1. A transport truck is on a two-lane road and approaches an underpass that is shaped like a parabola. The truck is 3 m wide and 4 m high. The bridge is 6 m high and 10 m wide at its base.

   (a) Show that the truck will not fit under the bridge if it stays in the right lane.

   (b) Will the truck fit under the bridge if it is allowed to cross the centre line on the road?

2. A popular clothing store sells t-shirts with the company's logo on them. Last year, the store sold 600 shirts at $15 each. The store manager is planning to increase the price. A consumer survey shows that for every $1 increase, there will be a drop of 30 sales per year.

   (a) What should the selling price be to maximize the annual revenue?

   (b) What is the maximum annual revenue from shirt sales?

3. Find the maximum area of a triangle, in square centimetres, if the sum of the base and the height is 13 cm.

4. The path of a thrown baseball can be modelled by the function

   $$h = -0.004d^2 + 0.14d + 2$$

   where h is the height of the ball, in metres, and d is the horizontal distance of the ball from the player, in metres.

   (a) What what is the maximum height reached by the ball?

   (b) What is the horizontal distance of the ball from the player when it reaches its maximum height?

   (c) How far from the ground is the ball when the player releases it?

5. In a nutrient medium, the rate of increase in the surface area of a cell culture can be modelled by the quadratic function

   $$S = -0.008t^2 + 0.04t$$

   where S is the rate of increase in the surface area, in square millimetres per hour, and t is the time, in hours, since the culture began growing. Find the maximum rate of increase in the surface area and the time taken to reach the maximum.

6. Owachomo Natural Bridge is found in Natural Bridges National Monument in Utah. If the origin $(0, 0)$ is located at one end of the natural arch, the curve can be modelled by the equation

$$h = -0.043d^2 + 2.365d$$

where h is the height, in metres, and d metres is the horizontal distance from the origin.

(a) What what is the maximum height of the arch, to the nearest hundredth of a metre?

(b) What is the width of the arch at its base?

7. A rectangular corral is to be built using 70 m of fencing.

(a) If the fencing is to enclose all four sides of the corral, what is the maximum possible area of the corral, in square metres?

(b) What are the dimensions of the largest corral in part (a)?

(c) If the corral is built with the wall of a large barn as one side and with the fencing enclosing the other three sides, what is the maximum possible area of the corral, in square metres?

(d) What are the dimensions of the largest corral in part (c)?

(e) The corral is built with the wall of a large barn as one side, with fencing enclosing the other three sides, and with a length of fence parallel to the two sections connected to the barn. The interior fencing divides the entire corral into two equal sections. What is the maximum possible area of each section of the corral, in square metres?

Barn

Fence
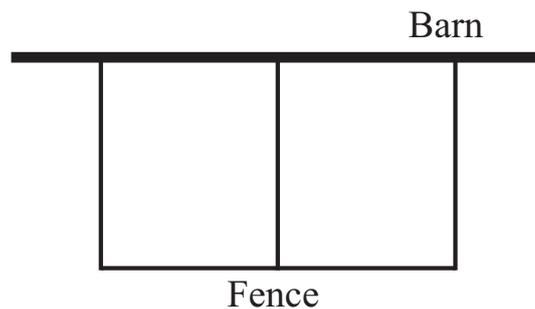
Question 7, Part (e)

8. Two whole numbers differ by 3 and the sum of their squares is 89. What are the numbers?

9. Is it possible for a rectangle with a perimeter of 44 cm to have each of the following areas? If so, find the dimensions of the rectangle.

   (a) 125 cm^2 (b) 121 cm^2 (c) 117 cm^2

10. The difference between the length of the hypotenuse and the length of the next longest side of a right triangle is 3 cm. The difference between the two perpendicular sides is 3 cm. Find the three side lengths.

11. The equation $h = -5t^2 + 20t + 2$ gives the approximate height h metres, of a thrown football as a function of time t seconds, since it was thrown. The ball hit the ground before it could be caught.

    (a) How long was the ball in the air to the nearest tenth of a second?

    (b) For how many seconds was the height of the ball at least 17 m?

12. A mural is to be painted on a wall that is 15 m long and 12 m high. A border of uniform width is to surround the mural. If the mural is to cover 75% of the area of the wall and the border 25%, how wide must the border be, to the nearest hundredth of a metre?

13. A rectangular swimming pool measuring 10 m by 4 m is surrounded by a deck of uniform width. The combined area of the pool and the deck is 135 m^2. What is the width of the deck?

14. You are designing a video game and for a particular animation sequence you need a rectangle that changes size according to a simple rule. The rectangle starts out with a length of 100 mm and a height of 20 mm. Every time the height increases by 4 mm the length must decrease by 2 mm.

    (a) What is the maximum area of the rectangle?

    (b) What are the dimension of the largest rectangle in part (a)?

15. Find the minimum product of two numbers whose difference is 17. What are the two numbers?

16. Two positive integers are in the ratio 1:3. If their sum is added to their product, the result is 224. Find the integers.