

---

# SL Paper 1

- a. The equation of the straight line  $L_1$  is  $y = 2x - 3$ . [1]

Write down the  $y$ -intercept of  $L_1$  .

- b. Write down the gradient of  $L_1$  . [1]

- c. The line  $L_2$  is parallel to  $L_1$  and passes through the point  $(0, 3)$  . [1]

Write down the equation of  $L_2$  .

- d. The line  $L_3$  is perpendicular to  $L_1$  and passes through the point  $(-2, 6)$ . [1]

Write down the gradient of  $L_3$ .

- e. Find the equation of  $L_3$  . Give your answer in the form  $ax + by + d = 0$  , where  $a$  ,  $b$  and  $d$  are integers. [2]
- 

The equation of a line  $L_1$  is  $2x + 5y = -4$ .

- a. Write down the gradient of the line  $L_1$ . [1]

- b. A second line  $L_2$  is perpendicular to  $L_1$ . [1]

Write down the gradient of  $L_2$ .

- c. The point  $(5, 3)$  is on  $L_2$ . [2]

Determine the equation of  $L_2$ .

- d. Lines  $L_1$  and  $L_2$  intersect at point P. [2]

Using your graphic display calculator or otherwise, find the coordinates of P.

---

Triangle ABC is such that AC is 7 cm, angle ABC is  $65^\circ$  and angle ACB is  $30^\circ$ .

- a. Sketch the triangle writing in the side length and angles. [1]

- b. Calculate the length of AB. [2]

- c. Find the area of triangle ABC. [3]
-

The equation of the line  $R_1$  is  $2x + y - 8 = 0$  . The line  $R_2$  is perpendicular to  $R_1$  .

a. Calculate the gradient of  $R_2$  . [2]

b. The point of intersection of  $R_1$  and  $R_2$  is  $(4, k)$  . [4]

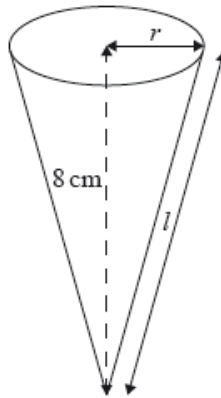
Find

(i) the value of  $k$  ;

(ii) the equation of  $R_2$  .

---

A type of candy is packaged in a right circular cone that has volume  $100 \text{ cm}^3$  and vertical height  $8 \text{ cm}$ .



a. Find the radius,  $r$ , of the circular base of the cone. [2]

b. Find the slant height,  $l$ , of the cone. [2]

c. Find the curved surface area of the cone. [2]

---

The straight line,  $L_1$ , has equation  $y = -2x + 5$ .

a. Write down the gradient of  $L_1$  . [1]

b. Line  $L_2$ , is perpendicular to line  $L_1$ , and passes through the point  $(4, 5)$  . [3]

(i) Write down the gradient of  $L_2$  .

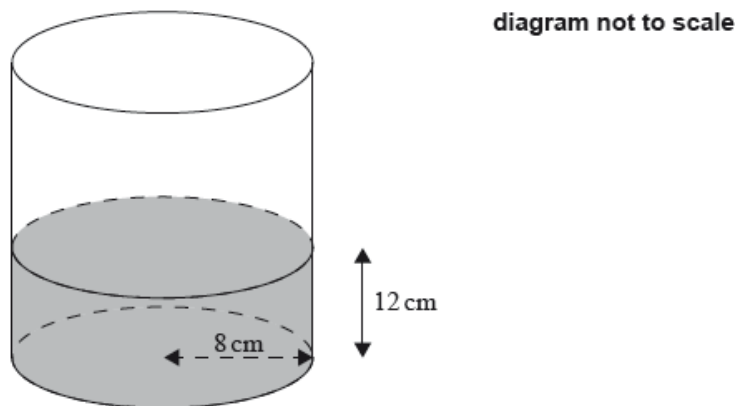
(ii) Find the equation of  $L_2$  .

c. Line  $L_2$ , is perpendicular to line  $L_1$ , and passes through the point  $(4, 5)$  . [2]

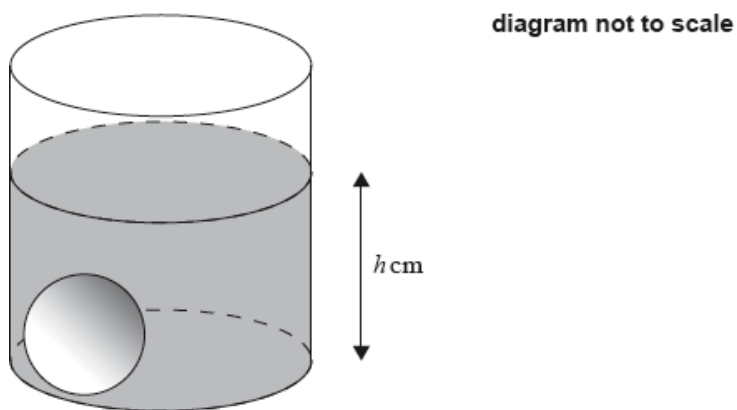
Write down the coordinates of the point of intersection of  $L_1$  and  $L_2$  .

---

A cylindrical container with a radius of 8 cm is placed on a flat surface. The container is filled with water to a height of 12 cm, as shown in the following diagram.



A heavy ball with a radius of 2.9 cm is dropped into the container. As a result, the height of the water increases to  $h$  cm, as shown in the following diagram.



- a. Find the volume of water in the container. [2]
- b. Find the value of  $h$ . [4]

$P(4, 1)$  and  $Q(0, -5)$  are points on the coordinate plane.

- a. Determine the [4]
  - (i) coordinates of  $M$ , the midpoint of  $P$  and  $Q$ .
  - (ii) gradient of the line drawn through  $P$  and  $Q$ .
  - (iii) gradient of the line drawn through  $M$ , perpendicular to  $PQ$ .
- b. The perpendicular line drawn through  $M$  meets the  $y$ -axis at  $R(0, k)$ . [2]  
Find  $k$ .

The area of a circle is equal to  $8 \text{ cm}^2$ .

a. Find the radius of the circle.

[2]

b. This circle is the base of a **solid** cylinder of height 25 cm.

[1]

Write down the volume of the **solid** cylinder.

c. This circle is the base of a **solid** cylinder of height 25 cm.

[3]

Find the **total** surface area of the **solid** cylinder.

---

Triangle ABC is drawn such that angle ABC is  $90^\circ$ , angle ACB is  $60^\circ$  and AB is 7.3 cm.

a. (i) Sketch a diagram to illustrate this information. Label the points A, B, C. Show the angles  $90^\circ$ ,  $60^\circ$  and the length 7.3 cm on your diagram.

[3]

(ii) Find the length of BC.

b. Point D is on the straight line AC extended and is such that angle CDB is  $20^\circ$ .

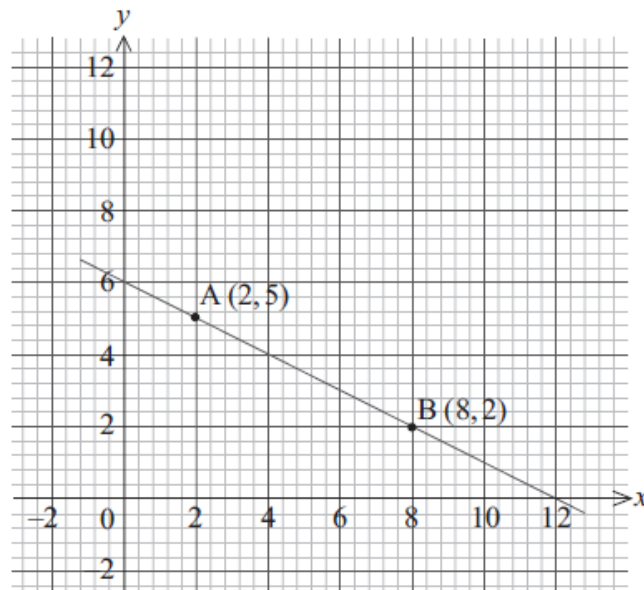
[3]

(i) Show the point D and the angle  $20^\circ$  on your diagram.

(ii) Find the size of angle CBD.

---

A and B are points on a straight line as shown on the graph below.



a. Write down the y-intercept of the line AB.

[1]

b. Calculate the gradient of the line AB.

