

# 2. Equations, Inequalities and Quadratics

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10. The equation  $kx^2 + 4kx + 3 = 0$ , where  $k$  is a constant, has no real roots.

Prove that

$$0 \leq k < \frac{3}{4} \tag{4}$$

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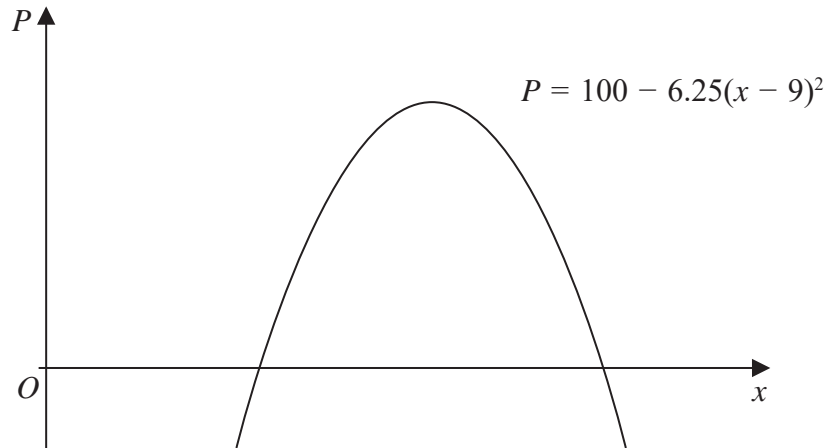
(Total for Question 10 is 4 marks)







6.



**Figure 1**

A company makes a particular type of children’s toy.

The annual profit made by the company is modelled by the equation

$$P = 100 - 6.25(x - 9)^2$$

where  $P$  is the profit measured in thousands of pounds and  $x$  is the selling price of the toy in pounds.

A sketch of  $P$  against  $x$  is shown in Figure 1.

Using the model,

- (a) explain why £15 is not a sensible selling price for the toy. (2)

Given that the company made an annual profit of more than £80 000

- (b) find, according to the model, the least possible selling price for the toy. (3)

The company wishes to maximise its annual profit.

State, according to the model,

- (c) (i) the maximum possible annual profit,  
 (ii) the selling price of the toy that maximises the annual profit. (2)

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14. A curve  $C$  has equation  $y = f(x)$  where

$$f(x) = -3x^2 + 12x + 8$$

(a) Write  $f(x)$  in the form

$$a(x + b)^2 + c$$

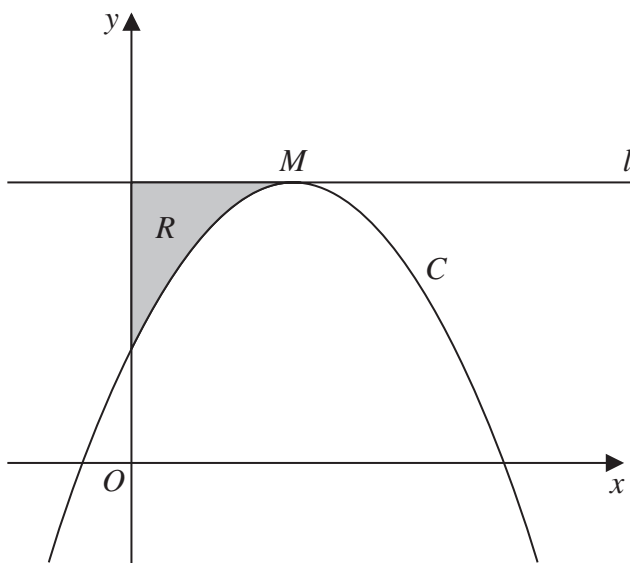
where  $a$ ,  $b$  and  $c$  are constants to be found.

(3)

The curve  $C$  has a maximum turning point at  $M$ .

(b) Find the coordinates of  $M$ .

(2)



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12.

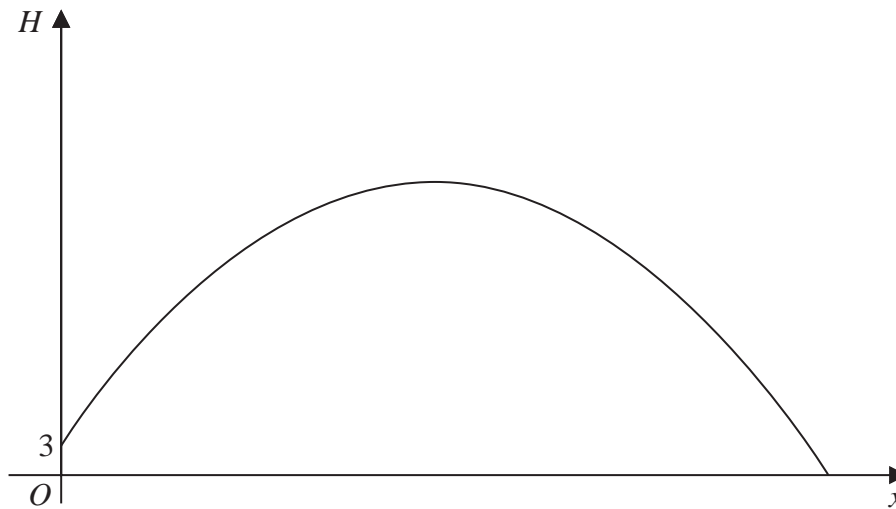


Figure 3

Figure 3 is a graph of the trajectory of a golf ball after the ball has been hit until it first hits the ground.

