Question **(25 marks)**

(a) Expand the brackets and simplify $(5x - 4)(x + 1)$

(b) Express r in terms of the other variables in the equation $V = \pi r^2 h$

(c) Sarah tried to solve the equation as follows. She made a mistake on the second line.

$$\frac{w + 4}{3} - \frac{2w - 1}{5} = 1$$

$$5w + 20 - 6w - 3 = 15$$

$$17 - w = 15$$

$$w = 2$$

Circle her mistake and explain what she did wrong. You should provide the correct answer to the question also.

Question **(25 marks)**

(a) A hostel website gives the cost of staying for three nights in a hotel in Copenhagen as 3112.5 Danish kroner.

(i) Find the cost of the trip, in euro, if €1 is 7.5 Danish Kroner.

(ii) The cost of the trip includes a 3.5% service charge for the hostel website. Find, in euro, how much the hotel will get for the transaction, correct to the nearest cent.

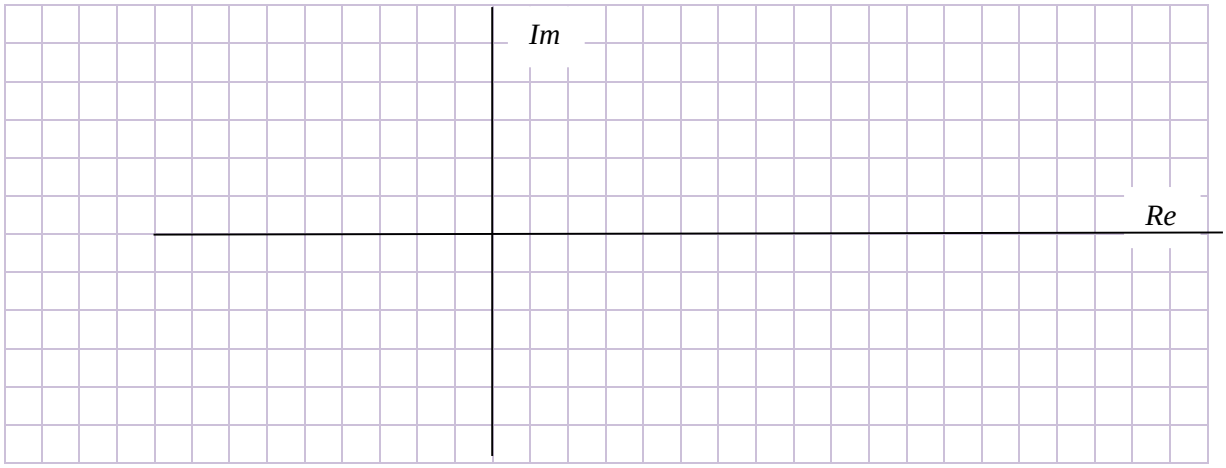
(b) A group of four friends, Jason, Philip, Nathalie and Ciara decide to book this deal. On the first night however, Jason loses his wallet which had €238 in it. Philip, Nathalie and Ciara decide to loan him the €238 in the ratio 2:5:7 respectively. How much does Jason receive from each person.

Question 3 **(25 marks)**

(i) Given $z = -3 + i$, write down $\bar{z}$, the complex conjugate of z.

(ii) Evaluate $z + \bar{z}$.

(iii) Show the three points z, $\bar{z}$ and $z + \bar{z}$ on an Argand Diagram.



(iv) Find $\frac{z}{1+3i}$, in the form $a + bi$.

Question **(25 marks)**

(a) Dots were used to create a pattern. The first three shapes in the pattern are shown.

