



# Linear Programming

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10 A company has a vehicle parking area of  $1200 \text{ m}^2$  with space for  $x$  cars and  $y$  trucks.

Each car requires  $20 \text{ m}^2$  of space and each truck requires  $100 \text{ m}^2$  of space.

(a) Show that  $x + 5y \leq 60$ .

Answer(a)

[1]

(b) There must also be space for

(i) at least 40 vehicles,

(ii) at least 2 trucks.

Write down two more inequalities to show this information.

Answer(b)(i) .....

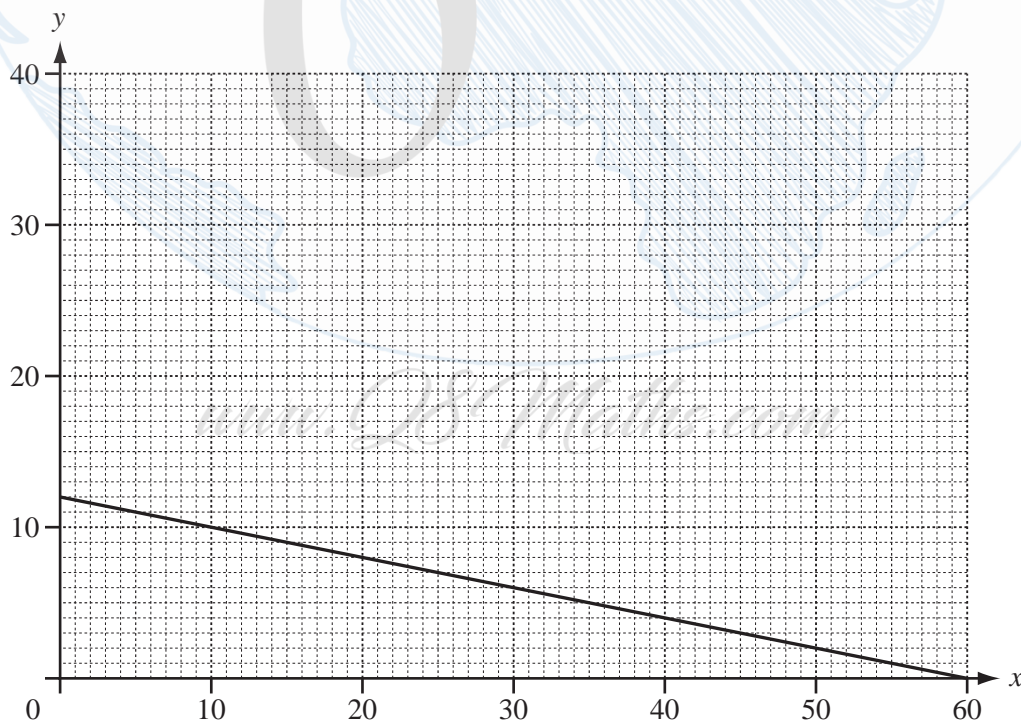
[1]

Answer(b)(ii) .....

[1]

(c) One line has been drawn for you.

On the grid, show the three inequalities by drawing the other two lines and shading the **unwanted** regions.



[4]

(d) Use your graph to find the largest possible number of trucks.

*Answer(d)* ..... [1]

(e) The company charges \$5 for parking each car and \$10 for parking each truck.  
Find the number of cars and the number of trucks which give the company the greatest possible income.

Calculate this income.

*Answer(e)* Number of cars = .....

Number of trucks = .....

Greatest possible income = \$ ..... [3]

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9 Peter wants to plant  $x$  plum trees and  $y$  apple trees.

He wants at least 3 plum trees and at least 2 apple trees.

(a) Write down one inequality in  $x$  and one inequality in  $y$  to represent these conditions.

*Answer(a)* ..... , ..... [2]

(b) There is space on his land for no more than 9 trees.

Write down an inequality in  $x$  and  $y$  to represent this condition.

*Answer(b)* ..... [1]

(c) Plum trees cost \$6 and apple trees cost \$14.

Peter wants to spend no more than \$84.

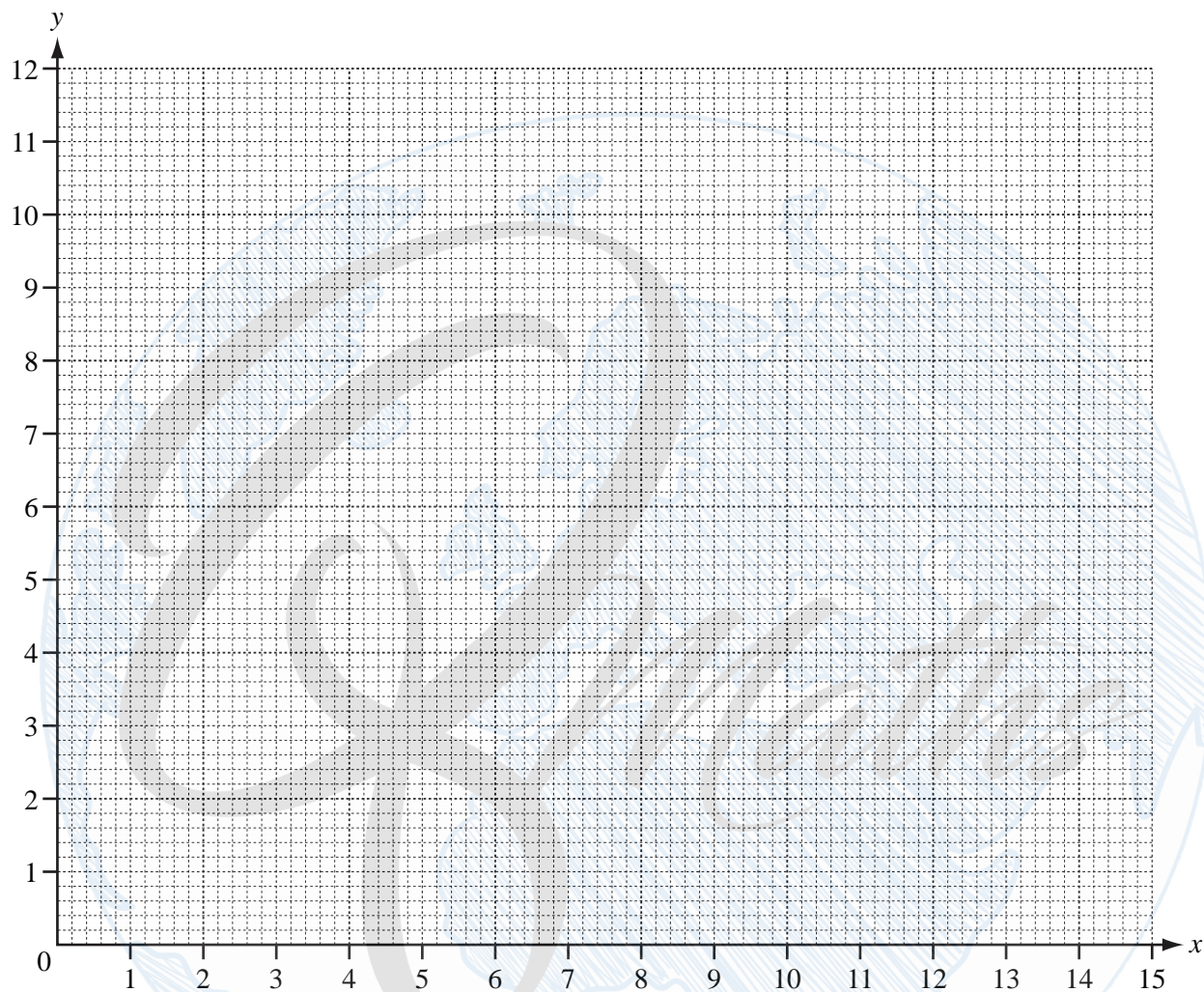
Write down an inequality in  $x$  and  $y$ , and show that it simplifies to  $3x + 7y \leq 42$ .

