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| **4(a)** | e.g. a graph cannot contain an odd number of odd nodes<br>e.g. number of arcs $= \frac{1+3+4+4+5}{2} = 8.5 \notin \mathbb{Z}$ | B1 | 2.4 |
| | | **(1)** | |
| **(b)(i)** | $\left(2^{2x}-1\right)+\left(2^{x}\right)+\left(x+1\right)+\left(2^{x+1}-3\right)+\left(11-x\right)=2\left(18\right)$ | M1 | 1.1b |
| | $2^{2x}+3\left(2^{x}\right)-28=0 \Rightarrow x=...$ | M1 | 1.1b |
| | $\left(2^{x}+7\right)\left(2^{x}-4\right)=0 \Rightarrow x=2$ | A1 | 1.1b |
| | | **(3)** | |
| **(b)(ii)** | The order of the nodes are 9, 15, 3, 4, 5 | M1 | 2.1 |
| | Therefore the graph is neither Eulerian nor semi-Eulerian as there are more than two odd nodes | A1 | 2.4 |
| | | A1 | 2.2a |
| | | **(3)** | |
| **(c)** |  | M1<br>A1 | 2.5<br>2.2a |
| | | **(2)** | |
| | | | **(9 marks)** |

**Notes:**

**(a)**
**B1:** Explanation referring to need for an even number of odd nodes oe

**(b)**
**M1:** Forming an equation involving the orders of the 5 odd nodes and 2(18)
**M1:** Simplifies to a quadratic in $2^x$ and attempts to solve
**A1:** 2 cao
**M1:** Construct an argument involving the order of the 5 nodes
**A1:** Explanation considering the number of odd nodes
**A1:** Deduction that therefore it is neither Eulerian nor semi-Eulerian

**(c)**
**M1:** Interprets mathematical language to construct a disconnected graph
**A1:** Deduce a correct graph

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| **5** | Minimise $(C=)\ 25x+35y$ | B1 | 3.3 |
| | Subject to:<br>$(500x+800y \geqslant 150\ 000 \Rightarrow)\ 5x+8y \geqslant 1500$ | B1 | 3.3 |
| | $\frac{7}{20}(x+y) \leqslant x \leqslant \frac{13}{20}(x+y)$ | M1<br>M1 | 3.3<br>3.3 |
| | Which simplifies to $7y \leqslant 13x$ **and** $13y \geqslant 7x$<br>$x, y \geqslant 0$ | A1 | 1.1b |
| | | | **(5 marks)** |

**Notes:**

**B1:** A correct objective function + minimise
**B1:** Translate information in to a correct inequality
**M1:** For translating the information given into the LHS inequality
**M1:** For translating the information given in to the RHS inequality
**A1:** Simplifying to the correct inequalities