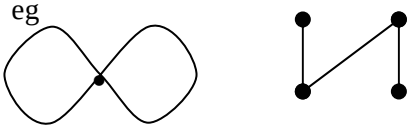
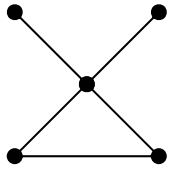
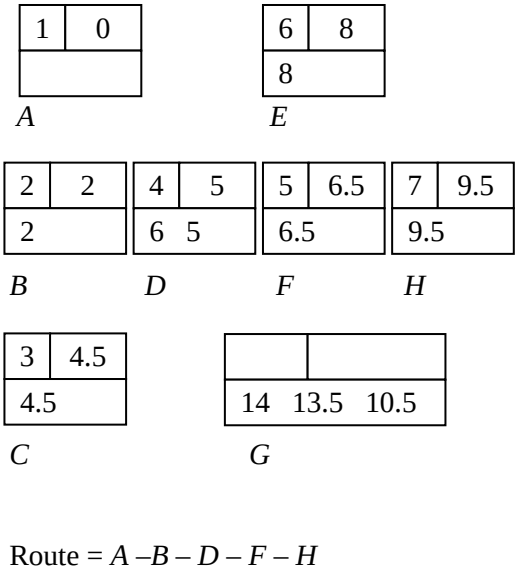
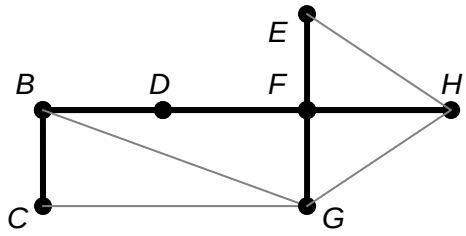
4736 Decision Mathematics 1

1 (i)	[43 172 536 17 314 462 220 231] 43 172 536 17 220 314 462 231	 M1 M1 A1	 First folder correct Second folder correct All correct (cao)	 [3]
(ii)	536 462 314 231 220 172 43 17 536 462 314 231 220 172 43 17	B1 M1 A1	List sorted into decreasing order seen (cao) [Follow through from a decreasing list with no more than 1 error or omission] First folder correct All correct	 [3]
(iii)	$(5000 \div 500)^2 \times 1.3$ = 130 seconds	M1 A1	$10^2 \times 1.3$ or any equivalent calculation Correct answer, with units	 [2]
				Total = 8

2 (i)	The sum of the orders must be even, (but 1+2+3+3 = 9 which is odd).	B1	There must be an even number of odd nodes.	[1]
(ii) a	eg 	M1 A1	A graph with five vertices that is neither connected nor simple Vertex orders 1, 1, 2, 2, 4	 [2]
b	Because it is not connected	B1	You cannot get from one part of the graph to the other part.	[1]
c	eg 	B1	A connected graph with vertex orders 1, 1, 2, 2, 4 (Need not be simple)	 [1]
(iii) a	There are five arcs joined to *A*. Either Ann has met (at least) three of the others or she has met two or fewer, in which case there are at least three that she has not met. In the first case at least three of the arcs joined to *A* are blue, in the second case at least three of the arcs joined to *A* are red.	M1 A1	A reasonable attempt (for example, identifying that there are five arcs joined to *A*) A convincing explanation (this could be a list of the possibilities or a well reasoned explanation)	 [2]
b	If any two of Bob, Caz and Del have met one another then *B*, *C* and *D* form a blue triangle with *A*. Otherwise *B*, *C* and *D* form a red triangle.	M1 A1	A reasonable or partial attempt (using *A* with *B*, *C*, *D*) A convincing explanation (explaining both cases fully)	 [2]
				Total = 9

3 **(i)**	$y \geq x$ $x + y \leq 8$ $x \geq 1$	M1 M1 M1 A1	Line $y = x$ in any form Line $x + y = 8$ in any form Line $x = 1$ in any form All inequalities correct [Ignore extra inequalities that do not affect the feasible region]	[4]
(ii)	(1, 1), (1, 7), (4, 4)	M1 A1	Any two correct coordinates All three correct [Extra coordinates given $\Rightarrow$ M1, A0]	[2]
(iii)	(1, 7) 23 (4, 4) 20 At optimum, $x = 1$ and $y = 7$ Maximum value = 23	M1 A1 A1	Follow through if possible Testing vertices or using a line of constant profit (may be implied) Accept (1, 7) identified 23 identified	[3]
(iv)	$2\times1 + k\times7 \geq 2\times4 + k\times4$ $k \geq 2$	M1 A1	$2 + 7k$ or implied, or using line of gradient $-\frac{2}{k}$ Greater than or equal to 2 (cao) [$k > 2 \Rightarrow$ M1, A0]	[2]
				Total = 11