*Answer(c)*

[1]

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(d) On the grid, draw four lines to show the four inequalities and shade the **unwanted** regions.



[7]

(e) Calculate the smallest cost when Peter buys a total of 9 trees.

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Answer(e) \$ ..... [2]

- 8 Mr Chang hires  $x$  large coaches and  $y$  small coaches to take 300 students on a school trip. Large coaches can carry 50 students and small coaches 30 students. There is a maximum of 5 large coaches.

(a) Explain clearly how the following two inequalities satisfy these conditions.

(i)  $x \leq 5$

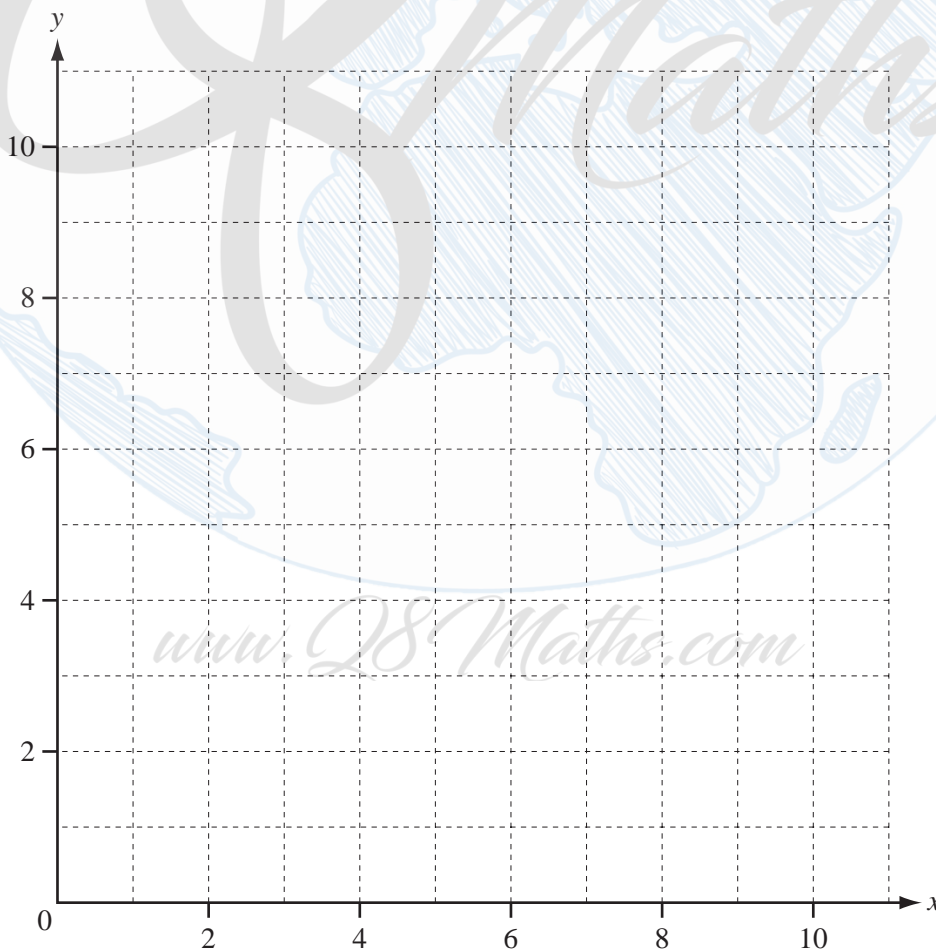
Answer(a)(i) ..... [1]

(ii)  $5x + 3y \geq 30$

Answer(a)(ii) ..... [2]  
 .....

Mr Chang also knows that  $x + y \leq 10$ .

(b) On the grid, show the information above by drawing three straight lines and shading the **unwanted** regions.



[5]

(c) A large coach costs \$450 to hire and a small coach costs \$350.

(i) Find the number of large coaches and the number of small coaches that would give the minimum hire cost for this school trip.

*Answer(c)(i)* Large coaches .....

Small coaches ..... [2]

(ii) Calculate this minimum cost.

*Answer(c)(ii)* \$ ..... [1]

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4) November 2011 V3

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  $2x + y \geq 20$ .

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.