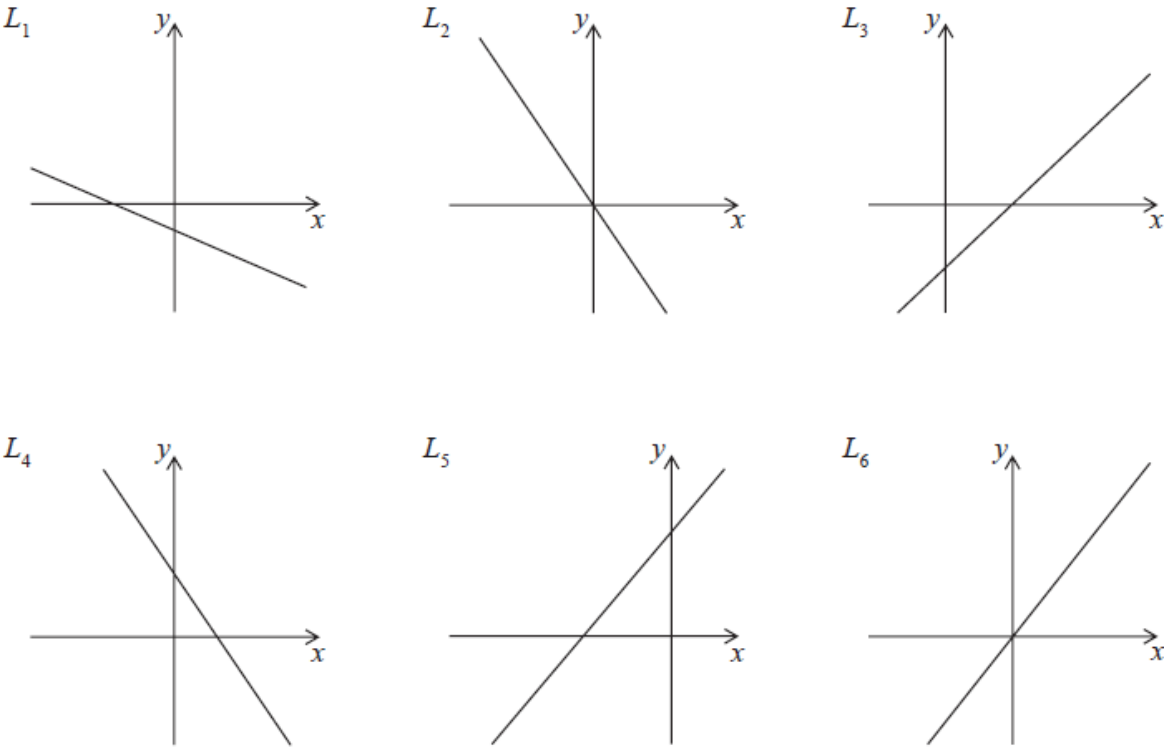
[2]

- c. The acute angle between the line AB and the  $x$ -axis is  $\theta$ .

Show  $\theta$  on the diagram.
- d. The acute angle between the line AB and the  $x$ -axis is  $\theta$ .

Calculate the size of  $\theta$ .

The following diagrams show six lines with equations of the form  $y = mx + c$ .



In the table below there are four possible conditions for the pair of values  $m$  and  $c$ . Match each of the given conditions with one of the lines drawn above.

Condition	Line
$m > 0$ and $c > 0$	
$m < 0$ and $c > 0$	
$m < 0$ and $c < 0$	
$m > 0$ and $c < 0$	

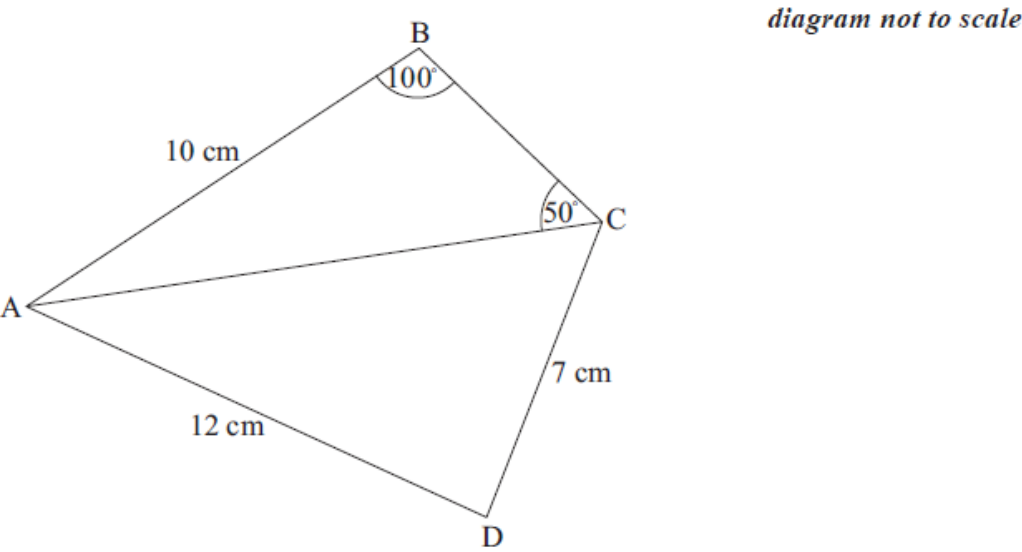
- a. A ladder is standing on horizontal ground and leaning against a vertical wall. The length of the ladder is 4.5 metres. The distance between the bottom of the ladder and the base of the wall is 2.2 metres.

Use the above information to sketch a labelled diagram showing the ground, the ladder and the wall.
- b. Calculate the distance between the top of the ladder and the base of the wall.

c. Calculate the **obtuse** angle made by the ladder with the ground. [3]

The quadrilateral ABCD has  $AB = 10\text{ cm}$ ,  $AD = 12\text{ cm}$  and  $CD = 7\text{ cm}$ .

The size of angle ABC is  $100^\circ$  and the size of angle ACB is  $50^\circ$ .



a. Find the length of AC in centimetres. [3]

b. Find the size of angle ADC. [3]

The straight line,  $L_1$ , has equation  $2y - 3x = 11$ . The point A has coordinates (6, 0).

a. Give a reason why  $L_1$  **does not** pass through A. [1]

b. Find the gradient of  $L_1$ . [2]

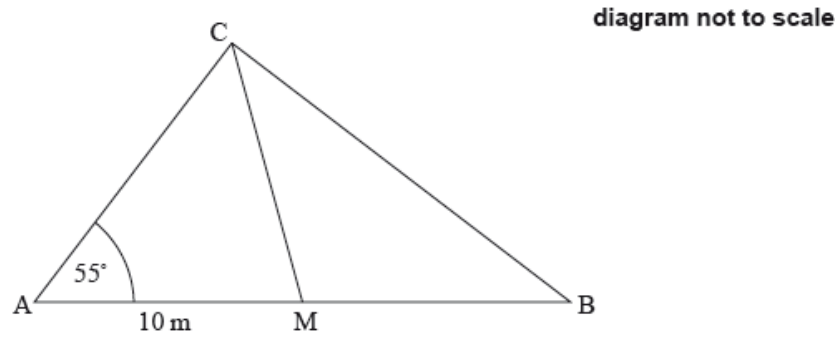
c.  $L_2$  is a line perpendicular to  $L_1$ . The equation of  $L_2$  is  $y = mx + c$ . [1]

Write down the value of  $m$ .

d.  $L_2$  **does** pass through A. [2]

Find the value of  $c$ .

The diagram shows a triangle ABC. The size of angle  $\hat{CAB}$  is  $55^\circ$  and the length of AM is 10 m, where M is the midpoint of AB. Triangle CMB is isosceles with  $CM = MB$ .



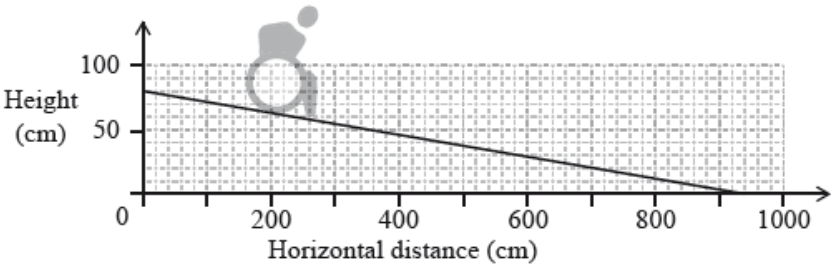
- a. Write down the length of MB. [1]
- b. Find the size of angle  $\hat{CMB}$ . [2]
- c. Find the length of CB. [3]

The coordinates of point A are  $(-4, p)$  and the coordinates of point B are  $(2, -3)$  .

The mid-point of the line segment AB, has coordinates  $(q, 1)$  .

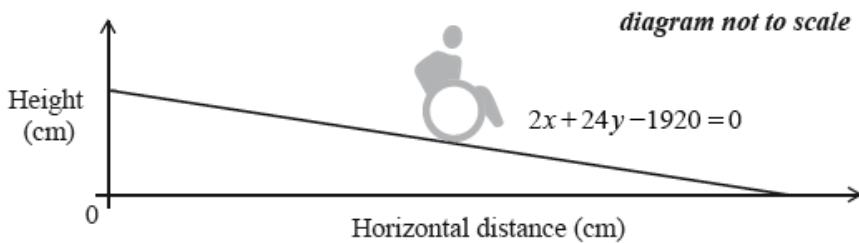
- a. Find the value of [4]
  - (i)  $q$  ;
  - (ii)  $p$  .
- b. Calculate the distance AB. [2]

The diagram shows a wheelchair ramp, A, designed to descend from a height of 80 cm.



