HIGHER

# 2.1 Linear Programming: 1-hour Pack

EDEXCEL 4MA1 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

**Answer ALL questions. Show all your working.**

**1** A shop makes x cakes and y pastries each day. The following conditions apply: (a) there must be no more cakes than pastries; (b) there must be at least 2 times as many pastries as cakes; (c) at least 12 items are made altogether.
Write down an inequality for each condition, using x and y.

**(Total for Question 1 is 3 marks)**

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**2** The region R satisfies all of the inequalities $x + y \leq 36$, $x \leq y$ and $x \geq 5$, with $x \geq 0$ and $y \geq 0$.
The points P(14, 19), Q(3, 30), R(9, 12), S(16, 22) are tested.
Which of the points lie inside R?

**(Total for Question 2 is 3 marks)**

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**3** Find the minimum value of $C = 8x + 9y$, where x and y satisfy $x + 2y \geq 10$, $x + 3y \geq 12$, $x \geq 0$ and $y \geq 0$.

**(Total for Question 3 is 5 marks)**


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**4** A shop makes x adult tickets and y child tickets each day. The following conditions apply: (a) there must be at least 3 times as many child tickets as adult tickets; (b) the total number of items made is at most 30; (c) there must be no more than 2 times as many child tickets as adult tickets.

Write down an inequality for each condition, using x and y.

**(Total for Question 4 is 3 marks)**

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**5** The region R satisfies all of the inequalities $3x + 6y \leq 150$, $y \leq 4x$ and $x \geq 8$, with $x \geq 0$ and $y \geq 0$.

The points P(2, 18), Q(4, 19), R(3, 27), S(10, 3) are tested.

Which of the points lie inside R?

**(Total for Question 5 is 3 marks)**

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**6** Find the minimum value of $C = x + y$, where x and y satisfy $2x + y \geq 14$, $2x + 3y \geq 30$, $x \geq 0$ and $y \geq 0$.

**(Total for Question 6 is 5 marks)**


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**7** A shop makes x adult tickets and y child tickets each day. The following conditions apply: (a) there must be no more adult tickets than child tickets; (b) the total number of items made is at most 50; (c) each of the adult tickets takes 15 minutes and each of the child tickets takes 25 minutes, and the total time available is 5 hours; (d) no more than 10 child tickets are made. Write down an inequality for each condition, using x and y.

**(Total for Question 7 is 4 marks)**

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**8** The region R satisfies all of the inequalities $y \leq 28$, $15x + 30y \leq 240$ and $y \leq 4x$, with $x \geq 0$ and $y \geq 0$.
The points P(10, 24), Q(9, 15), R(2, 5), S(4, 3) are tested.
Which of the points lie inside R?

**(Total for Question 8 is 3 marks)**

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**9** Find the maximum value of $P = x + 5y$, where x and y satisfy $x + y \leq 11$, $4x + 7y \leq 56$, $x \geq 0$ and $y \geq 0$.

**(Total for Question 9 is 5 marks)**


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**10** A shop makes x adult tickets and y child tickets each day. The following conditions apply: (a) the total number of items made is at most 24; (b) there must be no more than 3 times as many child tickets as adult tickets; (c) there must be at least 4 times as many child tickets as adult tickets; (d) there must be no more adult tickets than child tickets.
Write down an inequality for each condition, using x and y.

**(Total for Question 10 is 4 marks)**

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**11** The region R satisfies all of the inequalities $y \leq 4x$, $x + y \geq 12$ and $5x + 8y \leq 200$, with $x \geq 0$ and $y \geq 0$.
The points P(3, 26), Q(2, 4), R(3, 11), S(13, 4) are tested.
Which of the points lie inside R?