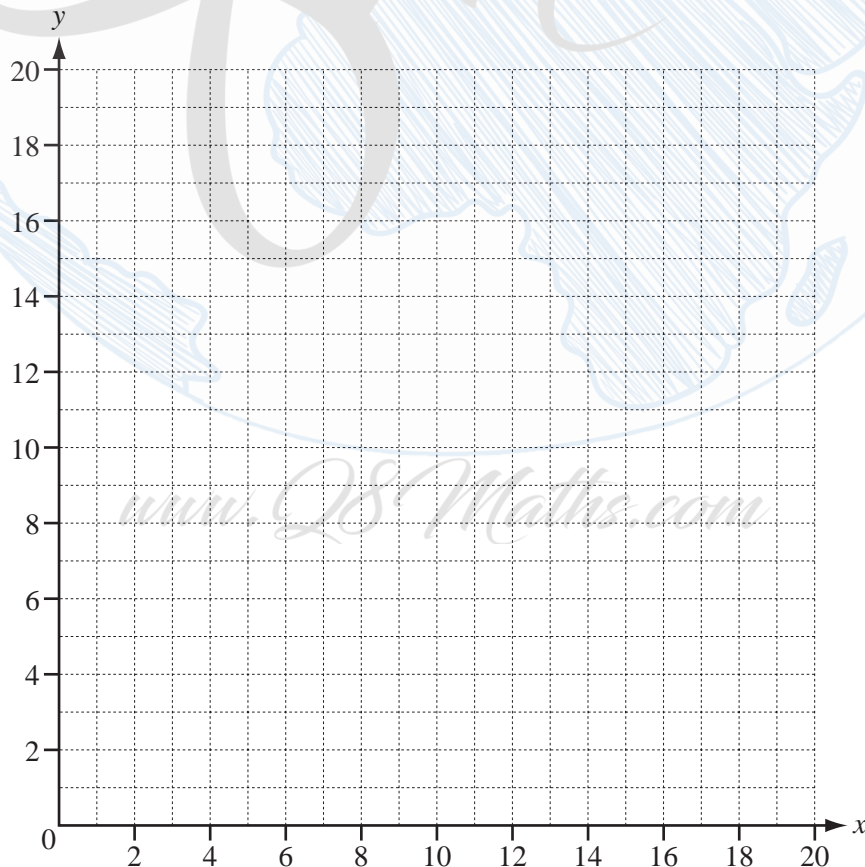
Answer(b) .....

.....

.....

[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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3 Pablo plants  $x$  lemon trees and  $y$  orange trees.

(a) (i) He plants at least 4 lemon trees.

Write down an inequality in  $x$  to show this information.

Answer(a)(i) ..... [1]

(ii) Pablo plants at least 9 orange trees.

Write down an inequality in  $y$  to show this information.

Answer(a)(ii) ..... [1]

(iii) The greatest possible number of trees he can plant is 20.

Write down an inequality in  $x$  and  $y$  to show this information.

Answer(a)(iii) ..... [1]

(b) Lemon trees cost \$5 each and orange trees cost \$10 each.

The maximum Pablo can spend is \$170.

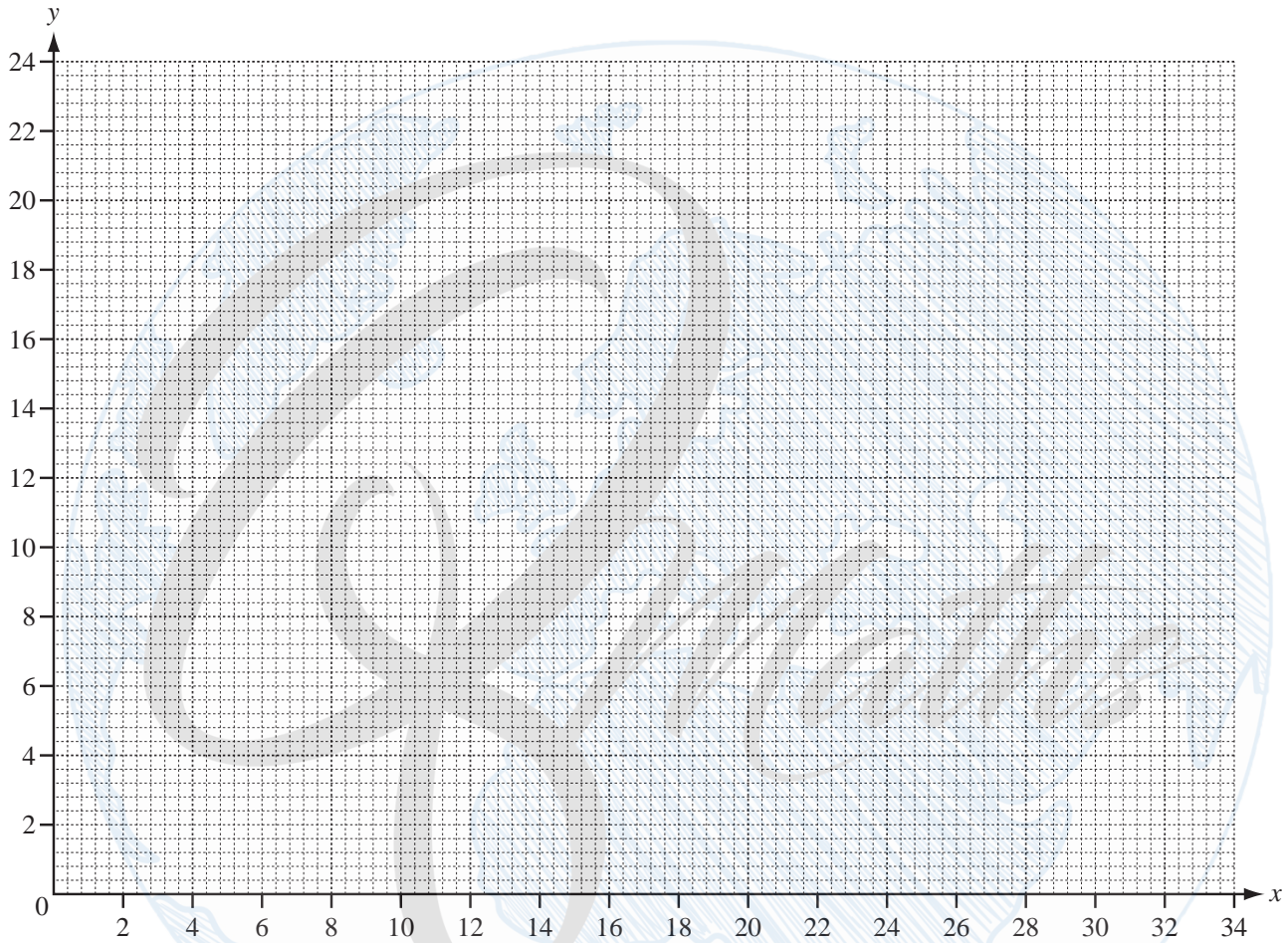
Write down an inequality in  $x$  and  $y$  and show that it simplifies to  $x + 2y \leq 34$ .

Answer (b)

[1]

(c) (i) On the grid opposite, draw four lines to show the four inequalities and shade the **unwanted** region.

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[7]

(ii) Calculate the smallest cost when Pablo buys a total of 20 trees.

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Answer(c)(ii) \$ ..... [2]

6) November 2012 V2

- 7 Jay makes wooden boxes in two sizes. He makes  $x$  small boxes and  $y$  large boxes.  
He makes at least 5 **small** boxes.  
The greatest number of **large** boxes he can make is 8.  
The greatest total number of boxes is 14.  
The number of **large** boxes is at least half the number of **small** boxes.

(a) (i) Write down four inequalities in  $x$  and  $y$  to show this information.