Shape 1 Shape 2 Shape 3

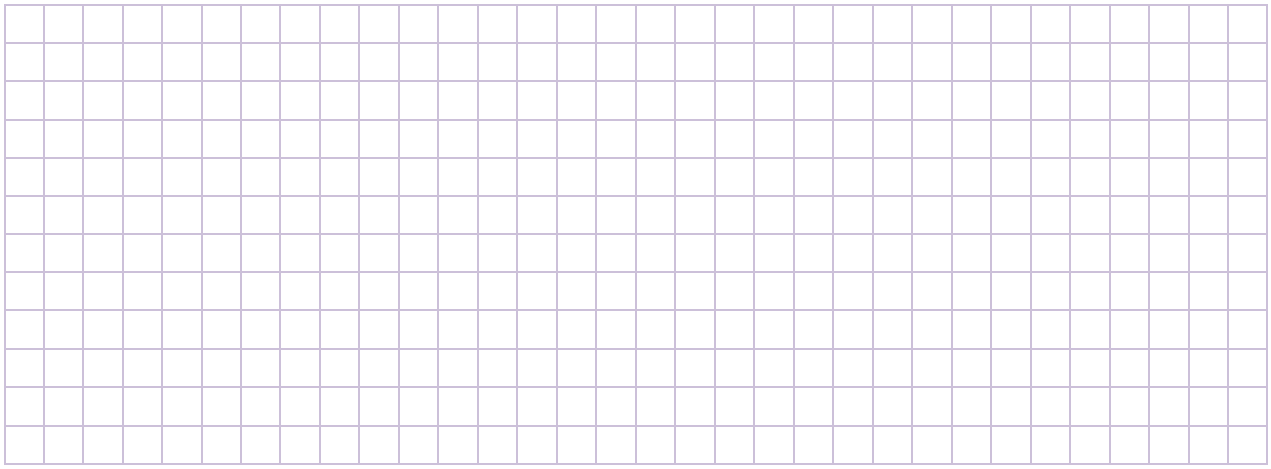
The number of dots used in each shape is recorded in the table.

Shape (S)	1	2	3
Number of Dots (N)	6	8	10

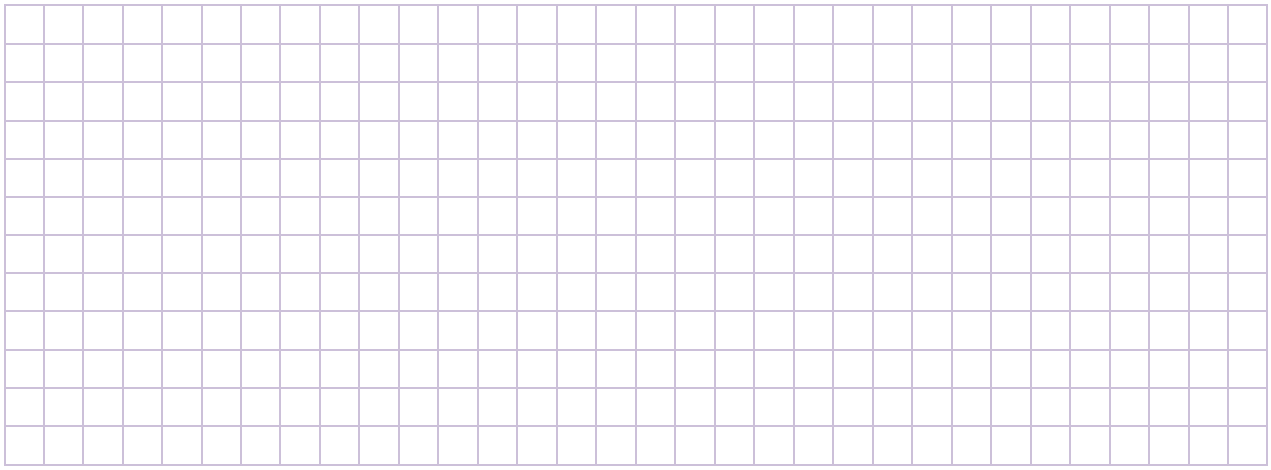
(i) Draw the next two shapes in the sequence

(ii) Síle thinks this is a Geometric pattern. Is she correct? Explain your answer fully.

(b) (i) Find an expression, T_n, for the number of dots in any shape of the sequence.

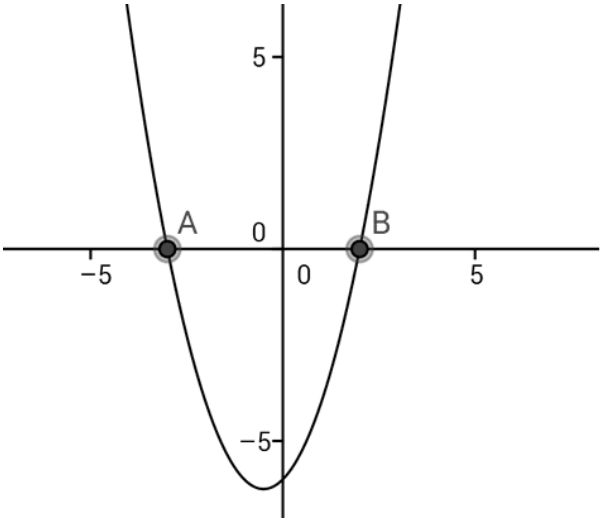


(ii) Hence, or otherwise, find the number of dots required to make Shape 156.