The vertical height,  $H$  metres, of the ball above the ground has been plotted against the horizontal distance travelled,  $x$  metres, measured from where the ball was hit.

The ball is modelled as a particle travelling in a vertical plane above horizontal ground.

Given that the ball

- is hit from a point on the top of a platform of vertical height 3 m above the ground
- reaches its maximum vertical height after travelling a horizontal distance of 90 m
- is at a vertical height of 27 m above the ground after travelling a horizontal distance of 120 m

Given also that  $H$  is modelled as a **quadratic** function in  $x$

- (a) find  $H$  in terms of  $x$  (5)
- (b) Hence find, according to the model,
- (i) the maximum vertical height of the ball above the ground,
  - (ii) the horizontal distance travelled by the ball, from when it was hit to when it first hits the ground, giving your answer to the nearest metre. (3)
- (c) The possible effects of wind or air resistance are two limitations of the model.  
Give one other limitation of this model. (1)

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11.

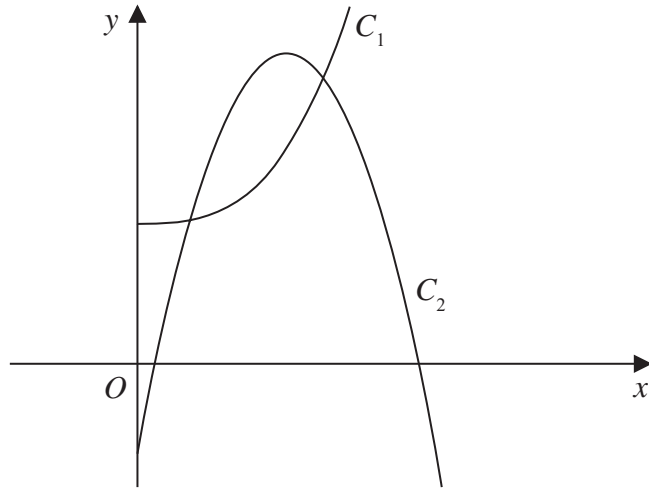


Figure 4

Figure 4 shows a sketch of part of the curve  $C_1$  with equation

$$y = 2x^3 + 10 \quad x > 0$$

and part of the curve  $C_2$  with equation

$$y = 42x - 15x^2 - 7 \quad x > 0$$

(a) Verify that the curves intersect at  $x = \frac{1}{2}$

(2)

The curves intersect again at the point  $P$

(b) Using algebra and showing all stages of working, find the exact  $x$  coordinate of  $P$

(5)

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9.

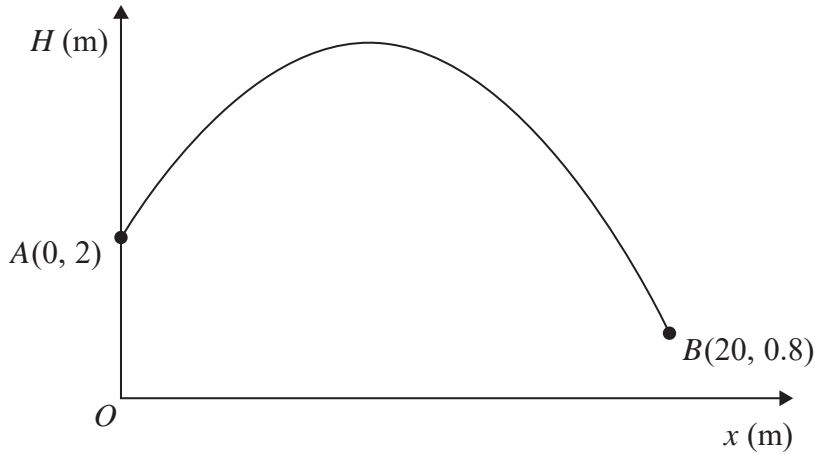


Figure 3

The graph in Figure 3 shows the path of a small ball.

The ball travels in a vertical plane above horizontal ground.

The ball is thrown from the point represented by  $A$  and caught at the point represented by  $B$ .

The height,  $H$  metres, of the ball above the ground has been plotted against the horizontal distance,  $x$  metres, measured from the point where the ball was thrown.

With respect to a fixed origin  $O$ , the point  $A$  has coordinates  $(0, 2)$  and the point  $B$  has coordinates  $(20, 0.8)$ , as shown in Figure 3.

The ball reaches its maximum height when  $x = 9$

A quadratic function, linking  $H$  with  $x$ , is used to model the path of the ball.

(a) Find  $H$  in terms of  $x$ . (4)

(b) Give one limitation of the model. (1)

Chandra is standing directly under the path of the ball at a point 16 m horizontally from  $O$ .

Chandra can catch the ball if the ball is less than 2.5 m above the ground.

(c) Use the model to determine if Chandra can catch the ball. (2)

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