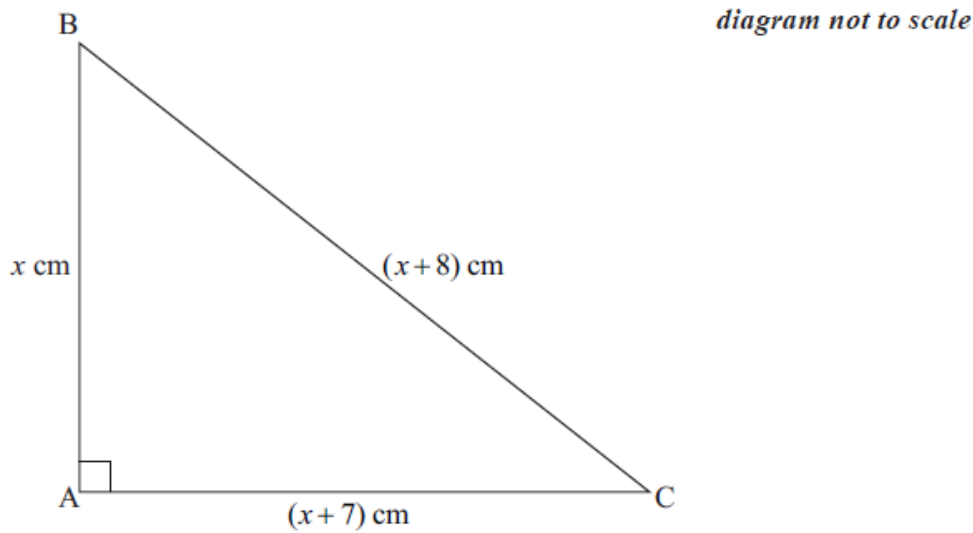
- a. Use the diagram above to calculate the gradient of the ramp. [1]
- b. The gradient for a **safe** descending wheelchair ramp is  $-\frac{1}{12}$ . [1]

Using your answer to part (a), comment on why wheelchair ramp A is **not safe**.
- c. The equation of a second wheelchair ramp, B, is  $2x + 24y - 1920 = 0$ . [4]



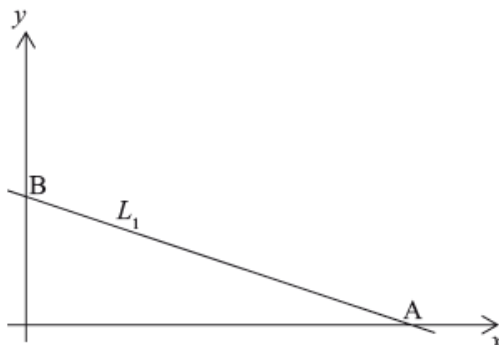
- (i) Determine whether wheelchair ramp B is safe or not. Justify your answer.
- (ii) Find the horizontal distance of wheelchair ramp B.

In the diagram,  $\hat{BAC} = 90^\circ$ . The length of the three sides are  $x$  cm,  $(x + 7)$  cm and  $(x + 8)$  cm.



- a. Write down and **simplify** a quadratic equation in  $x$  which links the three sides of the triangle. [3]
- b. Solve the quadratic equation found in part (a). [2]
- c. Write down the value of the perimeter of the triangle. [1]

The diagram shows the straight line  $L_1$ , which intersects the  $x$ -axis at  $A(6, 0)$  and the  $y$ -axis at  $B(0, 2)$ .





- a. Write down the coordinates of M, the midpoint of line segment AB. [2]
- b. Calculate the gradient of  $L_1$ . [2]
- c. The line  $L_2$  is parallel to  $L_1$  and passes through the point (3, 2). [2]
- Find the equation of  $L_2$ . Give your answer in the form  $y = mx + c$ .
- 

A straight line,  $L_1$ , has equation  $x + 4y + 34 = 0$ .

- a. Find the gradient of  $L_1$ . [2]
- b. The equation of line  $L_2$  is  $y = mx$ .  $L_2$  is perpendicular to  $L_1$ . [2]
- Find the value of  $m$ .
- c. The equation of line  $L_2$  is  $y = mx$ .  $L_2$  is perpendicular to  $L_1$ . [2]
- Find the coordinates of the point of intersection of the lines  $L_1$  and  $L_2$ .
- 

- a. The equation of line  $L_1$  is  $y = 2.5x + k$ . Point A (3, -2) lies on  $L_1$ . [2]
- Find the value of  $k$ .
- b. The line  $L_2$  is perpendicular to  $L_1$  and intersects  $L_1$  at point A. [1]
- Write down the gradient of  $L_2$ .
- c. Find the equation of  $L_2$ . Give your answer in the form  $y = mx + c$ . [2]
- d. Write your answer to part (c) in the form  $ax + by + d = 0$  where  $a, b$  and  $d \in \mathbb{Z}$ . [1]
- 

The straight line,  $L_1$ , has equation  $y = -\frac{1}{2}x - 2$ .

- a. Write down the  $y$  intercept of  $L_1$ . [1]
- b. Write down the gradient of  $L_1$ . [1]
- c. The line  $L_2$  is perpendicular to  $L_1$  and passes through the point (3, 7). [1]
- Write down the gradient of the line  $L_2$ .
- d. The line  $L_2$  is perpendicular to  $L_1$  and passes through the point (3, 7). [3]
- Find the equation of  $L_2$ . Give your answer in the form  $ax + by + d = 0$  where  $a, b, d \in \mathbb{Z}$ .

---

A hotel has a rectangular swimming pool. Its length is  $x$  metres, its width is  $y$  metres and its perimeter is 44 metres.

a. Write down an equation for  $x$  and  $y$ . [1]

b. The area of the swimming pool is  $112\text{m}^2$ . [1]

Write down a second equation for  $x$  and  $y$ .

c. Use your graphic display calculator to find the value of  $x$  and the value of  $y$ . [2]

d. An Olympic sized swimming pool is 50 m long and 25 m wide. [2]

Determine the area of the hotel swimming pool as a percentage of the area of an Olympic sized swimming pool.

---

A cuboid has the following dimensions: length = 8.7 cm, width = 5.6 cm and height = 3.4 cm.

a. Calculate the **exact** value of the volume of the cuboid, in  $\text{cm}^3$ . [2]

b. Write your answer to part (a) correct to [2]

(i) one decimal place;

(ii) three significant figures.

c. Write your answer to **part (b)(ii)** in the form  $a \times 10^k$ , where  $1 \leq a < 10, k \in \mathbb{Z}$ . [2]

---

The coordinates of the vertices of a triangle ABC are A (4, 3), B (7, -3) and C (0.5,  $p$ ).

a. Calculate the gradient of the line AB. [2]

b, iGiven that the line AC is perpendicular to the line AB [1]

write down the gradient of the line AC.

b, iGiven that the line AC is perpendicular to the line AB [3]

find the value of  $p$ .

---

The coordinates of point A are (6, -7) and the coordinates of point B are (-6, 2). Point M is the midpoint of AB.

$L_1$  is the line through A and B.

The line  $L_2$  is perpendicular to  $L_1$  and passes through M.

- a. Find the coordinates of M. [2]
- b. Find the gradient of  $L_1$ . [2]
- c.i. Write down the gradient of  $L_2$ . [1]
- c.ii. Write down, in the form  $y = mx + c$ , the equation of  $L_2$ . [1]

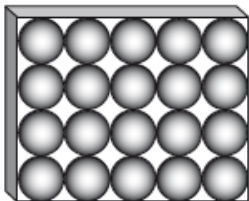
- 
- A satellite travels around the Earth in a circular orbit 500 kilometres above the Earth’s surface. The radius of the Earth is taken as 6400 kilometres.
- a. Write down the radius of the satellite’s orbit. [1]
  - b. Calculate the distance travelled by the satellite in one orbit of the Earth. Give your answer correct to the nearest km. [3]
  - c. Write down your answer to (b) in the form  $a \times 10^k$ , where  $1 \leq a < 10, k \in \mathbb{Z}$ . [2]

---

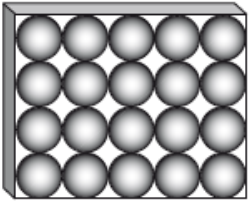
Chocolates in the shape of spheres are sold in boxes of 20.

Each chocolate has a radius of 1 cm.

- a. Find the volume of 1 chocolate. [2]
- b. Write down the volume of 20 chocolates. [1]
- c. The diagram shows the chocolate box from above. The 20 chocolates fit perfectly in the box with each chocolate touching the ones around it or the sides of the box. [2]

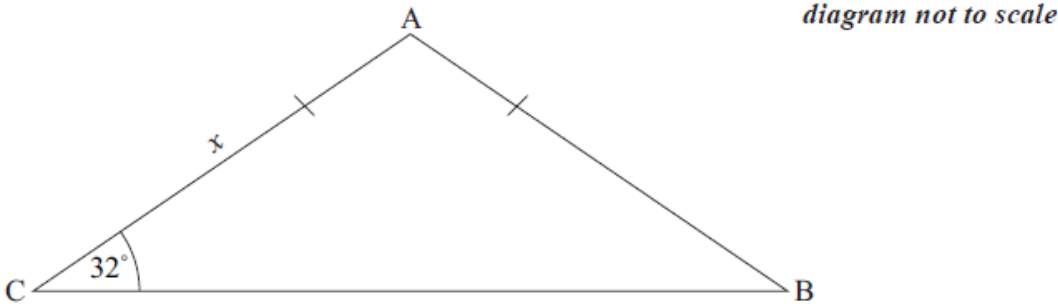


- Calculate the volume of the box.
- d. The diagram shows the chocolate box from above. The 20 chocolates fit perfectly in the box with each chocolate touching the ones around it or the sides of the box. [1]



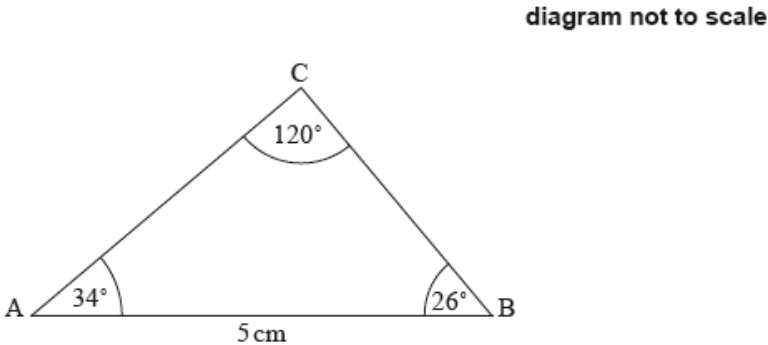
Calculate the volume of empty space in the box.