Question **(25 marks)**

(a) Part of the graph of the function $y = x^2 + x - 6$ is shown.



(i) Calculate the coordinates of points A and B.

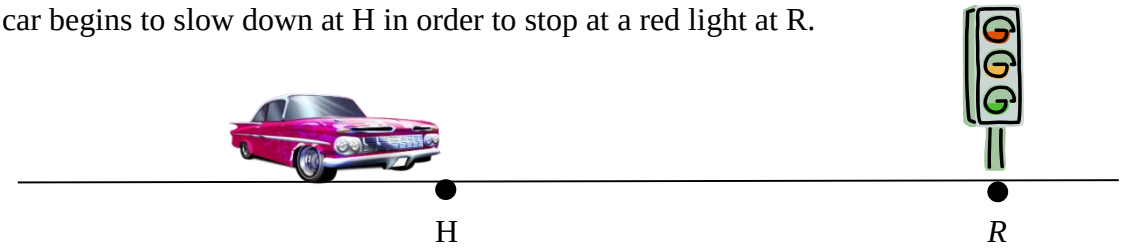
(ii) Find the derivative of the function $y = x^2 + x - 6$

(iii) Sketch the graph of the derivative of the function on the graph

(b) Explain why the derivative of the function $y = x^2 + x - 6$ has no turning points

Question **(25 marks)**

A car begins to slow down at H in order to stop at a red light at R.



The distance of the car from H, after *t* seconds, is given by $s = 11t - 2t^2$, where *s* is in metres.

(i) Find the speed of the car as it passes H.

(ii) Find the time taken to stop

(iii) The car stops exactly at *R*. Find the distance from *H* to *R*.

(iv) Find the acceleration of the car

Question **(50 marks)**

(a) Wind turbines, such as those shown, are used to generate power.

In theory, the power that could be generated by a wind turbine is modelled using the equation

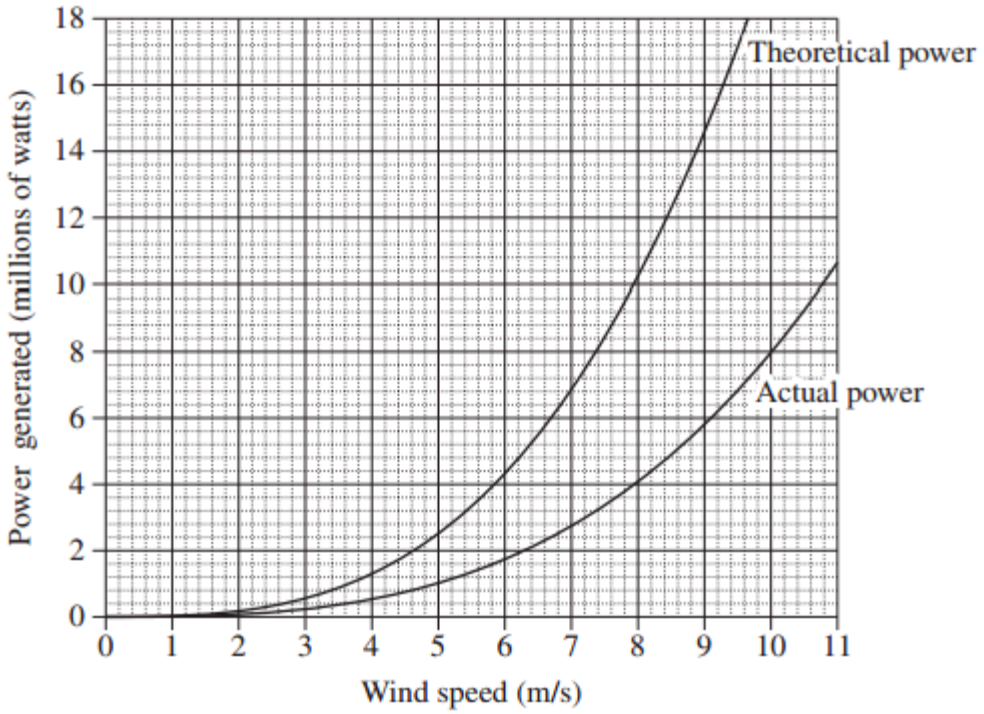
$$T = 20{,}000w^3$$

where T is the theoretical power generated, in watts and w is the speed of the wind, in metres per second.