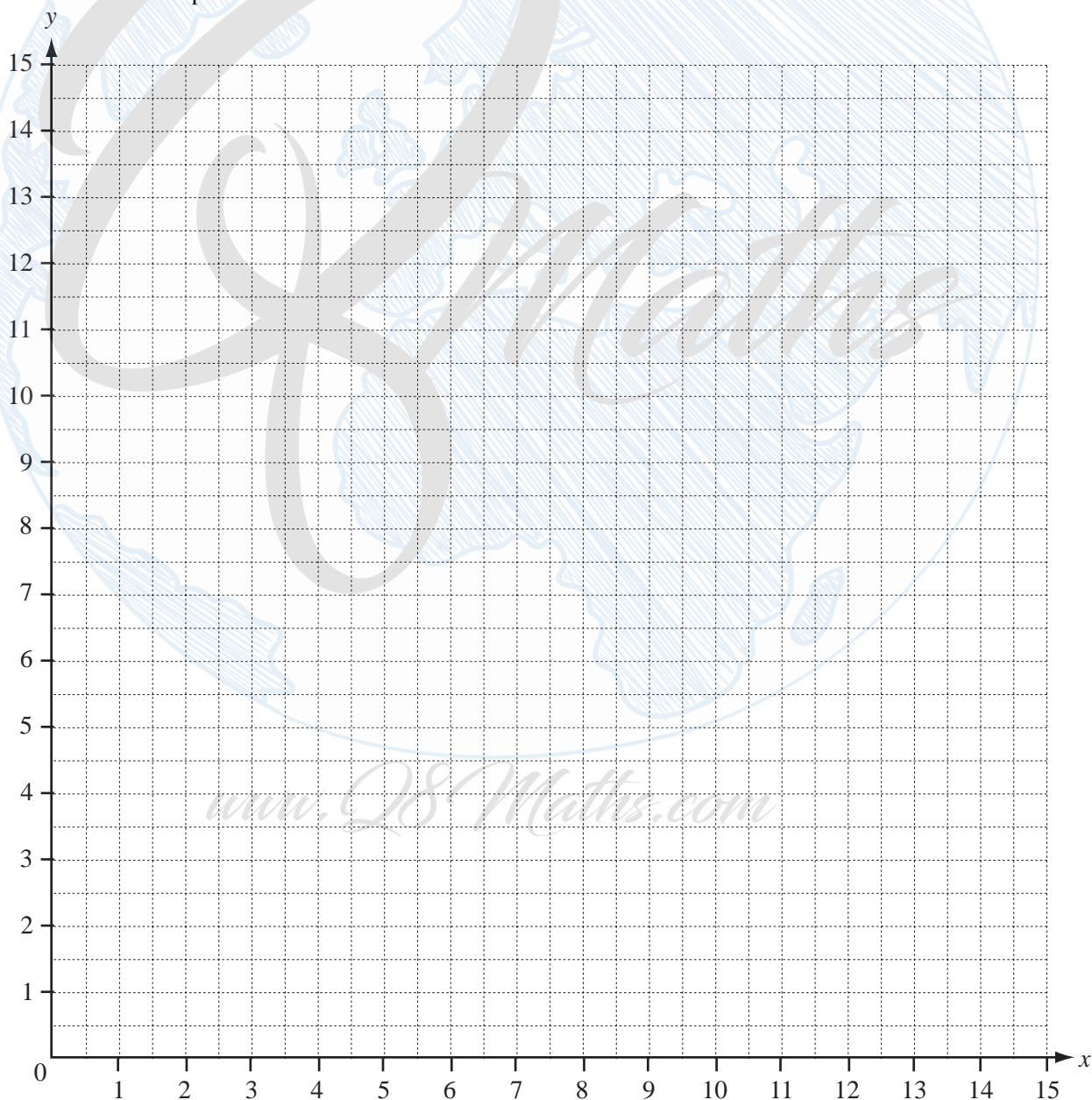
Answer(a)(i) .....

.....

.....

..... [4]

(ii) Draw four lines on the grid and write the letter R in the region which represents these inequalities.



[5]

(b) The price of the small box is \$20 and the price of the large box is \$45.

(i) What is the greatest amount of money he receives when he sells all the boxes he has made?

*Answer(b)(i)* \$ ..... [2]

(ii) For this amount of money, how many boxes of each size did he make?

*Answer(b)(ii)* ..... small boxes and ..... large boxes [1]

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3 (a) Luk wants to buy  $x$  goats and  $y$  sheep.

(i) He wants to buy at least 5 goats.

Write down an inequality in  $x$  to represent this condition.

Answer(a)(i) ..... [1]

(ii) He wants to buy at least 11 sheep.

Write down an inequality in  $y$  to represent this condition.

Answer(a)(ii) ..... [1]

(iii) He wants to buy at least 20 animals.

Write down an inequality in  $x$  and  $y$  to represent this condition.

Answer(a)(iii) ..... [1]

(b) Goats cost \$4 and sheep cost \$8.  
The maximum Luk can spend is \$160.