In the diagram, triangle ABC is isosceles.  $AB = AC$  and angle ACB is  $32^\circ$  . The length of side AC is  $x$  cm.



- a. Write down the size of angle CBA. [1]
- b. Write down the size of angle CAB. [1]
- c. The area of triangle ABC is  $360\text{ cm}^2$ . Calculate the length of side AC. Express your answer in **millimetres**. [4]

A triangular postage stamp, ABC, is shown in the diagram below, such that  $AB = 5\text{ cm}$ ,  $\hat{BAC} = 34^\circ$ ,  $\hat{ABC} = 26^\circ$  and  $\hat{ACB} = 120^\circ$ .

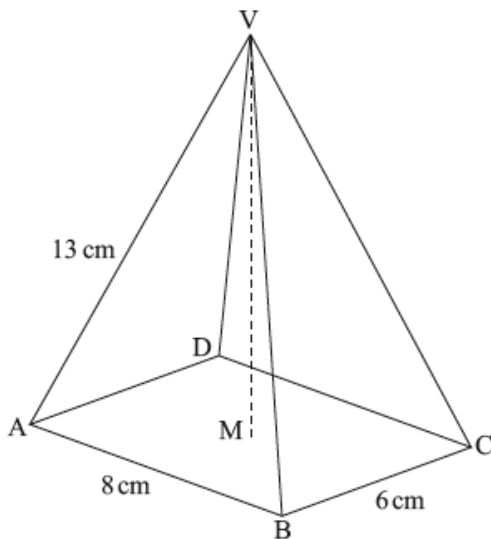


- a. Find the length of BC. [3]
- b. Find the area of the postage stamp. [3]

The equation of the line  $L_1$  is  $2x + y = 10$ .

- a. Write down [2]
- (i) the gradient of  $L_1$ ;
- (ii) the  $y$ -intercept of  $L_1$ .
- b. The line  $L_2$  is parallel to  $L_1$  and passes through the point P(0, 3). [2]
- Write down the equation of  $L_2$ .
- c. The line  $L_2$  is parallel to  $L_1$  and passes through the point P(0, 3). [2]
- Find the  $x$ -coordinate of the point where  $L_2$  crosses the  $x$ -axis.

A right pyramid has apex V and rectangular base ABCD, with AB = 8 cm, BC = 6 cm and VA = 13 cm. The vertical height of the pyramid is VM.



- a. Calculate VM. [4]
- b. Calculate the volume of the pyramid. [2]

The straight line,  $L$ , has equation  $2y - 27x - 9 = 0$ .

- a. Find the gradient of  $L$ . [2]
- b. Sarah wishes to draw the tangent to  $f(x) = x^4$  parallel to  $L$ . [1]
- Write down  $f'(x)$ .
- c, iFind the  $x$  coordinate of the point at which the tangent must be drawn. [2]
- c, iWrite down the value of  $f(x)$  at this point. [1]

a. The length of one side of a rectangle is 2 cm longer than its width. [1]

If the smaller side is  $x$  cm, find the perimeter of the rectangle in terms of  $x$ .

b. The length of one side of a rectangle is 2 cm longer than its width. [1]

The perimeter of a square is equal to the perimeter of the rectangle in part (a).

Determine the length of each side of the square in terms of  $x$ .

c. The length of one side of a rectangle is 2 cm longer than its width. [4]

The perimeter of a square is equal to the perimeter of the rectangle in part (a).

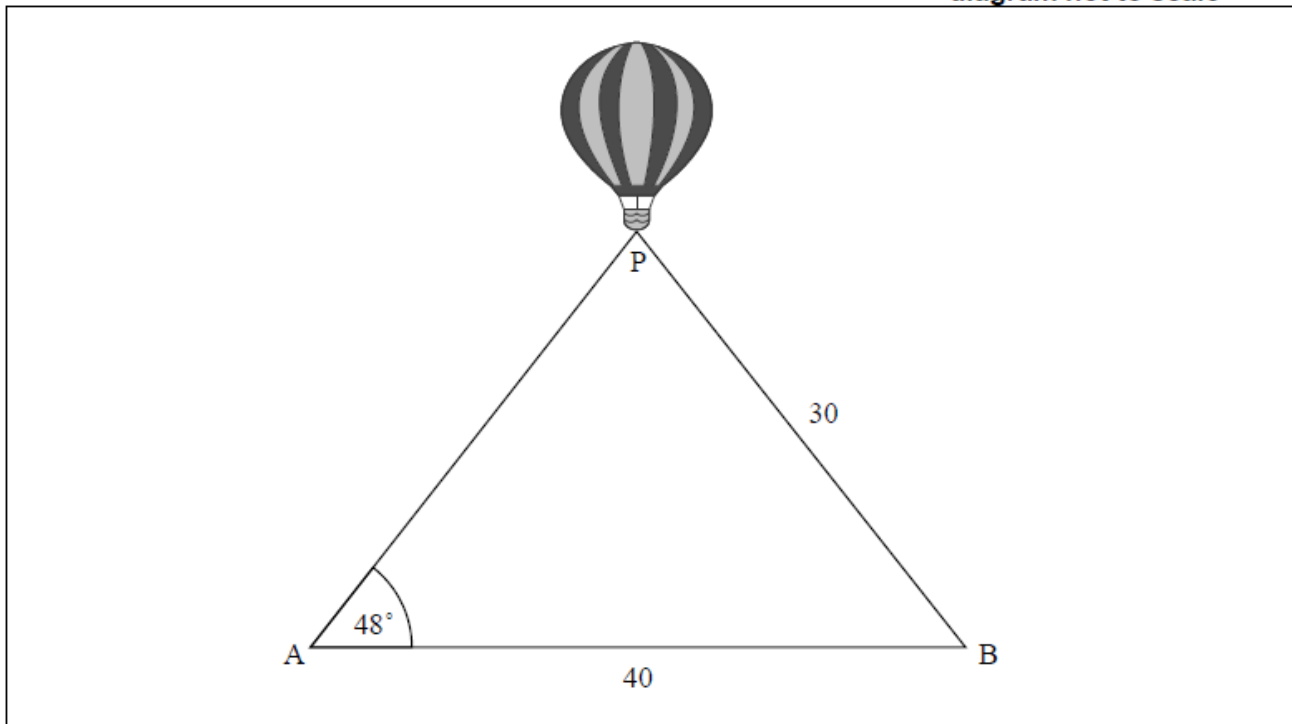
The sum of the areas of the rectangle and the square is  $2x^2 + 4x + 1$  ( $\text{cm}^2$ ).

(i) Given that this sum is  $49 \text{ cm}^2$ , find  $x$ .

(ii) Find the area of the square.

Two fixed points, A and B, are 40m apart on horizontal ground. Two straight ropes, AP and BP, are attached to the same point, P, on the base of a hot air balloon which is vertically above the line AB. The length of BP is 30m and angle BAP is  $48^\circ$ .

**diagram not to scale**



Angle APB is acute.

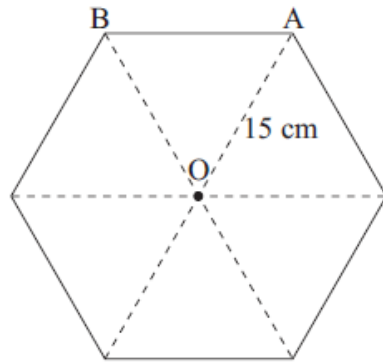
a. On the diagram, draw and label with an  $x$  the angle of depression of B from P. [1]

b. Find the size of angle APB. [3]

c. Find the size of the angle of depression of B from P.

[2]

The base of a prism is a **regular hexagon**. The centre of the hexagon is O and the length of OA is 15 cm.



*diagram not to scale*

a. Write down the size of angle AOB.

[1]

b. Find the area of the triangle AOB.

[3]

c. The height of the prism is 20 cm.

[2]

Find the volume of the prism.

A line joins the points A(2, 1) and B(4, 5).

a. Find the gradient of the line AB.

[2]

b. Let M be the midpoint of the line segment AB.

[1]

Write down the coordinates of M.

c. Let M be the midpoint of the line segment AB.

[3]

Find the equation of the line perpendicular to AB and passing through M.

**In this question, give all answers to two decimal places.**

Karl invests 1000 US dollars (USD) in an account that pays a nominal annual interest of 3.5%, **compounded quarterly**. He leaves the money in the account for 5 years.

a.i. Calculate the amount of money he has in the account after 5 years.

[3]

a.ii. Write down the amount of **interest** he earned after 5 years.

[1]

b. Karl decides to donate this **interest** to a charity in France. The charity receives 170 euros (EUR). The exchange rate is 1 USD =  $t$  EUR. [2]

Calculate the value of  $t$ .