(i) Using this equation, what is the theoretical power generated by a wind turbine if the wind speed is 7.3 m/s?

(ii) In practice however, the actual power generated by a wind turbine is only 40% of the theoretical power. If A is the actual power generated, in watts, write an equation for A in terms of w.

(b) The graph shown on the next page shows both the theoretical power generated and the actual power generated by a particular wind turbine.



(i) Using the graph, or otherwise, find the difference between the theoretical power and the actual power generated when the wind speed is 9 m/s.

(ii) A particular wind farm requires **at least** 4.4 million watts of actual power in order to be self-sufficient. What is the minimum wind speed required for the farm to be self-sufficient?

(c) A more accurate formula to calculate the power (P) generated by a wind turbine is

$$P = 0.61 \times \pi \times r^2 \times w^3$$

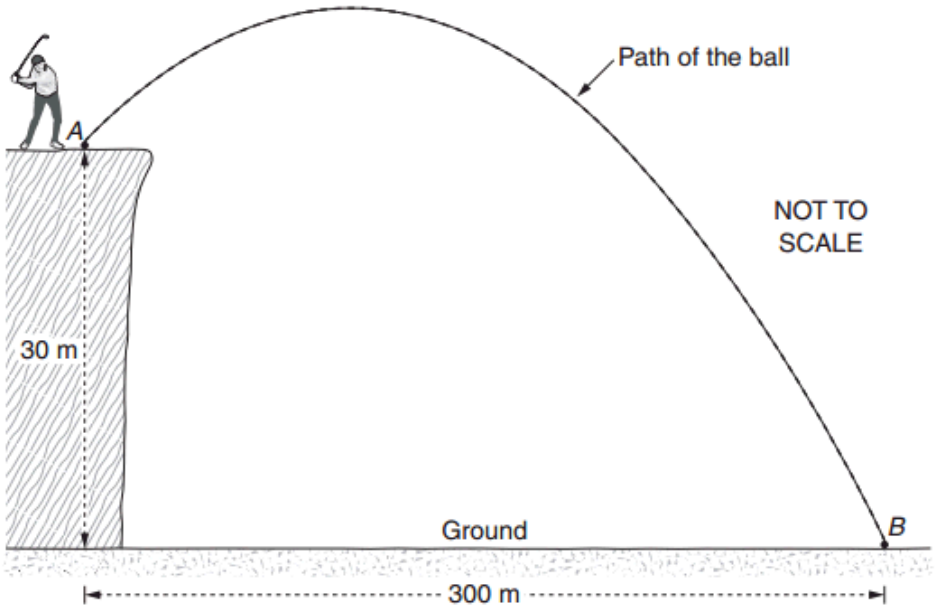
where *r* is the length of each blade, in metres *w* is the speed of the wind, in metres per second.

(i) Find the power generated by a wind turbine with a blade length of 43 metres, operating at a wind speed of 8 m/s, correct to two significant figures.

(ii) Using the formula above, what would be the percentage increase in the power generated, to two decimal places, by the same wind turbine of blade length 43 metres, if the wind speed increased by 10%? You may write the figure for the new power generated correct to the nearest whole number.

Question **(60 marks)**

A golf ball is hit from point A to point B, which is on the ground as shown. Point A is 30 m above the ground and the horizontal distance from point A to point B is 300 m.