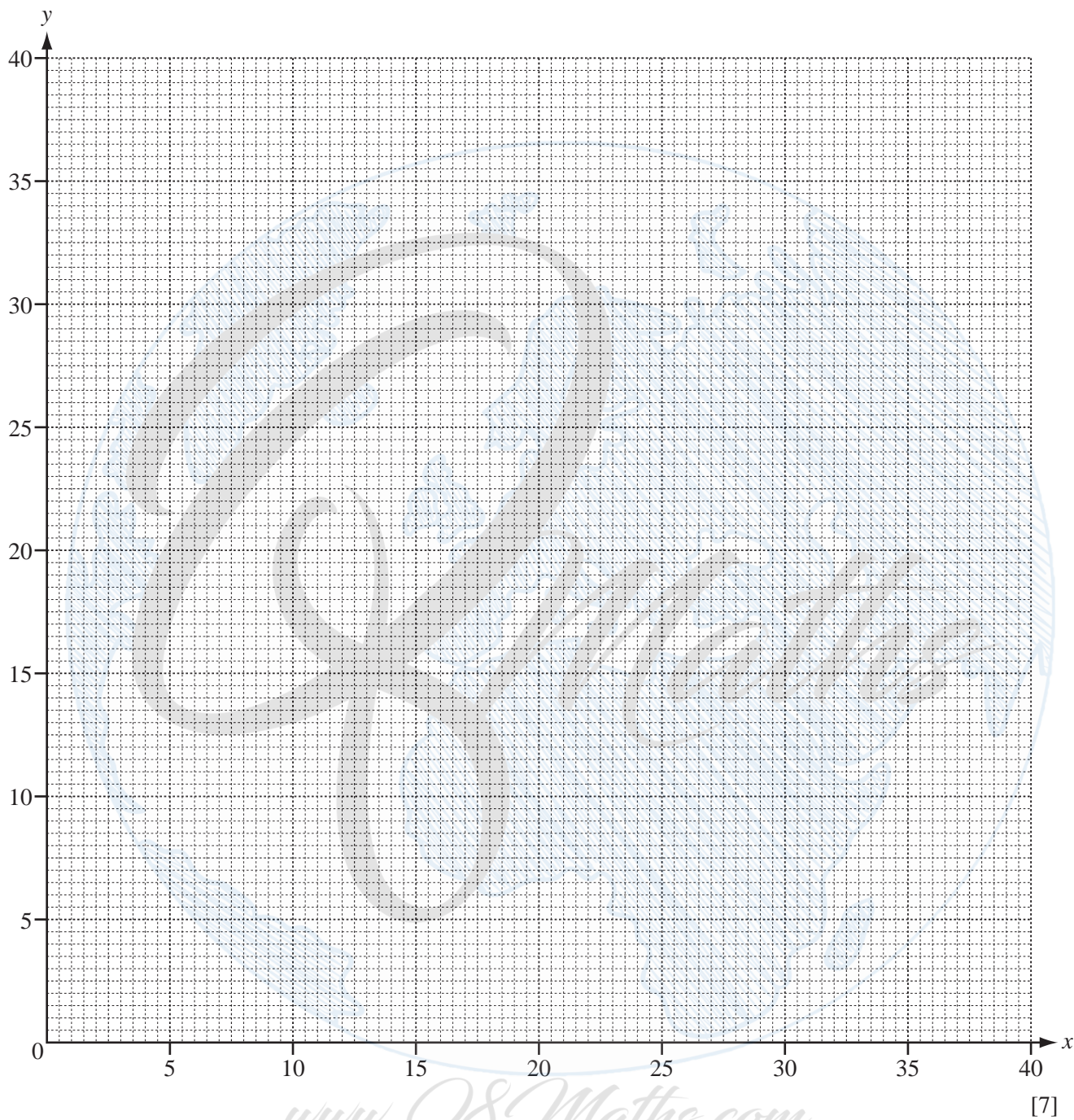
Write down an inequality in  $x$  and  $y$  and show that it simplifies to  $x + 2y \leq 40$ .

Answer(b)

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[1]

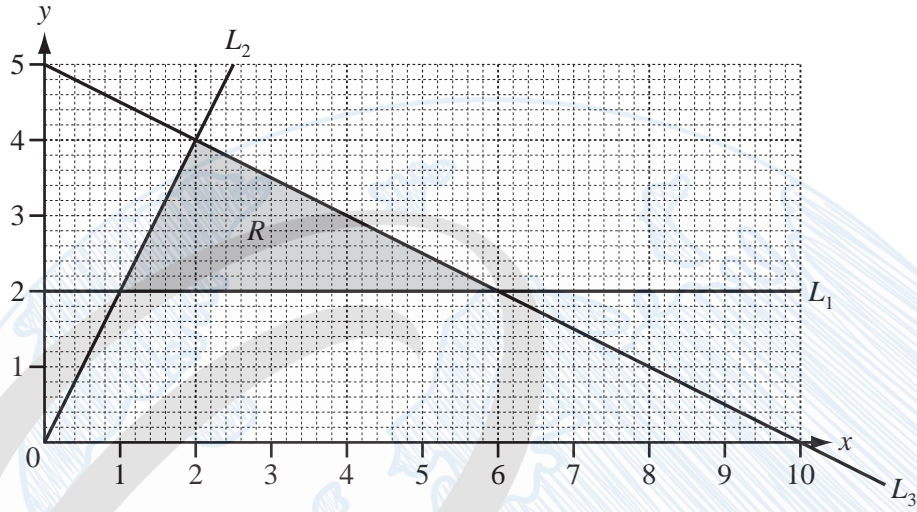
- (c) (i) On the grid below, draw four lines to show the four inequalities and shade the **unwanted** regions.



- (ii) Work out the maximum number of animals that Luk can buy.

Answer(c)(ii) ..... [2]

9



(a) Find the equations of the lines  $L_1$ ,  $L_2$  and  $L_3$ .

Answer(a)  $L_1$  .....

$L_2$  .....

$L_3$  ..... [5]

(b) Write down the three inequalities that define the shaded region,  $R$ .

Answer(b) .....

.....

..... [3]



(c) A gardener buys  $x$  bushes and  $y$  trees.  
 The cost of a bush is \$30 and the cost of a tree is \$200.  
 The shaded region  $R$  shows the only possible numbers of bushes and trees the gardener can buy.

(i) Find the number of bushes and the number of trees when the total cost is \$720.

Answer(c)(i) ..... bushes  
 ..... trees [2]

(ii) Find the number of bushes and the number of trees which give the greatest possible total cost.  
 Write down this greatest possible total cost.

Answer(c)(ii) ..... bushes  
 ..... trees  
 Greatest possible total cost = \$ ..... [3]