A rectangle is 2680 cm long and 1970 cm wide.

a. Find the perimeter of the rectangle, giving your answer in the form  $a \times 10^k$ , where  $1 \leq a \leq 10$  and  $k \in \mathbb{Z}$ . [3]

b. Find the area of the rectangle, giving your answer correct to the nearest thousand square centimetres. [3]

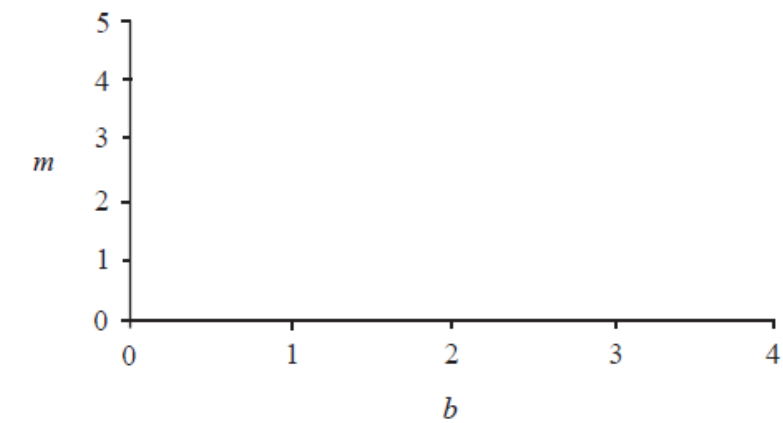
A store sells bread and milk. On Tuesday, 8 loaves of bread and 5 litres of milk were sold for \$21.40. On Thursday, 6 loaves of bread and 9 litres of milk were sold for \$23.40.

If  $b$  = the price of a loaf of bread and  $m$  = the price of one litre of milk, Tuesday’s sales can be written as  $8b + 5m = 21.40$ .

a. Using simplest terms, write an equation in  $b$  and  $m$  for Thursday’s sales. [2]

b. Find  $b$  and  $m$ . [2]

c. Draw a sketch, in the space provided, to show how the prices can be found graphically. [2]



The straight line  $L$  passes through the points  $A(-1, 4)$  and  $B(5, 8)$  .

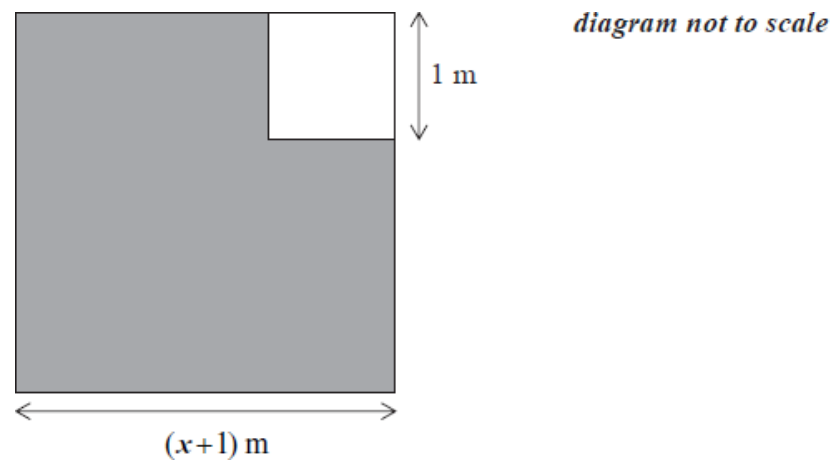
a. Calculate the gradient of  $L$  . [2]

b. Find the equation of  $L$  . [2]

c. The line  $L$  also passes through the point  $P(8, y)$  . Find the value of  $y$  . [2]



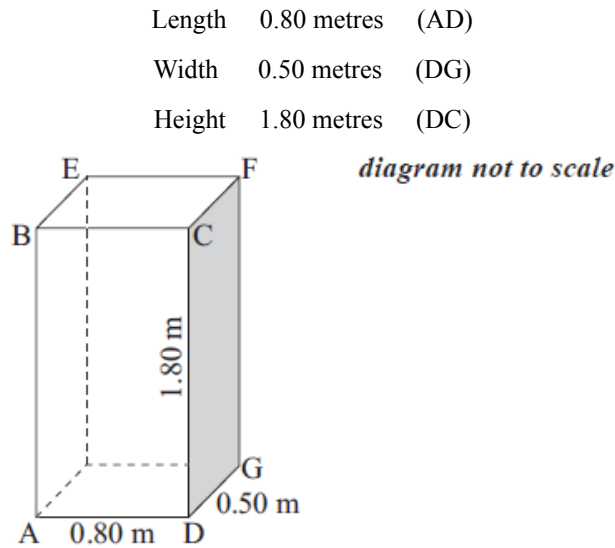
The length of a square garden is  $(x + 1)$  m. In one of the corners a square of 1 m length is used only for grass. The rest of the garden is only for planting roses and is shaded in the diagram below.



The area of the shaded region is  $A$  .

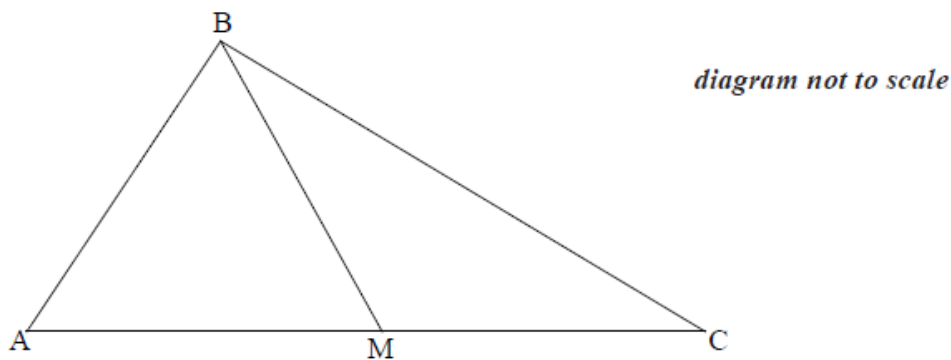
- a. Write down an expression for  $A$  in terms of  $x$ . [1]
- b. Find the value of  $x$  given that  $A = 109.25 \text{ m}^2$ . [3]
- c. The owner of the garden puts a fence around the shaded region. Find the length of this fence. [2]

A rectangular cuboid has the following dimensions.



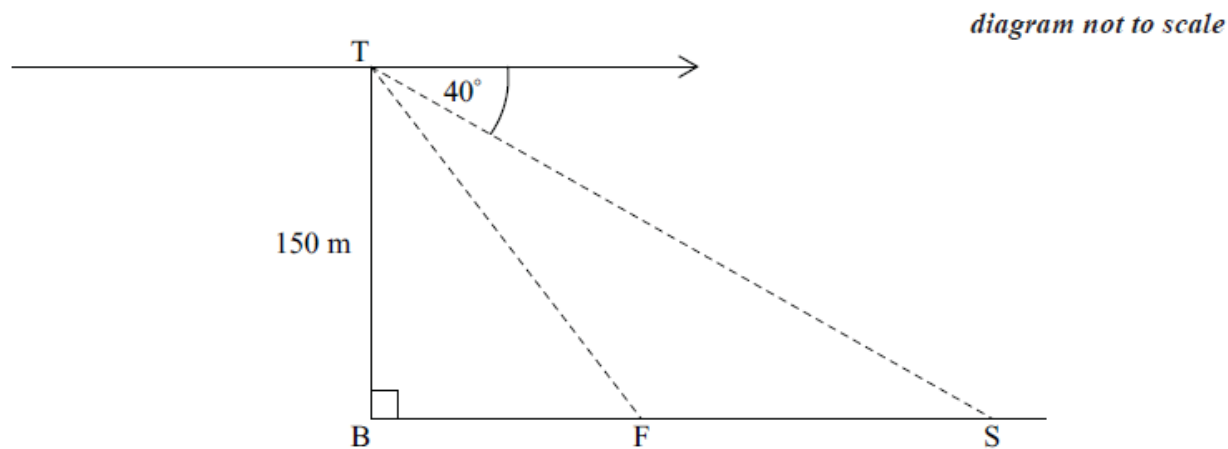
- a. Calculate the length of AG. [2]
- b. Calculate the length of AF. [2]
- c. Find the size of the angle between AF and AG. [2]

The diagram shows a triangle ABC in which AC = 17 cm. M is the midpoint of AC.  
Triangle ABM is equilateral.



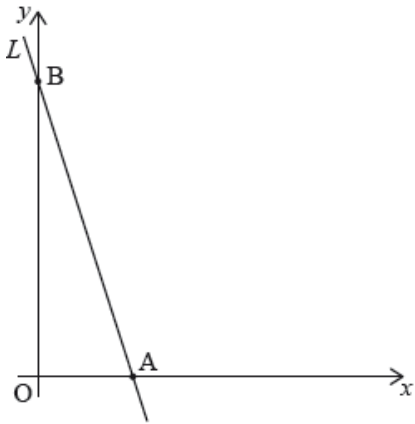
- a.1Write down the size of angle MCB. [1]
- a.i. Write down the length of BM in cm. [1]
- a.ii. Write down the size of angle BMC. [1]
- b. Calculate the length of BC in cm. [3]

Tom stands at the top, T , of a vertical cliff 150 m high and sees a fishing boat, F , and a ship, S . B represents a point at the bottom of the cliff directly below T . The angle of depression of the ship is  $40^\circ$  and the angle of depression of the fishing boat is  $55^\circ$  .



- a. Calculate, SB, the distance between the ship and the bottom of the cliff. [2]
- b. Calculate, SF, the distance between the ship and the fishing boat. Give your answer correct to the nearest metre. [4]

Line  $L$  intersects the  $x$ -axis at point A and the  $y$ -axis at point B, as shown on the diagram.