(a) The path of the golf ball is modelled using the equation

$$h = 30 + 0.2d - 0.001d^2$$

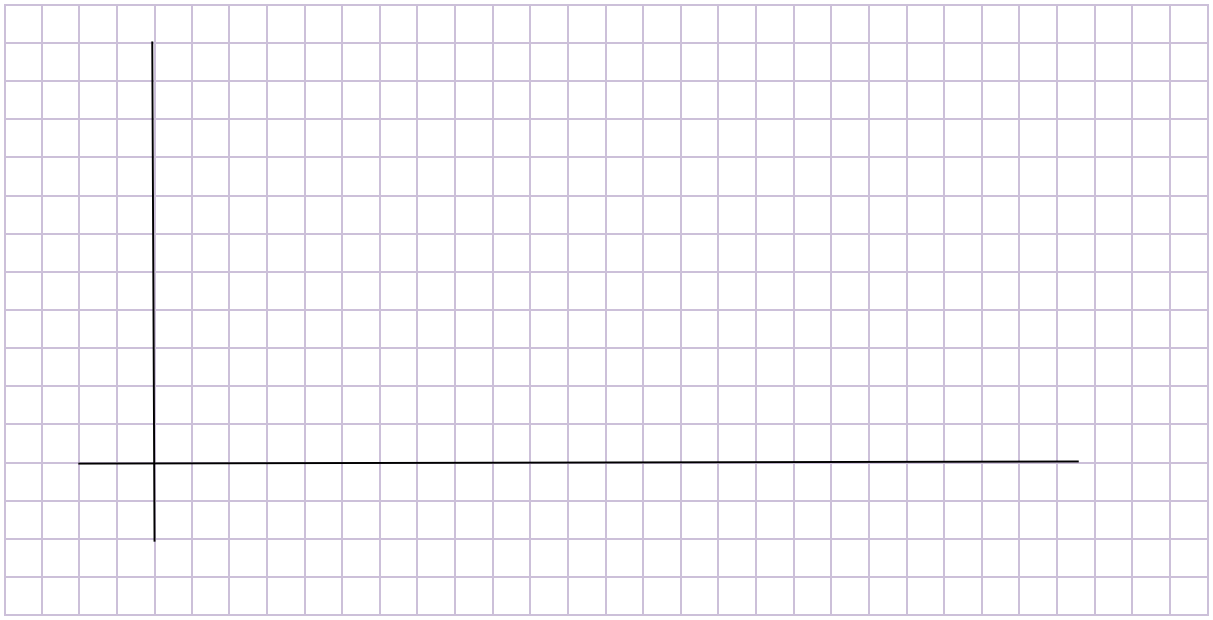
where h is the height of the golf ball above the ground in metres, and d is the horizontal distance of the golf ball from point A in metres.

(i) By using your calculator or otherwise, complete the table:

x	0	50	100	150	200	250	300
$h(x)$							

(ii) Using the values from your table, or otherwise, draw the graph of the function

$h = 30 + 0.2d - 0.001d^2$ in the grid below



(b) (i) From your graph, find the maximum height the ball reaches above the ground?

(ii) There are two occasions when the golf ball is at a height of 35 metres. What horizontal distance does the ball travel in the period between these two occasions? Show your work on your graph

(iii) What is the height of the ball above the ground when it still has to travel a horizontal distance of 50 metres to hit the ground at point B? Show work on your graph.

(c) (i) You calculated the maximum height of the graph in part (b) (i) already. Find the value of d which gives the maximum height.

(ii) Hence find the maximum height.

(iii) Explain fully what this maximum **point** means in the context of the question, i.e. explain the meaning of the x and y values found above in parts (c) (i) and (ii).