3

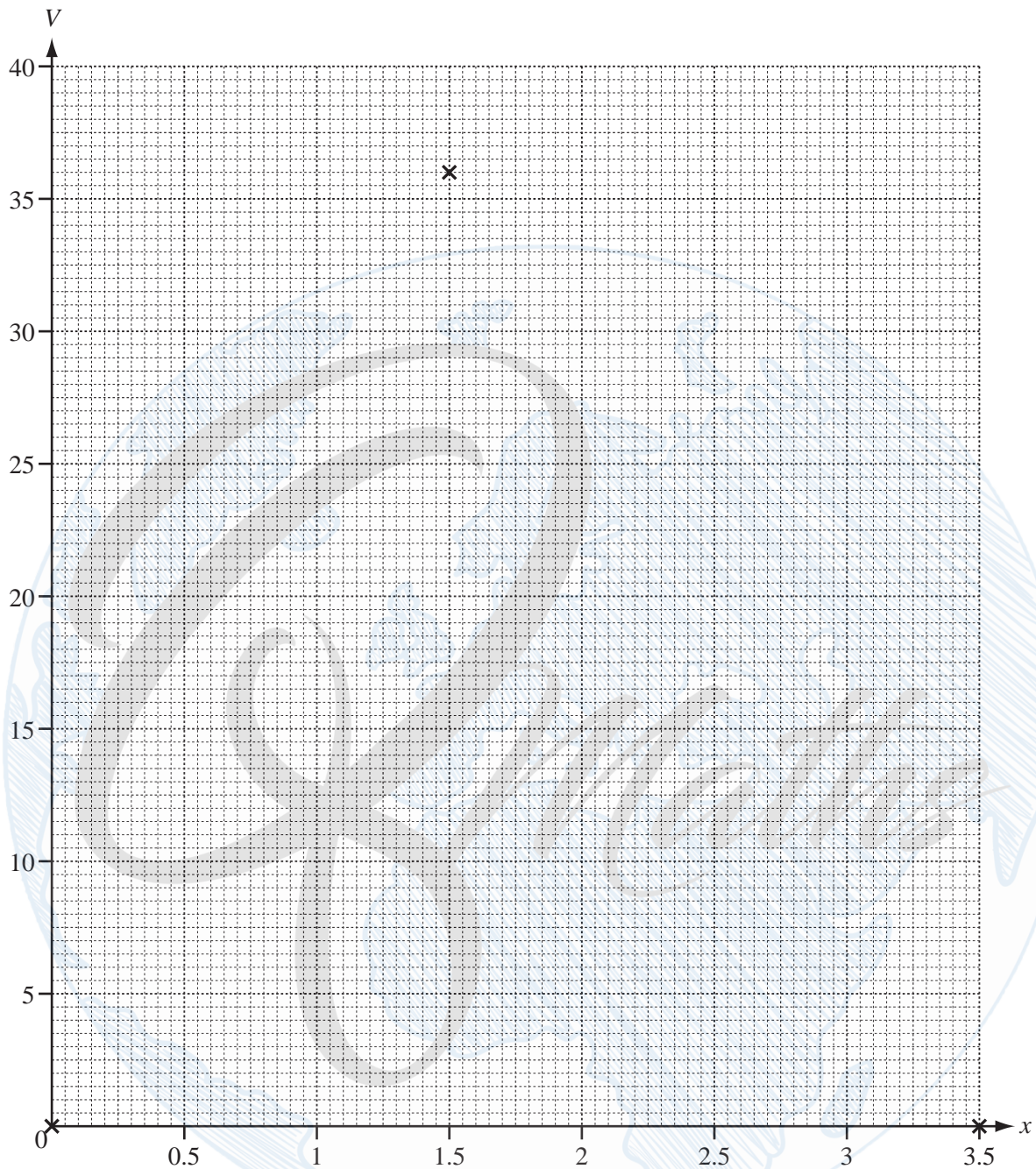
(c) Complete this table of values for  $V = 4x^3 - 32x^2 + 63x$ .

$x$	0	0.5	1	1.5	2	2.5	3	3.5
$V$	0		35	36	30		9	0

[2]

(d) On the grid opposite, draw the graph of  $V = 4x^3 - 32x^2 + 63x$  for  $0 \leq x \leq 3.5$ .  
Three of the points have been plotted for you.

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[3]

- (e) The volume of the box is at least  $30 \text{ cm}^3$ .  
Write down, as an inequality, the possible values of  $x$ .

Answer(e) ..... [2]

- (f) (i) Write down the maximum volume of the box.

Answer(f)(i) .....  $\text{cm}^3$  [1]

- (ii) Write down the value of  $x$  which gives the maximum volume.

Answer(f)(ii) ..... [1]

8 Sima sells  $x$  biscuits and  $y$  cakes.

(a) (i) She sells at least 100 biscuits.

Write down an inequality in  $x$ .

*Answer(a)(i)* ..... [1]

(ii) She sells at least 120 cakes.

Write down an inequality in  $y$ .

*Answer(a)(ii)* ..... [1]

(iii) She sells a maximum of 300 biscuits and cakes altogether.

Write down an inequality in  $x$  and  $y$

*Answer(a)(iii)* ..... [1]

(iv) Sima makes a profit of 40 cents on each biscuit and 80 cents on each cake.  
Her total profit is at least \$160.

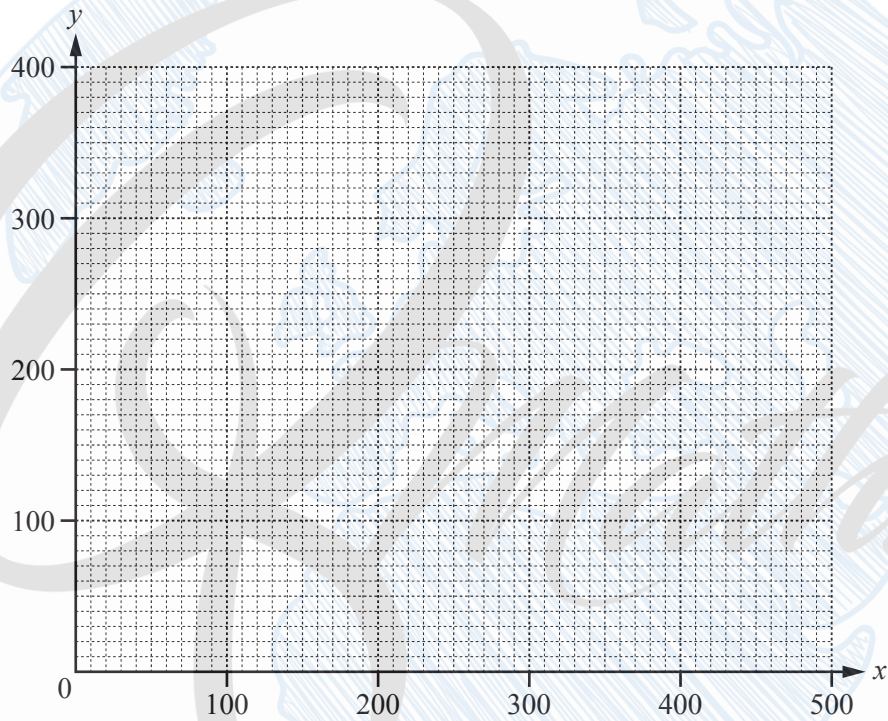
Show that  $x + 2y \geq 400$ .

*Answer(a)(iv)*

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[1]

(b) On the grid, draw four lines to show the four inequalities and shade the unwanted regions.



[6]

(c) Calculate Sima's maximum profit.  
Give your answer in dollars.

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Answer(c) \$ ..... [2]

4 Ali buys  $x$  rose bushes and  $y$  lavender bushes.

He buys:

- at least 5 rose bushes
- at most 8 lavender bushes
- at most 15 bushes in total
- more lavender bushes than rose bushes.

(a) (i) Write down four inequalities, in terms of  $x$  and/or  $y$ , to show this information.