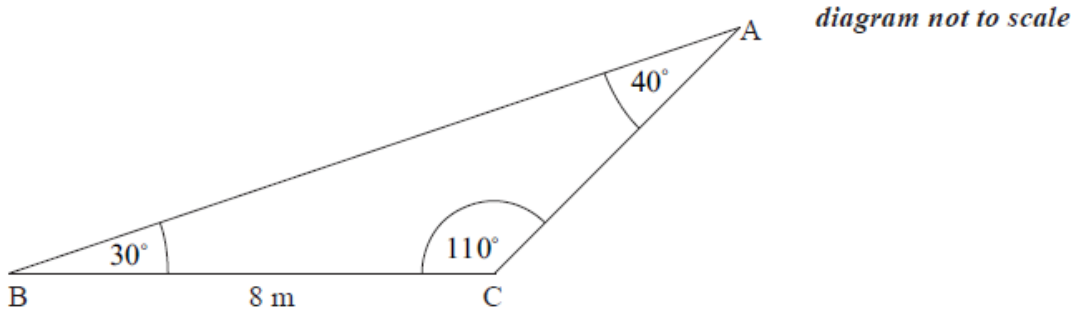


The length of line segment OB is three times the length of line segment OA, where O is the origin.

Point  $(2, 6)$  lies on  $L$ .

- a. Find the gradient of  $L$ . [2]
- b. Find the equation of  $L$  in the form  $y = mx + c$ . [2]
- c. Find the  $x$ -coordinate of point A. [2]

In triangle ABC,  $BC = 8\text{ m}$ , angle  $ACB = 110^\circ$ , angle  $CAB = 40^\circ$ , and angle  $ABC = 30^\circ$ .



- a. Find the length of AC. [3]
- b. Find the area of triangle ABC. [3]

Assume the Earth is a perfect sphere with radius 6371 km.

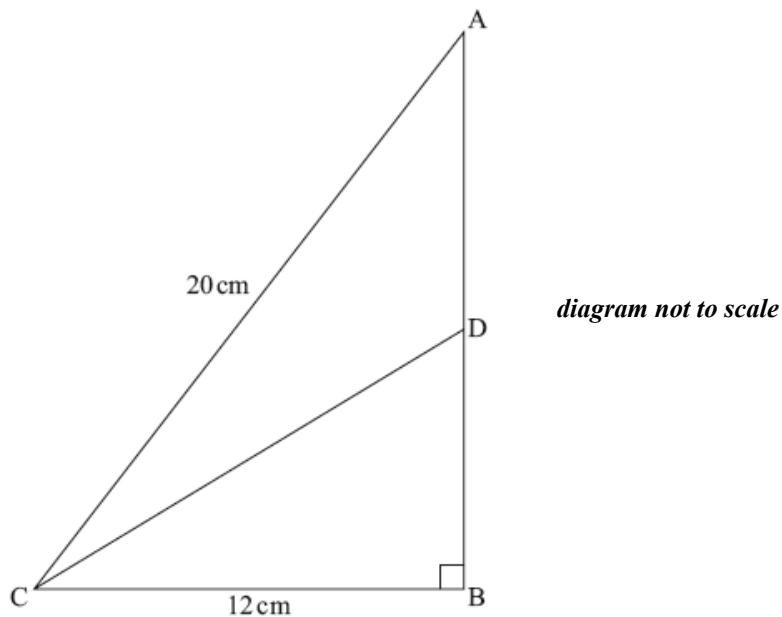
- a. Calculate the volume of the Earth in  $\text{km}^3$ . Give your answer in the form  $a \times 10^k$ , where  $1 \leq a < 10$  and  $k \in \mathbb{Z}$ . [3]
- b. The volume of the Moon is  $2.1958 \times 10^{10} \text{ km}^3$ . [3]

Calculate how many times greater in volume the Earth is compared to the Moon.

Give your answer correct to the nearest **integer**.

---

In triangle ABC,  $AC = 20$  cm,  $BC = 12$  cm and  $\hat{ABC} = 90^\circ$ .



a. Find the length of AB. [2]

b. D is the point on AB such that  $\tan(\hat{DCB}) = 0.6$ . [2]

Find the length of DB.

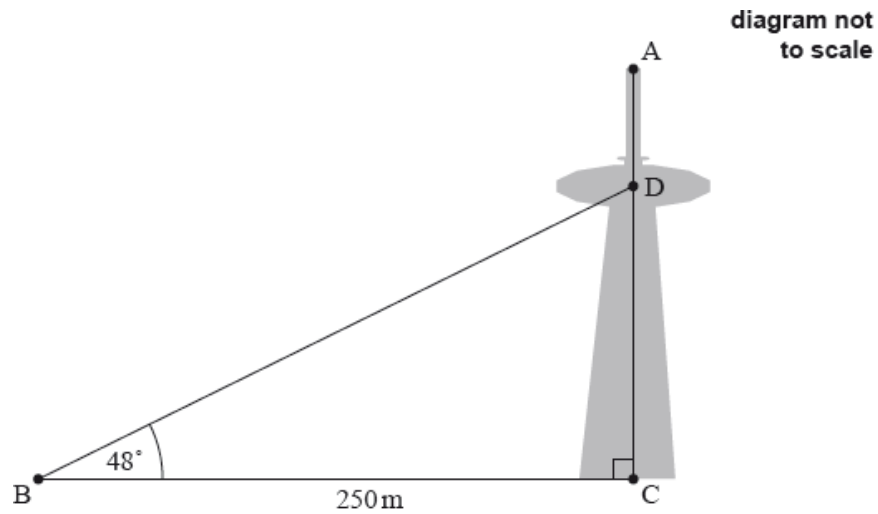
c. D is the point on AB such that  $\tan(\hat{DCB}) = 0.6$ . [2]

Find the area of triangle ADC.

---

AC is a vertical communications tower with its base at C.

The tower has an observation deck, D, three quarters of the way to the top of the tower, A.

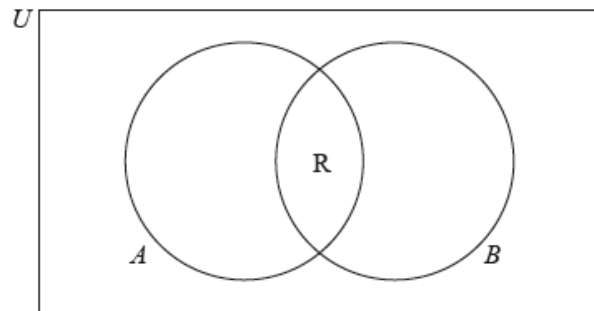


From a point B, on horizontal ground 250 m from C, the angle of elevation of D is  $48^\circ$ .

- Calculate CD, the height of the observation deck above the ground. [2]
- Calculate the angle of depression from A to B. [4]

Tuti has the following polygons to classify: rectangle (R), rhombus (H), isosceles triangle (I), regular pentagon (P), and scalene triangle (T).

In the Venn diagram below, set  $A$  consists of the polygons that have at least one pair of parallel sides, and set  $B$  consists of the polygons that have at least one pair of equal sides.

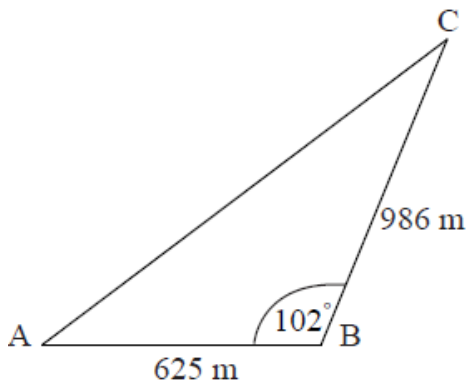


- Complete the Venn diagram by placing the letter corresponding to each polygon in the appropriate region. For example, R has already been placed, and represents the rectangle. [3]
- State which polygons from Tuti's list are elements of
  - $A \cap B$ ;
  - $(A \cup B)'$ .

On a map three schools A, B and C are situated as shown in the diagram.

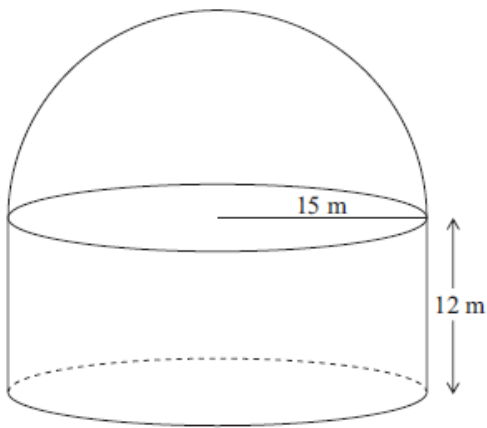
Schools A and B are 625 metres apart.

Angle  $ABC = 102^\circ$  and  $BC = 986$  metres.



- Find the distance between A and C. [3]
- Find the size of angle BAC. [3]

An observatory is built in the shape of a cylinder with a hemispherical roof on the top as shown in the diagram. The height of the cylinder is 12 m and its radius is 15 m.