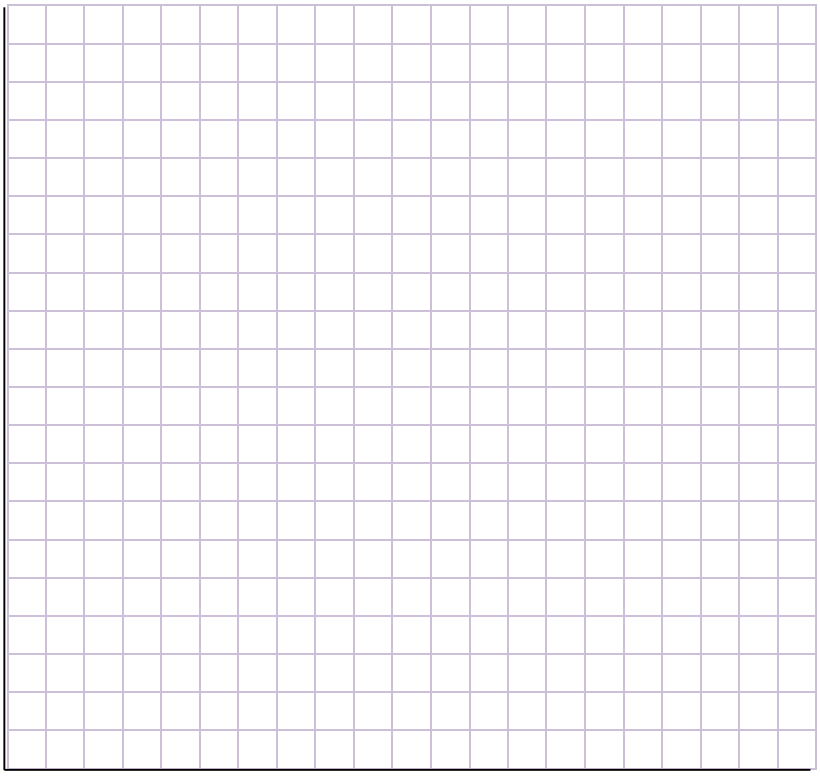
(iv) The graph of $h(d)$ is decreasing for all values of x shown. State whether you believe this to be true or false, explaining in detail why. You should use differentiation in your answer.

Question **(40 marks)**

Emma is employing Ian to build a deck at her house. She provides all the building material. She pays Ian €*P* for the number of hours, h, that he works. She also pays for Ian's travel to her home each day. Ian works for 8 hours each day. He knows the deck will take more than 4 hours to build. To help Emma know how much she can expect to pay, Ian provides the following table:

Number of hours worked (h)	***Payment (P)***
4	€160
5	€185
6	€210
7	€235
8	€260
9	€345
10	€370

(a) On the grid below, plot a graph showing the payment required for the number of hours worked, plotting time, in hours, along the *x* axis.

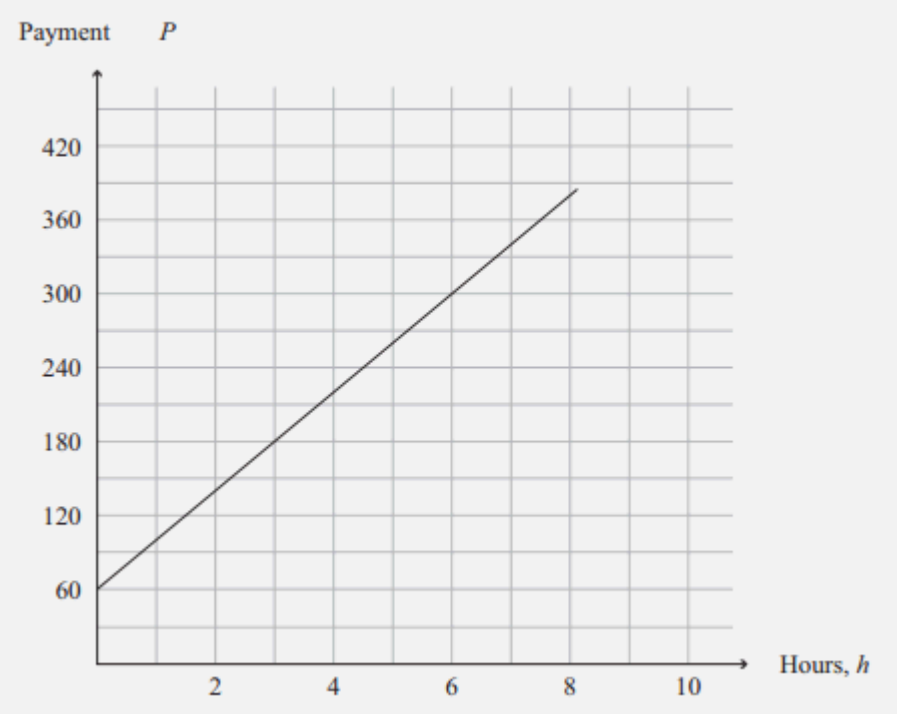


(b) (i) How much does Ian charge for his travel each day?

