Linear Programming
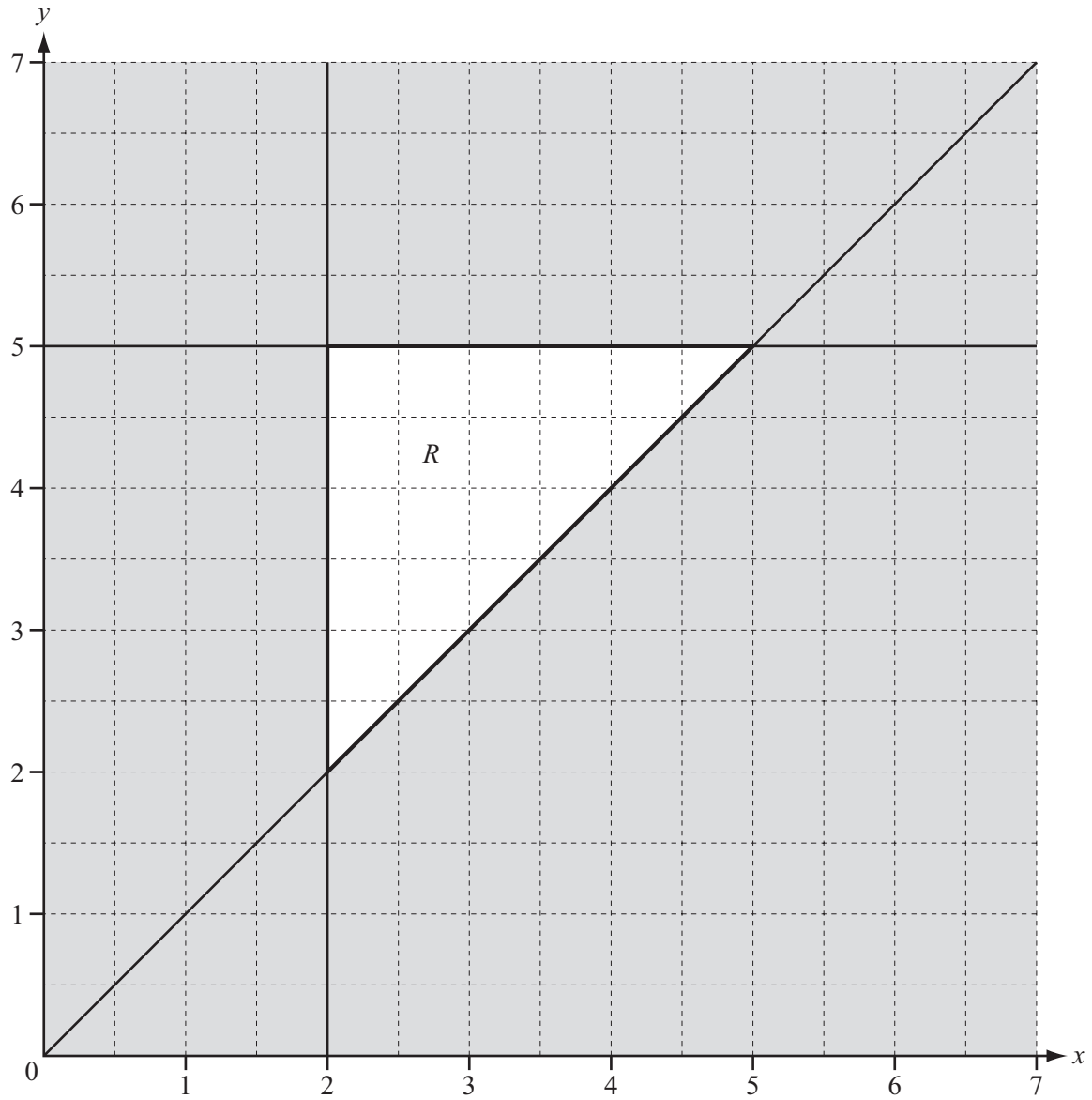# 2002 - 2011

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The region *R* is bounded by three lines.

