

**Mark Scheme 4772
June 2007**

1.

(a)(i) He should salute it.
 Since all objects which don't move are painted any unpainted object must move, and anything that moves must be saluted.

B1
 M1 A1

(ii) We do not know.
 We do not know about painted objects. Some will have been painted because they do not move, but there may be some objects which move which are painted. We do not know whether this object moves or not.

B1
 M1 A1

(b)

| (m | ⇒ | s) | ∧ | (~ | m | ⇒ | p)) | ∧ | ~ | p | ⇒ | s |
|----|---|----|---|----|---|---|-----|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |

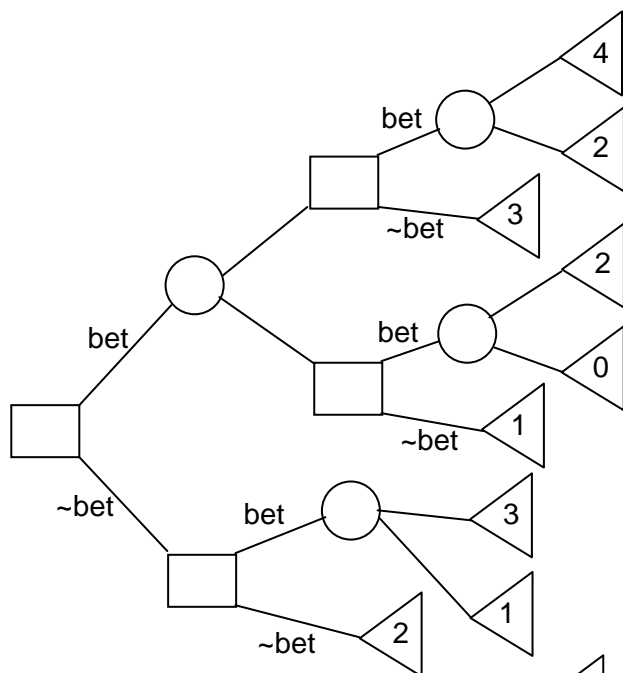
M1 8 rows
 A1 m⇒s
 A1 ~m⇒p
 A1 first ∧
 A1 second ∧
 A1 result

(c) $((m \Rightarrow s) \wedge (\sim m \Rightarrow p)) \wedge \sim p$
 $\Leftrightarrow (\sim p \wedge (\sim m \Rightarrow p)) \wedge (m \Rightarrow s)$
 $\Leftrightarrow (\sim p \wedge (\sim p \Rightarrow m)) \wedge (m \Rightarrow s)$ (contrapositive)
 $\Rightarrow m \wedge (m \Rightarrow s)$ (modus ponens)
 $\Rightarrow s$ (modus ponens)

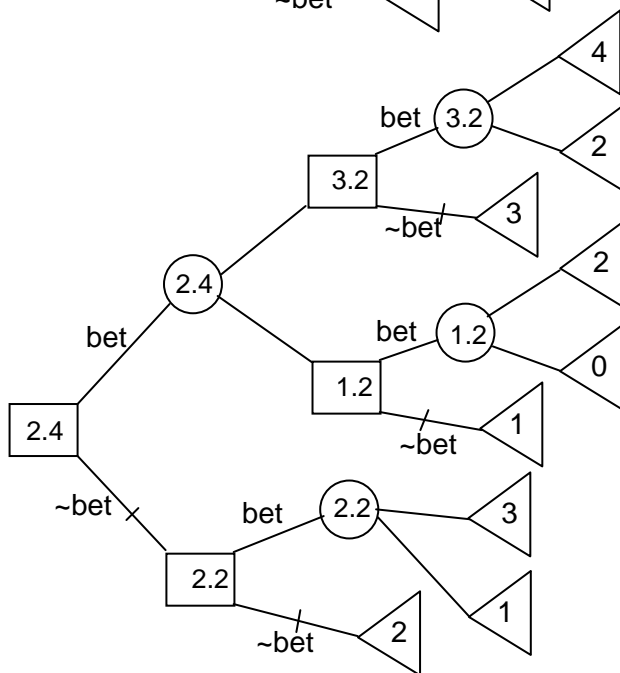
M1
 A1 reordering
 A1 contrapositive
 A1 modus ponens

2.