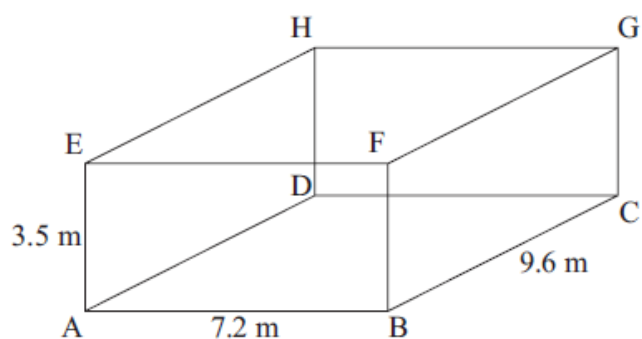


*diagram not to scale*

- Calculate the volume of the observatory. [4]
- The hemispherical roof is to be painted.  
Calculate the area that is to be painted. [2]

- Write down the gradient of the line  $y = 3x + 4$ . [1]
- Find the gradient of the line which is perpendicular to the line  $y = 3x + 4$ . [1]
- Find the equation of the line which is perpendicular to  $y = 3x + 4$  and which passes through the point (6, 7). [2]
- Find the coordinates of the point of intersection of these two lines. [2]

A room is in the shape of a cuboid. Its floor measures 7.2 m by 9.6 m and its height is 3.5 m.



*diagram not to scale*

- Calculate the length of AC. [2]
- Calculate the length of AG. [2]
- Calculate the angle that AG makes with the floor. [2]

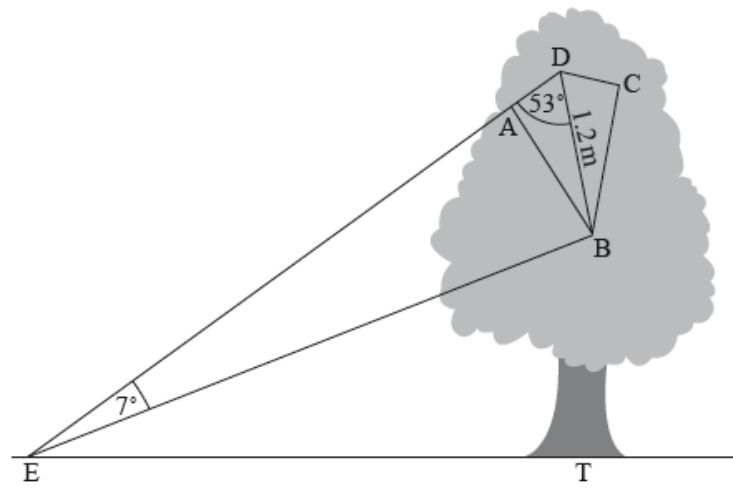
Let  $f(x) = x^4$ .

- Write down  $f'(x)$ . [1]
- Point P(2, 6) lies on the graph of  $f$ . [2]  
Find the gradient of the tangent to the graph of  $y = f(x)$  at P.
- Point P(2, 16) lies on the graph of  $f$ . [3]

Find the equation of the normal to the graph at P. Give your answer in the form  $ax + by + d = 0$ , where  $a$ ,  $b$  and  $d$  are integers.

Emily's kite ABCD is hanging in a tree. The plane ABCDE is vertical.

Emily stands at point E at some distance from the tree, such that EAD is a straight line and angle BED = 7°. Emily knows BD = 1.2 metres and angle BDA = 53°, as shown in the diagram



T is a point at the base of the tree. ET is a horizontal line. The angle of elevation of A from E is  $41^\circ$ .

- Find the length of EB. [3]
- Write down the angle of elevation of B from E. [1]
- Find the vertical height of B above the ground. [2]

A cuboid has a rectangular base of width  $x$  cm and length  $2x$  cm. The height of the cuboid is  $h$  cm. The total length of the edges of the cuboid is 72 cm.

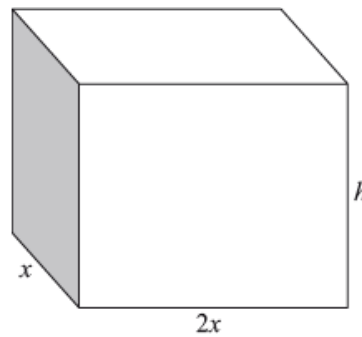


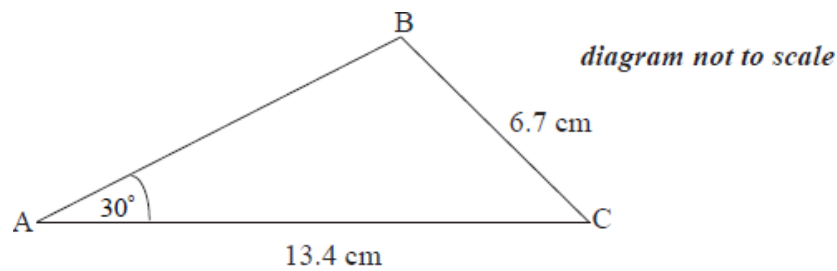
diagram not to scale

The volume,  $V$ , of the cuboid can be expressed as  $V = ax^2 - 6x^3$ .

- Find the value of  $a$ . [3]
- Find the value of  $x$  that makes the volume a maximum. [3]

The diagram shows triangle ABC in which angle  $BAC = 30^\circ$ ,  $BC = 6.7$  cm and  $AC = 13.4$  cm.





- a. Calculate the size of angle ACB. [4]
- b. Nadia makes an accurate drawing of triangle ABC. She measures angle BAC and finds it to be  $29^\circ$ . [2]
- Calculate the percentage error in Nadia's measurement of angle BAC.

Consider  $f : x \mapsto x^2 - 4$ .

- a. Find  $f'(x)$ . [1]
- b. Let  $L$  be the line with equation  $y = 3x + 2$ . [1]
- Write down the gradient of a line parallel to  $L$ .
- c. Let  $L$  be the line with equation  $y = 3x + 2$ . [4]
- Let P be a point on the curve of  $f$ . At P, the tangent to the curve is parallel to  $L$ . Find the coordinates of P.

The number of apartments in a housing development has been increasing by a constant amount every year.

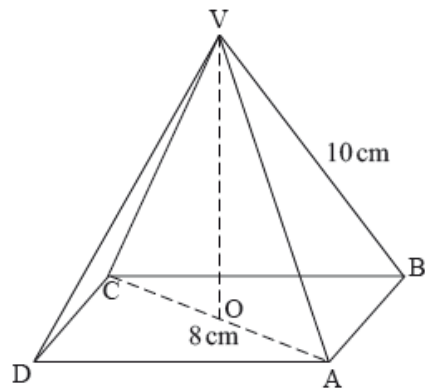
At the end of the first year the number of apartments was 150, and at the end of the sixth year the number of apartments was 600.

The number of apartments,  $y$ , can be determined by the equation  $y = mt + n$ , where  $t$  is the time, in years.

- a. Find the value of  $m$ . [2]
- b. State what  $m$  represents **in this context**. [1]
- c. Find the value of  $n$ . [2]
- d. State what  $n$  represents **in this context**. [1]

In the following diagram, ABCD is the square base of a right pyramid with vertex V. The centre of the base is O. The diagonal of the base, AC, is 8 cm long. The sloping edges are 10 cm long.

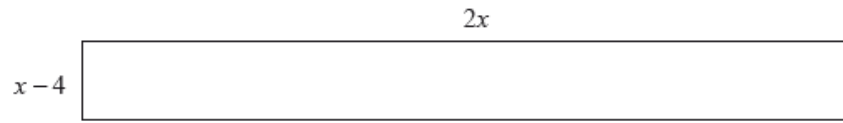
diagram not to scale



- Write down the length of  $AO$ . [1]
- Find the size of the angle that the sloping edge  $VA$  makes with the base of the pyramid. [2]
- Hence, or otherwise, find the area of the triangle  $CAV$ . [3]

The surface of a red carpet is shown below. The dimensions of the carpet are in metres.

*diagram not to scale*



- Write down an expression for the area,  $A$ , in  $\text{m}^2$ , of the carpet. [1]
- The area of the carpet is  $10 \text{ m}^2$ . [3]  
Calculate the value of  $x$ .
- The area of the carpet is  $10 \text{ m}^2$ . [2]  
Hence, write down the value of the length and of the width of the carpet, in metres.

75 metal spherical cannon balls, each of diameter 10 cm, were excavated from a Napoleonic War battlefield.

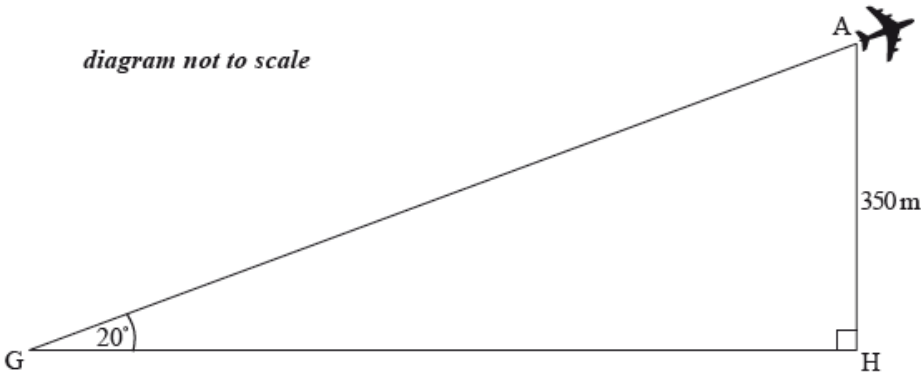
- Calculate the total volume of all 75 metal cannon balls excavated. [3]
- The cannon balls are to be melted down to form a sculpture in the shape of a cone. The base radius of the cone is 20 cm. [3]  
Calculate the height of the cone, assuming that no metal is wasted.