Write down the three inequalities which define the region *R*.

Answer ....

....

.... [4]

10 Hassan stores books in large boxes and small boxes.
Each large box holds 20 books and each small box holds 10 books.
He has x large boxes and y small boxes.

(a) Hassan must store at least 200 books.

Show that $2x + y \geqslant 20$.

Answer(a)

[1]

(b) Hassan must not use more than 15 boxes.
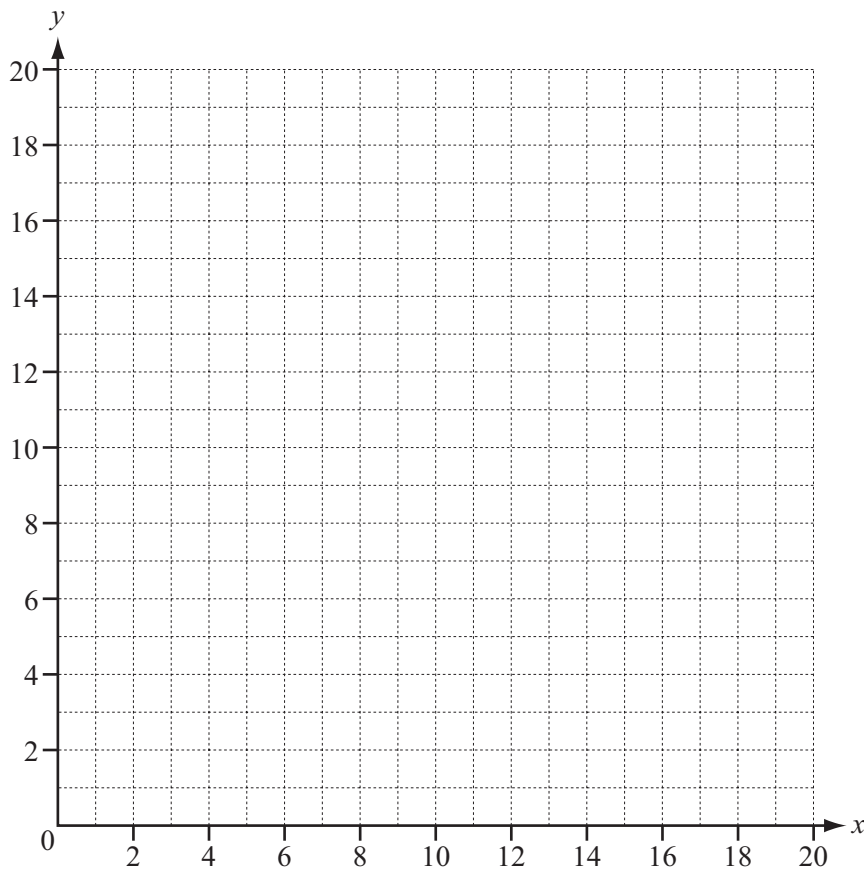He must use at least 3 small boxes.
The number of small boxes must be less than or equal to the number of large boxes.

Write down three inequalities to show this information.

Answer(b) ....

....

.... [3]

(c) On the grid, show the information in **part (a)** and **part (b)** by drawing four straight lines and shading the **unwanted** regions.

[6]

(d) A large box costs $5 and a small box costs $2.