**(Total for Question 11 is 3 marks)**


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# Mark scheme · 2.1 Linear Programming: 1-hour Pack

## Question 1

| | |
|---|---|
| (a) $x \leq y$ | **B1** |
| (b) $y \geq 2x$ | **B1** |
| (c) $x + y \geq 12$ | **B1** |

**Answer: (a) $x \leq y$; (b) $y \geq 2x$; (c) $x + y \geq 12$**

## Question 2

| | |
|---|---|
| substitutes each point into each of the three inequalities | **M1** |
| correct decision for each point (at least three correct) | **A1** |
| inside R: P, R; the other points break at least one inequality | **A1** |

**Answer: P, R**

## Question 3

| | |
|---|---|
| solves $x + 2y \geq 10$ and $x + 3y \geq 12$ simultaneously to find the corner where the lines cross | **M1** |
| corner at (6, 2) | **A1** |
| finds the other corners of the region on the axes | **M1** |
| evaluates C at each corner: (0, 5) gives 45; (6, 2) gives 66; (12, 0) gives 96 | **M1** |
| minimum C = 45 at (0, 5) | **A1** |

**Answer: Minimum C = 45 at (0, 5)**

## Question 4

| | |
|---|---|
| (a) $y \geq 3x$ | **B1** |
| (b) $x + y \leq 30$ | **B1** |
| (c) $y \leq 2x$ | **B1** |

**Answer: (a) $y \geq 3x$; (b) $x + y \leq 30$; (c) $y \leq 2x$**

## Question 5

| | |
|---|---|
| substitutes each point into each of the three inequalities | **M1** |
| correct decision for each point (at least three correct) | **A1** |
| inside R: S; the other points break at least one inequality | **A1** |

**Answer: S**

## Question 6

| | |
|---|---|
| solves $2x + y \geq 14$ and $2x + 3y \geq 30$ simultaneously to find the corner where the lines cross | **M1** |
| corner at (3, 8) | **A1** |
| finds the other corners of the region on the axes | **M1** |
| evaluates C at each corner: (0, 14) gives 14; (3, 8) gives 11; (15, 0) gives 15 | **M1** |
| minimum C = 11 at (3, 8) | **A1** |

**Answer: Minimum C = 11 at (3, 8)**

## Question 7

| | |
|---|---|
| (a) $x \leq y$ | **B1** |
| (b) $x + y \leq 50$ | **B1** |
| (c) $15x + 25y \leq 300$ | **B1** |
| (d) $y \leq 10$ | **B1** |

**Answer: (a) $x \leq y$; (b) $x + y \leq 50$; (c) $15x + 25y \leq 300$; (d) $y \leq 10$**

## Question 8

| | |
|---|---|
| substitutes each point into each of the three inequalities | **M1** |
| correct decision for each point (at least three correct) | **A1** |
| inside R: R, S; the other points break at least one inequality | **A1** |

**Answer: R, S**

## Question 9

| | |
|---|---|
| solves $x + y \leq 11$ and $4x + 7y \leq 56$ simultaneously to find the corner where the lines cross | **M1** |
| corner at (7, 4) | **A1** |
| finds the other corners of the region on the axes | **M1** |
| evaluates P at each corner: (0, 0) gives 0; (0, 8) gives 40; (7, 4) gives 27; (11, 0) gives 11 | **M1** |
| maximum P = 40 at (0, 8) | **A1** |

**Answer: Maximum P = 40 at (0, 8)**

## Question 10

| | |
|---|---|
| (a) $x + y \leq 24$ | **B1** |
| (b) $y \leq 3x$ | **B1** |
| (c) $y \geq 4x$ | **B1** |
| (d) $x \leq y$ | **B1** |

**Answer: (a) $x + y \leq 24$; (b) $y \leq 3x$; (c) $y \geq 4x$; (d) $x \leq y$**

## Question 11

| | |
|---|---|
| substitutes each point into each of the three inequalities | **M1** |
| correct decision for each point (at least three correct) | **A1** |
| inside R: R, S; the other points break at least one inequality | **A1** |

**Answer: R, S**


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