C14

Linear programming

CHAPTER ASSIGNMENT · 96 MARKS

Name _____ Class _____ No. _____ Date _____

Answer every question in the space given. Work without a calculator. A fraction bar in the book is written here with /, so y/3 means y over 3. Draw graphs on squared or graph paper, or in the box given. Use a solid line for ≤ and ≥ and a broken line for < and >.

Practice questions from *Cambridge IGCSE Mathematics Core and Extended* (4th edition), Chapter 14 (Linear programming), for classroom use. Every book exercise and Student assessment question is included. The Check yourself and Chapter quiz questions are Guru Jazzy's own.

Exercise 14.1 · Revision: solving inequalities

14.1.1 Solve each of the following inequalities:

(a) $15 + 3x < 21$	(b) $18 \le 7y + 4$	(c) $19 - 4x \ge 27$
(d) $2 \ge y/3$	(e) $-4t + 1 < 1$	(f) $1 \ge 3p + 10$

14.1.2 Solve each of the following inequalities:

(a) $7 < 3y + 1 \le 13$	(b) $3 \le 3p < 15$
(c) $9 \le 3(m - 2) < 15$	(d) $20 < 8x - 4 < 28$

Exercise 14.2 · Graphing an inequality

14.2.1 By drawing appropriate axes, shade the region which satisfies each of the following inequalities: (a) $y > 2$ · (b) $x < 3$ · (c) $y \le 4$ · (d) $x \ge -1$ · (e) $y > 2x + 1$ · (f) $y \le x - 3$ [6]

14.2.2 By drawing appropriate axes, leave unshaded the region which satisfies each of the following inequalities: (a) $y \geq -x$ · (b) $y \leq 2 - x$ · (c) $x \leq y - 3$ · (d) $x + y \geq 4$ · (e) $2x - y \geq 3$ · (f) $2y - x < 4$ [6]

Exercise 14.3 · Graphing more than one inequality

14.3 On the same pair of axes, plot the following inequalities and leave unshaded the region which satisfies all of them simultaneously.

14.3.1 $y \leq x$ · $y > 1$ · $x \leq 5$ [3]

14.3.2 $x + y \leq 6 \cdot y < x \cdot y \geq 1$ [3]

14.3.3 $y \geq 3x \cdot y \leq 5 \cdot x + y > 4$ [3]

14.3.4 $2y \geq x + 4 \cdot y \leq 2x + 2 \cdot y < 4 \cdot x \leq 3$ [4]

Exercise 14.4 · Linear programming

14.4 In the following questions draw both axes numbered from 0 to 12. For each question: (a) write an inequality for each statement, (b) graph the inequalities, leaving the region which satisfies the inequalities unshaded, (c) using your graph, state one solution which satisfies all the inequalities simultaneously.

14.4.1 A taxi firm has at its disposal one morning a car and a minibus for hire. During the morning, it makes x car trips and y minibus trips. [5]

- It makes at least five car trips.
- It makes between two and eight minibus trips.
- The total number of car and minibus trips does not exceed 12.

14.4.2 A woman is baking bread and cakes. She makes p loaves and q cakes. She bakes at least five loaves and at least two cakes but no more than ten loaves and cakes altogether. [5]

14.4.3 A couple are buying curtains for their house. They buy m long curtains and n short curtains. They buy at least two long curtains. They also buy at least twice as many short curtains as long curtains. A maximum of 11 curtains are bought altogether. [5]

14.4.4 A shop sells large and small oranges. A girl buys L large oranges and S small oranges. She buys at least three but fewer than nine large oranges. She also buys fewer than six small oranges. The maximum number of oranges she needs to buy is 10. [5]

Student assessment 1

SA1.1 Solve the following inequalities:

(a) $17 + 5x \leq 42$	(b) $3 \geq y/3 + 2$

SA1.2 Find the range of values for which:

(a) $7 < 4y - 1 \leq 15$	(b) $18 < 3(p + 2) \leq 30$

SA1.3 A garage stocks two kinds of engine oil. They have r cases of regular oil and s cases of super oil.

They have fewer than ten cases of regular oil in stock and between three and nine cases of super oil in stock. They also have fewer than 12 cases in stock altogether.

(a) Express the three constraints described above as inequalities. [3]

(b) Draw an appropriate pair of axes and identify the region which satisfies all the inequalities by shading the unwanted regions. [3]

(c) State two possible solutions for the number of each case in stock. [2]

SA1.4 Students from Argentina and students from England are meeting on a cultural exchange.

In total there will be between 12 and 20 students. There are fewer than 10 students from Argentina, while the number from England cannot be more than three greater than the number from Argentina.