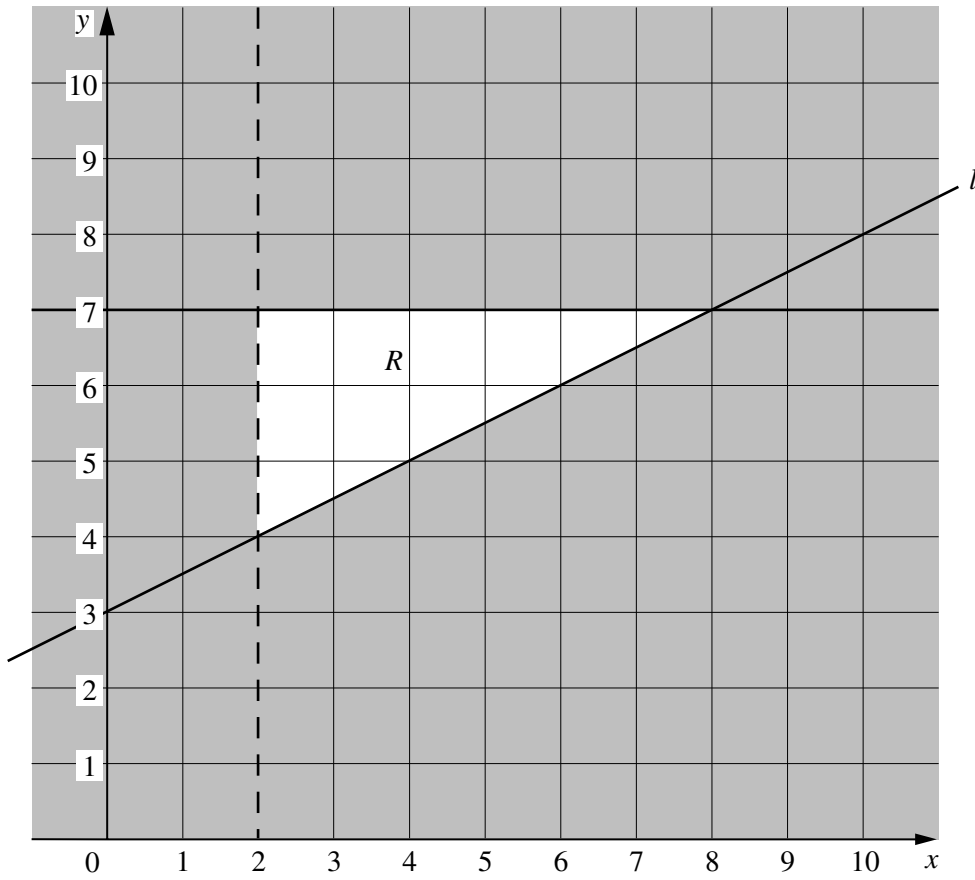   **(i)** Find the least possible total cost of the boxes.

Answer(d)(i) $ .... [1]

    (ii) Find the number of large boxes and the number of small boxes which give this least possible cost.

Answer(d)(ii) Number of large boxes = ...

Number of small boxes = ... [2]

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(a) Find the equation of the line *l* shown in the grid above.

Answer (a) .... [2]

(b) Write down three inequalities which define the region *R*.

Answer (b) ....

....

.... [3]

9 **Answer all of this question on a sheet of graph paper.**

A shop buys x pencils and y pens.
Pencils cost 15 cents each and pens cost 25 cents each.

(a) There is a maximum of $20 to spend.
Show that $3x + 5y \leqslant 400$. [1]

(b) The number of pens must not be greater than the number of pencils.
Write down an inequality, in terms of x and y, to show this information. [2]

(c) There must be at least 35 pens.
Write down an inequality to show this information. [1]

(d) **(i)** Using a scale of 1 cm to represent 10 units on each axis, draw an x-axis for $0 \leqslant x \leqslant 150$
and a y-axis for $0 \leqslant y \leqslant 100$. [1]

    (ii) Draw three lines on your graph to show the inequalities in **parts (a)**, **(b) and (c)**.
Shade the **unwanted** regions. [5]

(e) When 70 pencils are bought, what is the largest possible number of pens? [1]

(f) The profit on each pencil is 5 cents and the profit on each pen is 7 cents.
Find the largest possible profit. [3]

9 **Answer the whole of this question on a sheet of graph paper.**

A taxi company has "SUPER" taxis and "MINI" taxis.
One morning a group of 45 people needs taxis.
For this group the taxi company uses x "SUPER" taxis and y "MINI" taxis.
A "SUPER" taxi can carry 5 passengers and a "MINI" taxi can carry 3 passengers.
So $5x + 3y \geqslant 45$.