(ii) Explain why the graph rises more steeply after 8 hours.

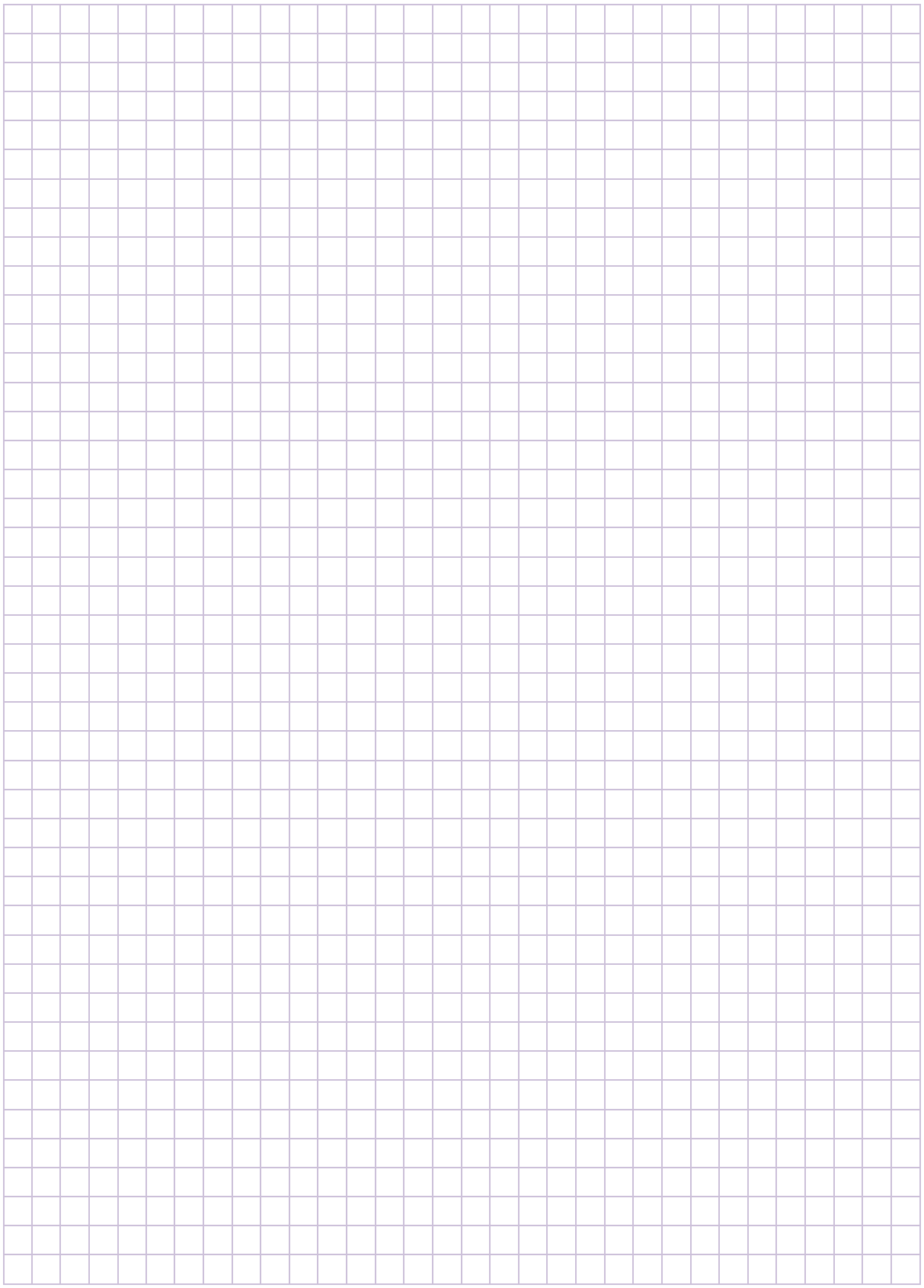
(iii) What would Emma expect to pay if the work took 30 hours? Explain how you arrived at your answer.

(c) (i) Another builder gives Emma a graph, showing the amount she would charge for 8 hours work.



Give the rule for the payment that this builder would receive for the first 8 hours that she worked.

(ii) Which builder is better value for the work Emma needs done, assuming the work will take 8 hours to complete?

You may use this page for extra work.

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