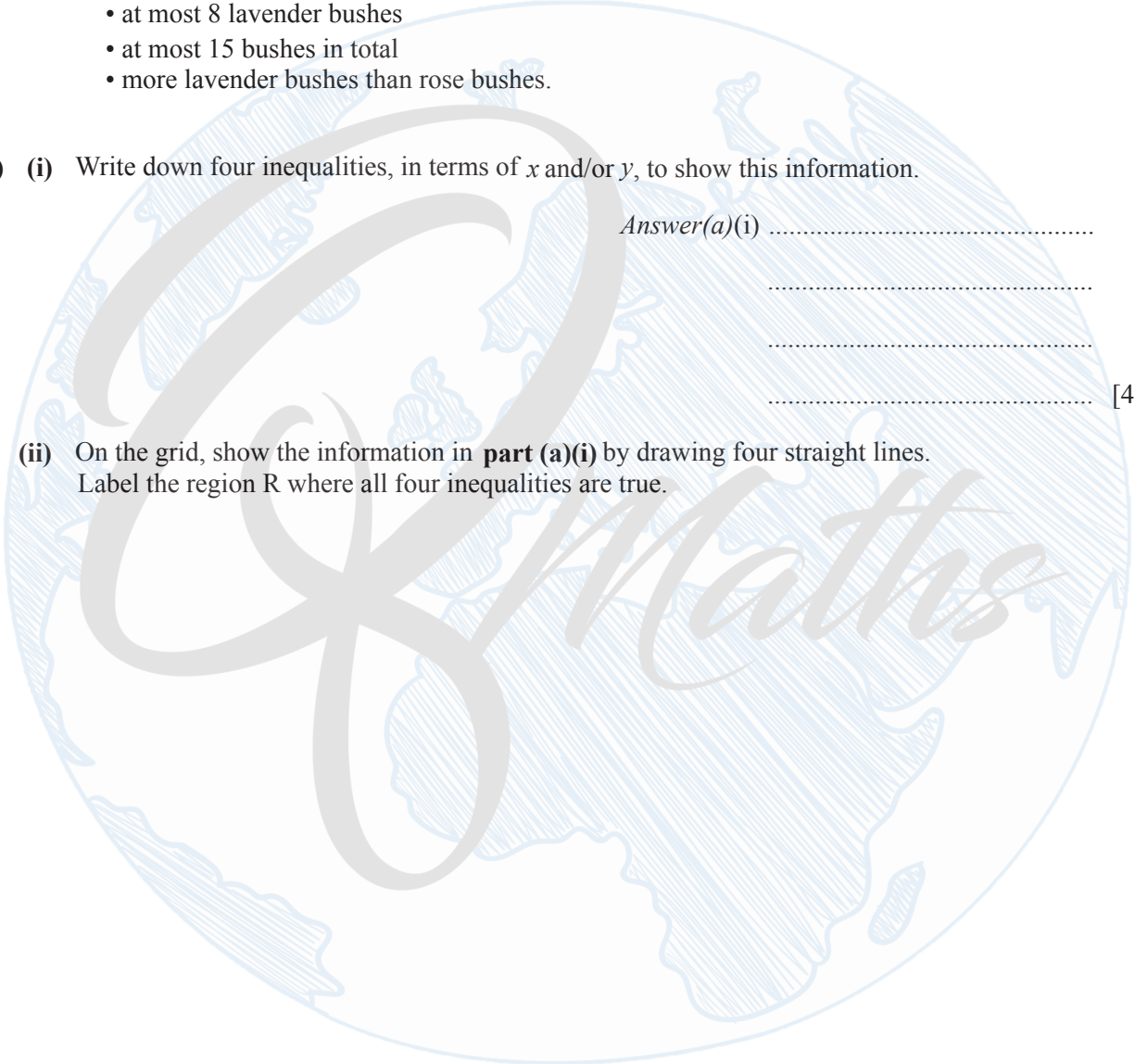
Answer(a)(i) .....

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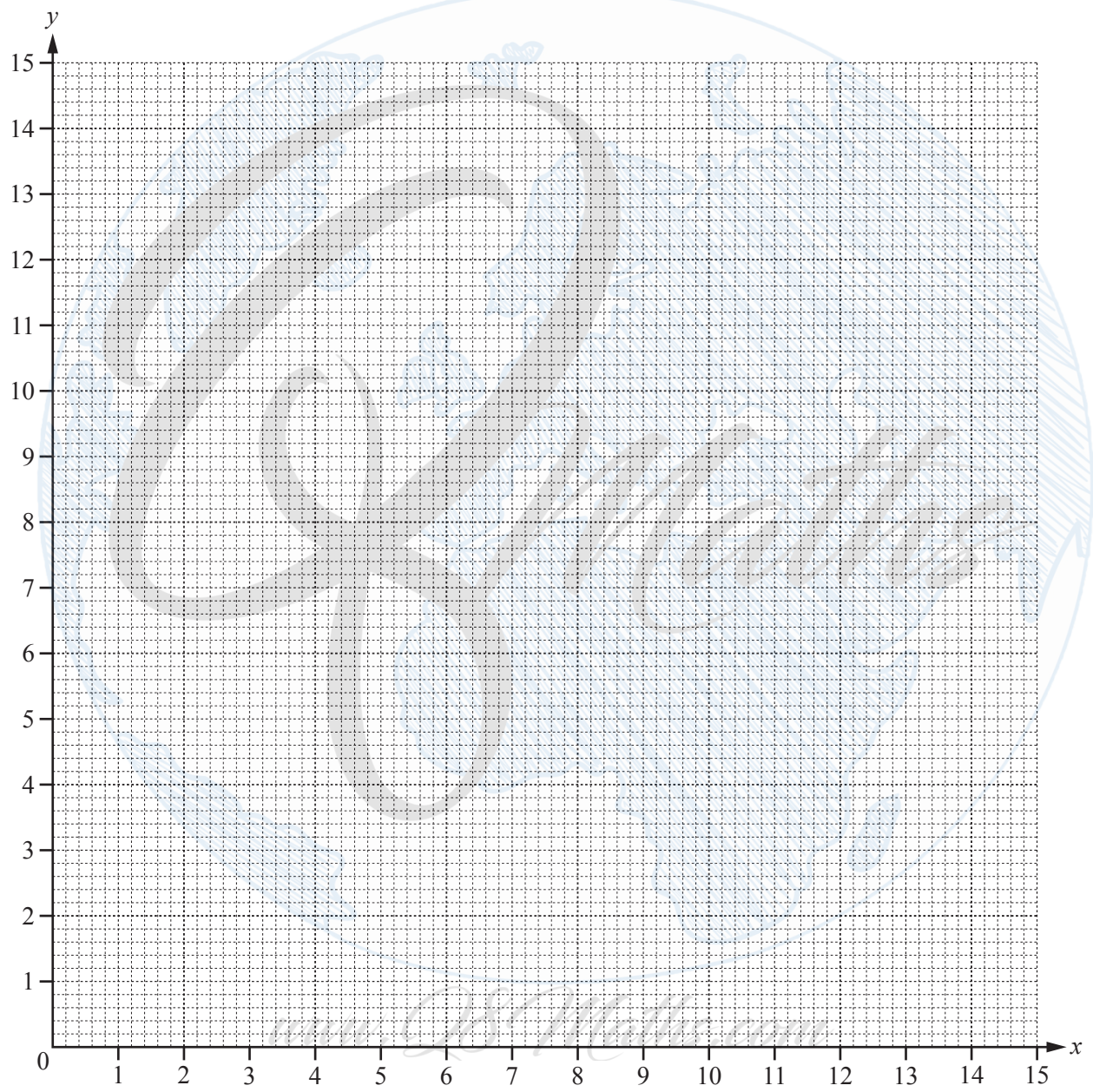
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..... [4]