(a) The taxi company has 12 taxis.
Write down **another** inequality in x and y to show this information. [1]

(b) The taxi company always uses at least 4 "MINI" taxis.
Write down an inequality in y to show this information. [1]

(c) Draw x and y axes from 0 to 15 using 1 cm to represent 1 unit on each axis. [1]

(d) Draw three lines on your graph to show the inequality $5x + 3y \geqslant 45$ **and** the inequalities from **parts (a) and (b)**.
Shade the **unwanted** regions. [6]

(e) The cost to the taxi company of using a "SUPER" taxi is $20 and the cost of using a "MINI" taxi is $10.
The taxi company wants to find the cheapest way of providing "SUPER" and "MINI" taxis for this group of people.
Find the **two** ways in which this can be done. [3]

(f) The taxi company decides to use 11 taxis for this group.
  (i) The taxi company charges $30 for the use of each "SUPER" taxi and $16 for the use of each "MINI" taxi.
  Find the two possible **total** charges. [3]

  (ii) Find the largest possible **profit** the company can make, using 11 taxis. [1]

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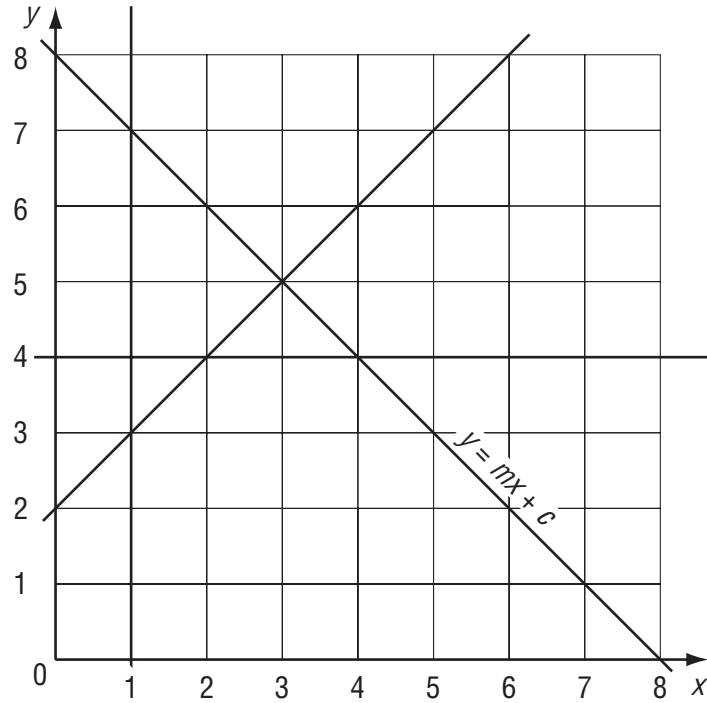
(a) One of the lines in the diagram is labelled $y = mx + c$.
Find the values of m and c.

Answer(a) m=................................... [1]