(a) Write inequalities for the number (A) of students from Argentina and the number (E) of students from England. [4]

(b) On an appropriate pair of axes, graph the inequalities, leaving unshaded the region which satisfies all of them. [4]



(c) State two of the possible combinations of A and E which satisfy the given conditions. [2]

Student assessment 2

SA2.1 Solve the following inequalities:

(a) $5 + 6x \leq 47$	(b) $4 \geq (y + 3)/3$

SA2.2 Find the range of values for which:

(a) $3 \leq 3p < 12$	(b) $24 < 8(x - 1) \leq 48$

SA2.3 A breeder of horses has x stallions and y mares. She has fewer than four stallions and more than two mares. She has enough room for a maximum of eight animals in total.

(a) Express the three conditions above as inequalities. [3]

(b) Draw an appropriate pair of axes and leave unshaded the region which satisfies all the inequalities. [3]



(c) State two of the possible combinations of stallions and mares which she can have. [2]

SA2.4 Antonio is employed by a company to do two jobs. He mends cars and he also repairs electrical goods. His terms of employment are listed below.

- He is employed for a maximum of 40 hours.
- He must spend at least 16 hours mending cars.
- He must spend at least 5 hours repairing electrical goods.
- He must spend more than twice as much time mending cars as repairing electrical goods.

(a) Express the conditions above as inequalities, using c to represent the number of hours spent mending cars, and e to represent the number of hours spent mending electrical goods. [4]

(b) On an appropriate pair of axes, graph the inequalities, leaving unshaded the region which satisfies all four. [4]



(c) State two of the possible combinations which satisfy the above conditions. [2]

Check yourself

C1 Solve $11 - 3x > 2$. Explain why the inequality sign changes direction in your working. [2]

C2 Which of the points (1, 1), (2, 5) and (4, 3) satisfy $y < x + 2$? Show the substitution for each point. [3]

C3 For the inequality $3x + 2y \geq 12$, state whether the boundary line is solid or broken, find where it crosses each axis, and use the test point (0, 0) to say which side is wanted. [4]

C4 A club buys b basketballs and f footballs. It buys at least 2 basketballs, more footballs than basketballs, and no more than 9 balls in total. Write three inequalities for these conditions. [3]

C5 Use your inequalities from C4 to list every whole-number pair (b, f) that satisfies all three conditions. [3]

Chapter quiz

Q1 Which symbol means “is greater than or equal to”?

A	B	C	D
>	≥	<	≤

Q2 Solve $3x + 5 < 20$.

A	B	C	D
$x < 5$	$x > 5$	$x < 25/3$	$x \leq 5$

Q3 Solve $8 - 2x \geq 2$.

A	B	C	D
$x \geq 3$	$x \leq 3$	$x \geq -3$	$x \leq 5$

Q4 Find the range of values for which $1 < 2y - 1 \leq 9$.

A	B	C	D
$0 < y \leq 4$	$1 < y \leq 5$	$2 < y \leq 10$	$1 \leq y < 5$

Q5 On a graph, which inequality has its boundary drawn as a broken (dashed) line?

A	B	C	D
$y \leq 4$	$x \geq -1$	$y > 2x + 1$	$x + y \leq 6$

Q6 The region $x \geq 3$ lies on which side of the line $x = 3$?

A	B	C	D
Above it	Below it	To the left	To the right

Q7 Which point satisfies $y \leq x + 2$?

A	B	C	D
(0, 3)	(1, 4)	(3, 1)	(−2, 1)

Q8 For $2x + y > 4$, the test point (0, 0) gives $0 > 4$. What does that tell you?

A	B	C	D
The origin side is wanted	The origin side is not wanted	The line must be solid	The origin is on the line

---

Q9 Which point lies in the region $x \le 2$, $y > -1$, $y \le 3$?

A	B	C	D
(3, 0)	(1, −1)	(0, 4)	(1, 2)

Q10 "There must be at least 4 fields of corn (c)." Which inequality is this?

A	B	C	D
$c > 4$	$c < 4$	$c \ge 4$	$c \le 4$

Q11 She buys at least twice as many short curtains (n) as long ones (m). Which is right?

A	B	C	D
$n \ge 2m$	$m \ge 2n$	$n \le 2m$	$2n \ge m$

Q12 With $c \ge 2$, $w \ge 2$ and $c + w \le 10$, which plan is allowed?

A	B	C	D
$c = 1, w = 5$	$c = 6, w = 5$	$c = 3, w = 7$	$c = 9, w = 2$

End of assignment · Check your answers against the chapter at gurujazzy.com/subjects/o-level-mathematics/chapter-14-linear-programming/