(ii) On the grid, show the information in **part (a)(i)** by drawing four straight lines.  
Label the region R where all four inequalities are true.



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(b) Rose bushes cost \$6 each and lavender bushes cost \$4.50 each. [5]

What is the greatest amount of money Ali could spend?

Answer(b) \$ ..... [2]

- 10** The school cook buys potatoes in small sacks, each of mass 4 kg, and large sacks, each of mass 10 kg. He buys  $x$  small sacks and  $y$  large sacks. Today, he buys less than 80 kg of potatoes.

(a) Show that  $2x + 5y < 40$ .

*Answer(a)*

[1]

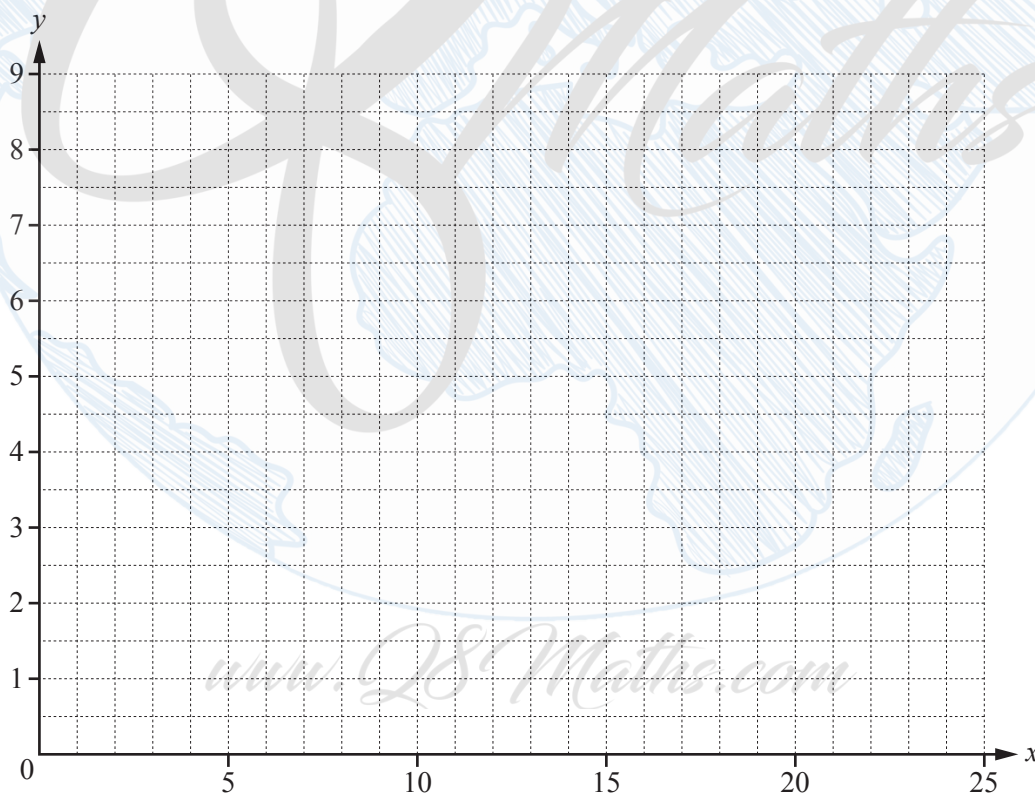
- (b) He buys more large sacks than small sacks.  
He buys no more than 6 large sacks.

Write down two inequalities to show this information.

*Answer(b)* .....

..... [2]

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



[5]

- (d) Find the greatest mass of potatoes the cook can buy today.

*Answer(d)* ..... kg [2]

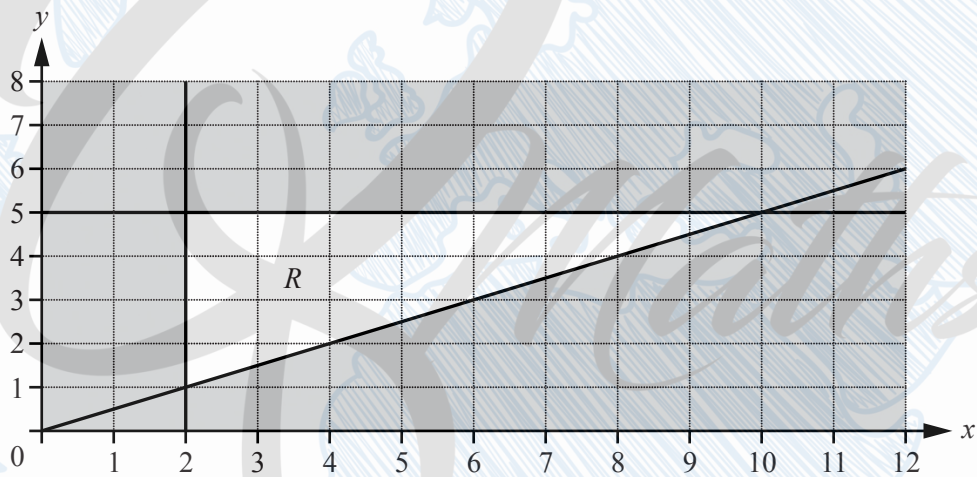


13) June 2018 V3

- 9 (a) Find the equation of the straight line that is perpendicular to the line  $y = \frac{1}{2}x + 1$  and passes through the point (1, 3).

..... [3]

(b)



- (i) Find the three inequalities that define the region  $R$ .

.....

.....

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- (ii) Find the point  $(x, y)$ , with integer co-ordinates, inside the region  $R$  such that  $3x + 5y = 35$ .

( ..... , ..... ) [2]