c=................................... [1]
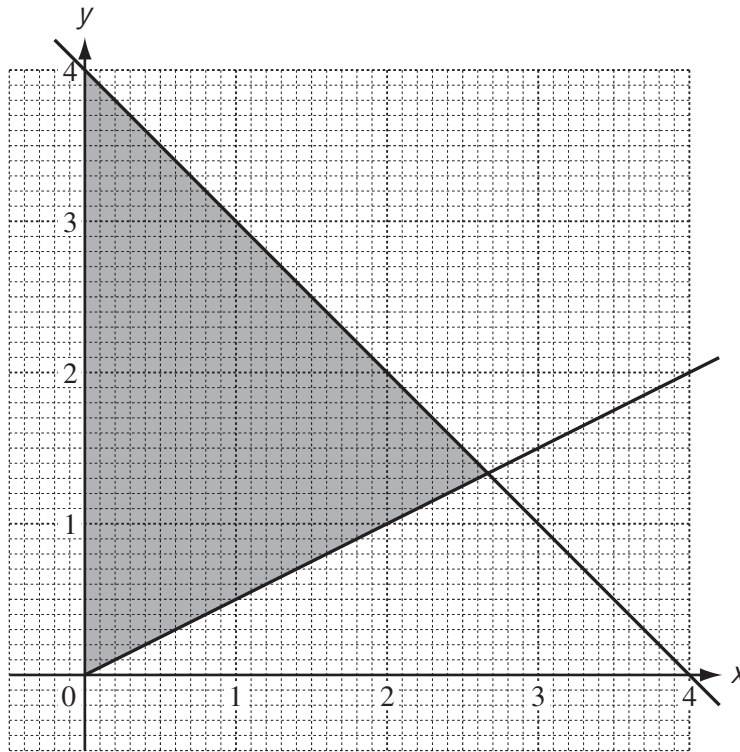
(b) Show, by shading all the **unwanted** regions on the diagram, the region defined by the inequalities

$$x \geqslant 1, \quad y \leqslant mx + c, \quad y \geqslant x+2 \quad \text{and} \quad y \geqslant 4.$$

Write the letter **R** in the region required. [2]

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Find the three inequalities which define the shaded region on the grid.

Answer ....

....

.... [5]

9 **Answer the whole of this question on a sheet of graph paper.**

Tiago does some work during the school holidays.
In one week he spends x hours cleaning cars and y hours repairing cycles.
The time he spends repairing cycles is at least equal to the time he spends cleaning cars.
This can be written as $y \geqslant x$.

He spends no more than 12 hours working.
He spends at least 4 hours cleaning cars.

(a) Write down two more inequalities in x and/or y to show this information. [3]

(b) Draw x and y axes from 0 to 12, using a scale of 1 cm to represent 1 unit on each axis. [1]

(c) Draw three lines to show the three inequalities. Shade the **unwanted** regions. [5]

(d) Tiago receives $3 each hour for cleaning cars and $1.50 each hour for repairing cycles.

    (i) What is the least amount he could receive? [2]

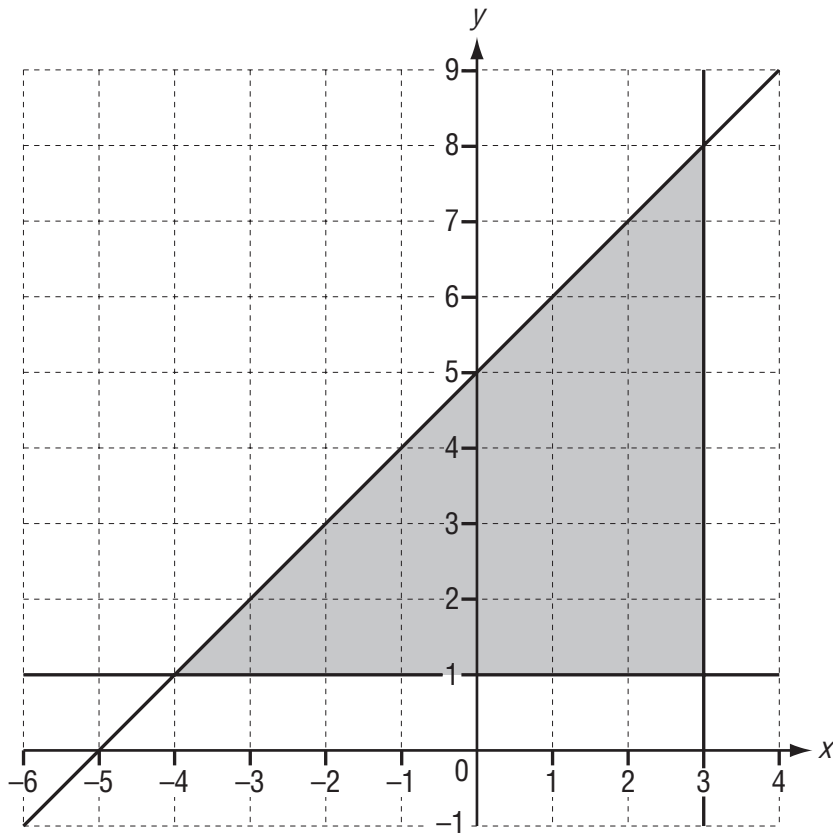   **(ii)** What is the largest amount he could receive? [2]