(i)



(ii)(A)



EMV = 2.4 by betting and betting again

M1
 A1 first D box
 A1 D box on ~bet branch
 A1 P box on bet branch
 A1 D boxes following P box
 A1 remaining P boxes

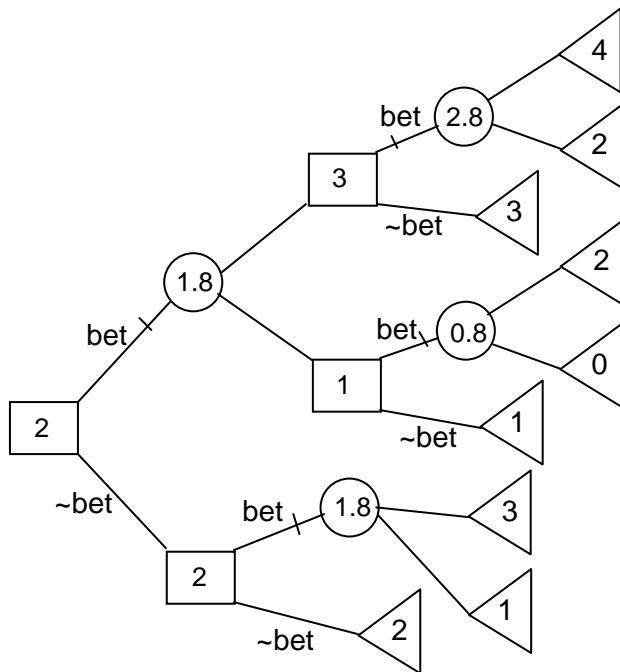
M1 outcomes
 A1

M1
 A1

B1 course of action

2(cont).

(ii)(B)



EMV = 2 by not betting

(iii) $2^{0.5} \times 0.4 = 0.566 < 1$, but $2^{1.5} \times 0.4 = 1.131 > 1$

A1

B1 course of action

M1 A1 A1

3.

(i)

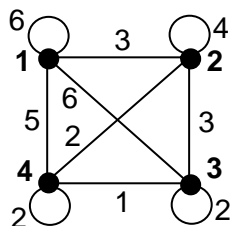
| | | | | |
|----------|----------|----------|----------|----------|
| | 1 | 2 | 3 | 4 |
| 1 | 6 | 3 | 6 | 5 |
| 2 | 3 | 4 | 3 | 2 |
| 3 | 6 | 3 | 2 | 1 |
| 4 | 5 | 2 | 1 | 2 |

| | | | | |
|----------|----------|----------|----------|----------|
| | 1 | 2 | 3 | 4 |
| 1 | 2 | 2 | 2 | 2 |
| 2 | 1 | 4 | 4 | 4 |
| 3 | 4 | 4 | 4 | 4 |
| 4 | 2 | 2 | 3 | 3 |

(ii)

Distance from row 1 col 3 of distance matrix (6)
Route from row 1 col 3 of route matrix (2), then from row 2 col 3 (4), then from row 4 col 3 (3). So 1 2 4 3.

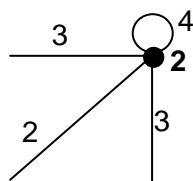
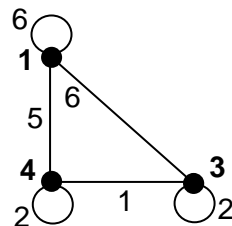
(iii)



(iv)

1 2 4 3 1
length = 12
1 2 4 3 4 2 1

(v)



MST has length 6, so lower bound = 6 + 2 + 3 = 11

(vi)

TSP length is either 11 or 12

M1 distances
A2 6 changes
(-1 each error)
M1 a correct update
A1 1 to 3 route (2)
A2 rest
(-1 each error)

B1 B1
B1
B1

B1 whether or not
loops included

B1
B1
B1

M1
A1 MST
A1 add back

B1 11 to 12
B1 either 11 or 12

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4.