4 **(i)**	 Route = *A* –*B* – *D* – *F* – *H* Length = 9.5 miles	M1 M1 A1 B1 B1 B1 B1	Both 6 and 5 shown at *D* [5 may appear as perm label only] 14, 13.5 and 10.5 shown at *G* No extra temporary labels All temporary labels correct [condone perm values only appearing as perm labels] [Dep on both M marks] All permanent labels correct [may omit *G*, but if given it must be correct] Order of labelling correct [may omit *G* but if given it must be correct] cao cao	[7]
(ii)	Route Inspection problem	B1	Accept Chinese Postman	[1]
(iii)	Odd nodes: *A*, *D*, *E* and *H* *AD* = 5 *AE* = 8 *AH* = 9.5 *EH* = 5 *DH* = 4.5 *DE* = 3.5 10 12.5 13.0 Repeat *AD* (*A*-*B*-*D*) and *EH* (*E*-*F*-*H*) Length = 67.5 +10 = 77.5 miles	B1 M1 A1 M1 A1	Identifying or using *A*,*D*,*E*,*H* Attempting at least one pairing At least one correct pairing or correct total Adding their 10 to 67.5 77.5 (cao)	[5]
(iv)	Repeat arcs *EF* and *FD* 3.5 + 67.5 = 71 miles	B1 B1	cao [NOT *DE* or *D*-*F*-*E*] cao	[2]
(v)	*A* – *B* – *C* – *G* –*F* – *D* then method stalls *E* and *H* are missed out	B1	Showing route as far as *D* and then explaining the problem	[1]
(vi)	*C* – *B* – *A* – *D* – *F* – *E* – *H* – *G* – *C* 37.5 miles	M1 A1 B1	[If final *C* is missing ⇒ M1, A0] [A diagram needs arrows for A1] 37.5 (cao)	[3]
(vii)	 Nodes: *B C D F E H G* Weight = 16 miles [Two shortest arcs from *A* are *AB* and *AD*] 2 + 6 + 16 Lower bound = 24 miles	M1 A1 B1 B1 M1 A1	A spanning tree on reduced network (may show *AB*, *AD*) Correct minimum spanning tree marked, with no extra arcs cao cao 8 + their 16 (or implied) cao	[6]
				Total = 25

5 (i)

$15x+15y+30z \leq 9000$

[divide through by 15 to get $x+y+2z \leq 600$ as given]

Stamping out: $5x+8y+10z \leq 3600$

Fixing pin: $50x+50y+50z \leq 25000$

$x + y + z \leq 500$

Checking: $100x+50y+20z \leq 10000$

$10x+5y+2z \leq 1000$

B1 $15x+15y+30z \leq 9000$

B1 $5x+8y+10z \leq 3600$

B1 $x + y + z \leq 500$

B1 $10x+5y+2z \leq 1000$ **[4]**

(ii) x, y and z are non-negative

B1 $x \geq 0$, $y \geq 0$ and $z \geq 0$ **[1]**

(iii) (P =) $4x + 3y + z$

B1 cao [1]

(iv)

P	x	y	z	s	t	u	v	RHS
1	-4	-3	-1	0	0	0	0	0
0	1	1	2	1	0	0	0	600
0	5	8	10	0	1	0	0	3600
0	1	1	1	0	0	1	0	500
0	10	5	2	0	0	0	1	1000

B1 -4 -3 -1 in objective row
B1 Correct use of slack variables
M1 1 1 2 and 600 correct
A1 All constraint rows correct
Accept variations in order of rows and columns [4]

(v)

Pivot on the 10 in the x-column

1	0	-1	-0.2	0	0	0	0.4	400
0	0	0.5	1.8	1	0	0	-0.1	500
0	0	5.5	9	0	1	0	-0.5	3100
0	0	0.5	0.8	0	0	1	-0.1	400
0	1	0.5	0.2	0	0	0	0.1	100

B1 Correct choice of pivot from x- column
[Follow through their tableau and valid pivot if possible: no negative values in RHS column and P value has not decreased]
M1 Pivot row correct
A1 Other rows correct [3]

Pivot on 0.5 in the last row of y-column

1	2	0	0.2	0	0	0	0.6	600
0	-1	0	1.6	1	0	0	-0.2	400
0	-11	0	6.8	0	1	0	-1.6	2000
0	-1	0	0.6	0	0	1	-0.2	300
0	2	1	0.4	0	0	0	0.2	200

B1 Correct choice of pivot from y-column
[Follow through their tableau and valid pivot if possible]
M1 Pivot row correct
A1 Other rows correct [3]

$x = 0$, $y = 200$, $z = 0$, $P = 600$
Make 20 000 metallic badges (and no laminated badges or plastic badges)

B1 Interpretation of their x, y and z values in context (may imply zero entries)

To give a profit of £600

B1 Interpretation of their P value in context

6000 seconds (100 min) of printing time not used, 2000 seconds (33 min 20 sec) of stamping out time not used, 15000 seconds (250 min) of fixing pin time not used.
All the checking time is used

B1 Interpretation of their slack variable values [3]

Total = 19