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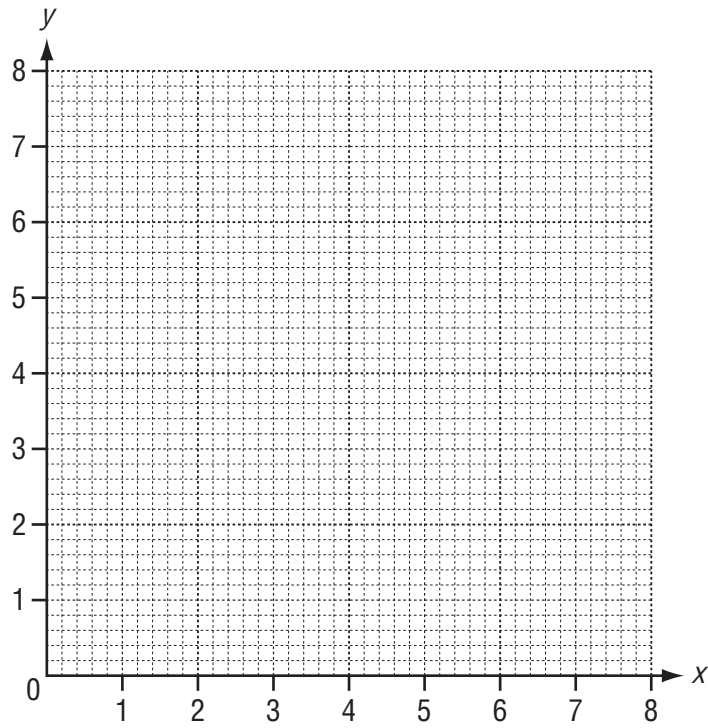
(a) Draw the lines $y = 2$, $x + y = 6$ and $y = 2x$ on the grid above. [4]

(b) Label the region R which satisfies the three inequalities

$x + y \geqslant 6$, $\qquad y \geqslant 2$ $\qquad$ and $\qquad$ $y \leqslant 2x$. [1]

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Find the three inequalities which define the shaded triangle in the diagram.

Answer ....

....

.... [5]

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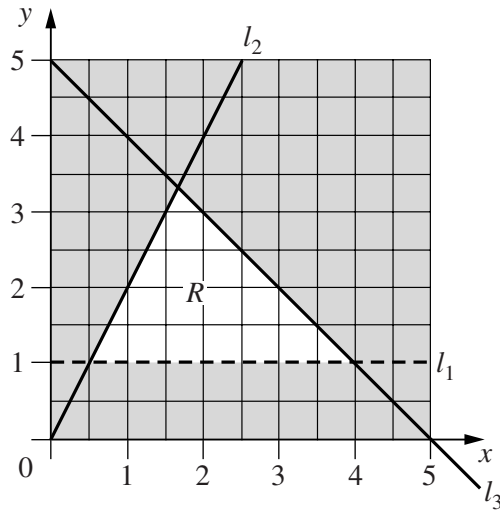
(a) Find the equations of the lines l_1, l_2 and l_3.

Answer (a) l_1: ....

l_2: ....

l_3: ....   [3]

(b) The unshaded region, labelled R, is defined by three inequalities.
Write down these three inequalities.

Answer (b) ....

....

....[2]