(i)

| P | x | y | s_1 | s_2 | RHS |
|---|----|----|-------|-------|------|
| 1 | -1 | -1 | 0 | 0 | 0 |
| 0 | 2 | 1 | 1 | 0 | 1250 |
| 0 | 2 | -1 | 0 | 1 | 0 |
| | | | | | |
| 1 | 1 | 0 | 1 | 0 | 1250 |
| 0 | 2 | 1 | 1 | 0 | 1250 |
| 0 | 4 | 0 | 1 | 1 | 1250 |

1250 m² of paving and no decking

(ii) 2-phase

| A | P | x | y | s_1 | s_2 | s_3 | a | RHS |
|---|---|---|---|-------|-------|-------|----|------|
| 1 | 0 | 1 | 0 | 0 | 0 | -1 | 0 | 200 |
| 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1250 |
| 0 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 1250 |
| 0 | 0 | 4 | 0 | 1 | 1 | 0 | 0 | 1250 |
| 0 | 0 | 1 | 0 | 0 | 0 | -1 | 1 | 200 |
| | | | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 |
| 0 | 1 | 0 | 0 | 1 | 0 | 1 | -1 | 1050 |
| 0 | 0 | 0 | 1 | 1 | 0 | 2 | -2 | 850 |
| 0 | 0 | 0 | 0 | 1 | 1 | 4 | -4 | 450 |
| 0 | 0 | 1 | 0 | 0 | 0 | -1 | 1 | 200 |

Big-M alternative

| P | x | y | s_1 | s_2 | s_3 | a | RHS |
|---|-------|---|-------|-------|-------|-------|-----------|
| 1 | $1-M$ | 0 | 1 | 0 | M | 0 | $1250-2M$ |
| 0 | 2 | 1 | 1 | 0 | 0 | 0 | 1250 |
| 0 | 4 | 0 | 1 | 1 | 0 | 0 | 1250 |
| 0 | 1 | 0 | 0 | 0 | -1 | 1 | 200 |
| | | | | | | | |
| 1 | 0 | 0 | 1 | 0 | 1 | $M-1$ | 1050 |
| 0 | 0 | 1 | 1 | 0 | 2 | -2 | 850 |
| 0 | 0 | 0 | 1 | 1 | 4 | -4 | 450 |
| 0 | 1 | 0 | 0 | 0 | -1 | 1 | 200 |

850 m² of paving and 200 m² of decking.M1 initial tableau
A1M1 pivot
A2 (-1 each error)

B1 interpretation

M1 A1 new objective

B1 surplus

B1 artificial

B1 new constraint

M1

A2

*M1 A1 new objective**B1 surplus**B1 artificial**B1 new constraint**M1**A2*

A1 interpretation

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| | | | | | | | | |
|---|---|---|----------------|----------------|----------------|----------------|--------|-------------------|
| (iii) | | | | | | | | |
| C | x | y | s ₁ | s ₂ | s ₃ | s ₄ | RHS | |
| 1 | 0 | 0 | 1.25 | 0 | 1.75 | 0 | 1212.5 | B1 new objective |
| 0 | 0 | 1 | 1 | 0 | 2 | 0 | 850 | |
| 0 | 0 | 0 | 1 | 1 | 4 | 0 | 450 | |
| 0 | 1 | 0 | 0 | 0 | -1 | 0 | 200 | |
| 0 | 0 | 0 | 1 | 0 | 1 | 1 | 50 | B1 new constraint |
| | | | | | | | | |
| 1 | 0 | 0 | -0.5 | 0 | 0 | -1.75 | 1125 | |
| 0 | 0 | 1 | -1 | 0 | 0 | -2 | 750 | |
| 0 | 0 | 0 | -3 | 1 | 0 | -4 | 250 | M1 |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 | 250 | A1 |
| 0 | 0 | 0 | 1 | 0 | 1 | 1 | 50 | |
| 750 m ² of paving and 250 m ² of decking at an annual cost of £1125 | | | | | | | | A1 interpretation |