A balloon in the shape of a sphere is filled with helium until the radius is 6 cm.

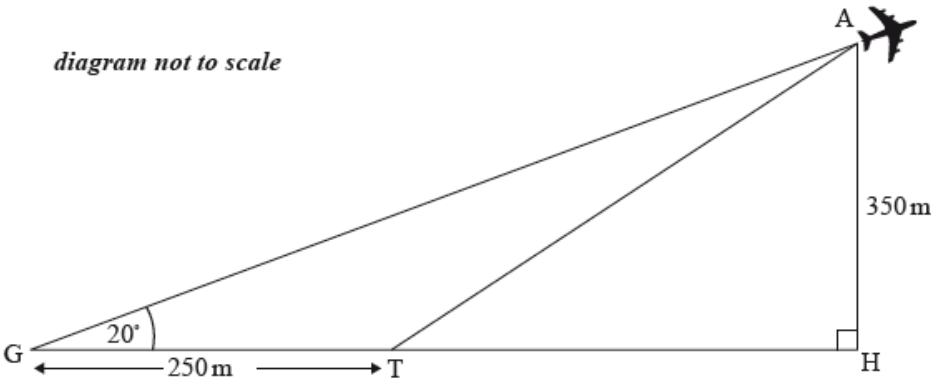
The volume of the balloon is increased by 40%.

- a. Calculate the volume of the balloon. [2]
- b. Calculate the radius of the balloon following this increase. [4]

Günter is at Berlin Tegel Airport watching the planes take off. He observes a plane that is at an angle of elevation of  $20^\circ$  from where he is standing at point G. The plane is at a height of 350 metres. This information is shown in the following diagram.



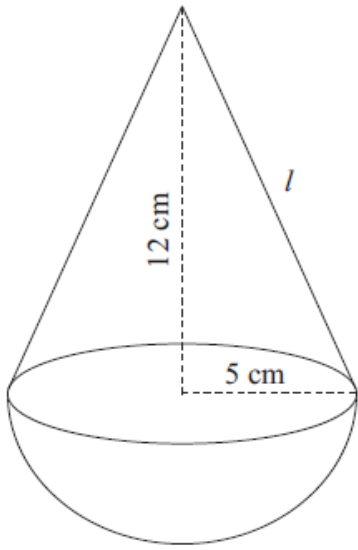
- a. Calculate the horizontal distance, GH, of the plane from Günter. **Give your answer to the nearest metre.** [3]
- b. The plane took off from a point T, which is 250 metres from where Günter is standing, as shown in the following diagram. [3]



Using your answer from part (a), calculate the angle ATH, the takeoff angle of the plane.

A child’s toy consists of a hemisphere with a right circular cone on top. The height of the cone is 12 cm and the radius of its base is 5 cm . The toy is painted red.

*diagram not to scale*



a. Calculate the length,  $l$ , of the slant height of the cone.

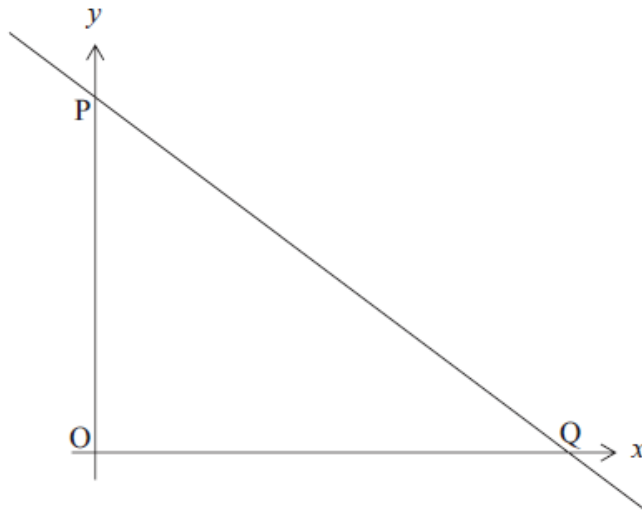
[2]

b. Calculate the area that is painted red.

[4]

---

The diagram below shows the line PQ, whose equation is  $x + 2y = 12$ . The line intercepts the axes at P and Q respectively.



*diagram not to scale*

a. Find the coordinates of P and of Q.

[3]

b. A second line with equation  $x - y = 3$  intersects the line PQ at the point A. Find the coordinates of A.

[3]

---

The mid-point, M, of the line joining A( $s$ , 8) to B( $-2$ ,  $t$ ) has coordinates M(2, 3).

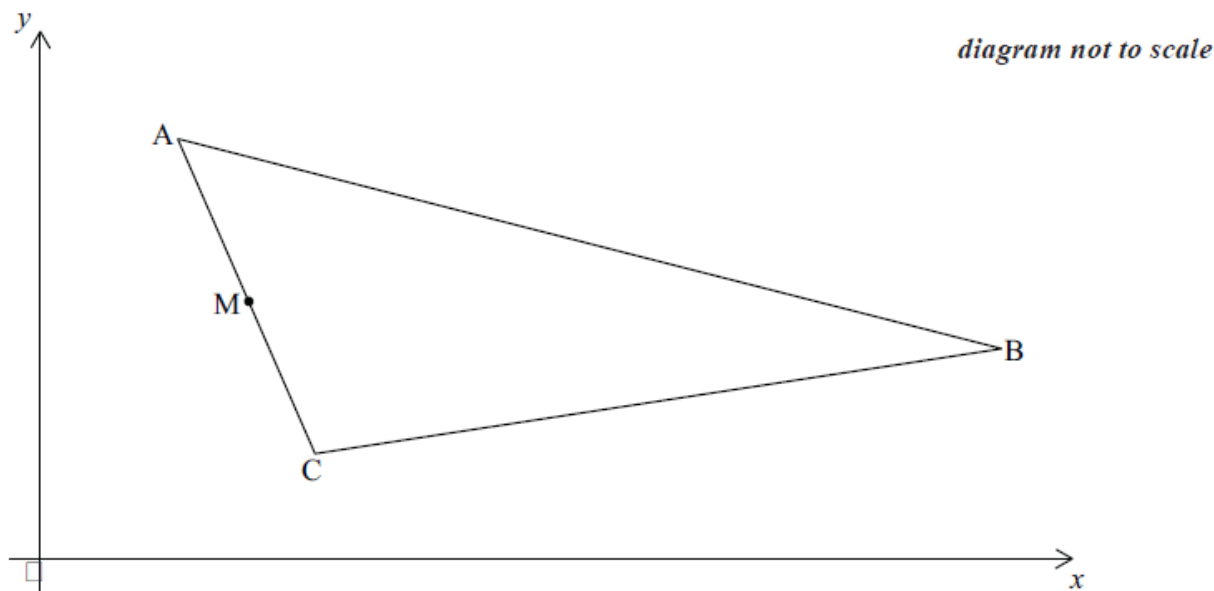
a. Calculate the values of  $s$  and  $t$ .

[2]

- b. Find the equation of the straight line perpendicular to AB, passing through the point M.

[4]

The diagram shows points A(2, 8), B(14, 4) and C(4, 2). M is the midpoint of AC.



- a. Write down the coordinates of M.

[2]

- b. Calculate the gradient of the line AB.

[2]

- c. Find the equation of the line parallel to AB that passes through M.

[2]

Line  $L$  is given by the equation  $3y + 2x = 9$  and point P has coordinates  $(6, -5)$ .

- a. Explain why point P is not on the line  $L$ .

[1]

- b. Find the gradient of line  $L$ .

[2]

- c. (i) Write down the gradient of a line perpendicular to line  $L$ .

[3]

- (ii) Find the equation of the line perpendicular to  $L$  and passing through point P.

A lampshade, in the shape of a cone, has a wireframe consisting of a circular ring and four straight pieces of equal length, attached to the ring at points A, B, C and D.

The ring has its centre at point O and its radius is 20 centimetres. The straight pieces meet at point V, which is vertically above O, and the angle they make with the base of the lampshade is  $60^\circ$ .

This information is shown in the following diagram.

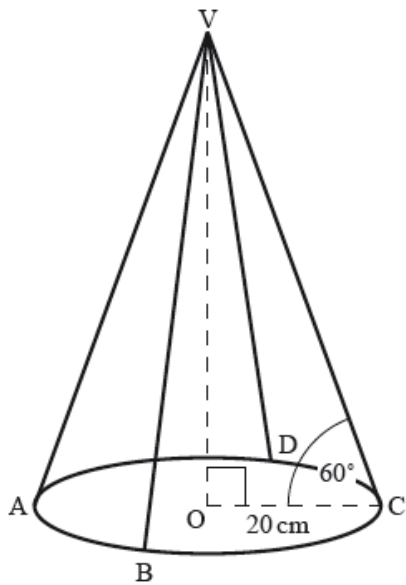


diagram not to scale

- a. Find the length of one of the straight pieces in the wireframe. [2]
- b. Find the total length of wire needed to construct this wireframe. Give your answer in centimetres correct to the nearest millimetre. [4]

A building company has many rectangular construction sites, of varying widths, along a road.

The area,  $A$ , of each site is given by the function

$$A(x) = x(200 - x)$$

where  $x$  is the **width** of the site in metres and  $20 \leq x \leq 180$ .

- a. Site S has a width of 20 m. Write down the area of S. [1]
- b. Site T has the same area as site S, but a different width. Find the width of T. [2]
- c. When the width of the construction site is  $b$  metres, the site has a maximum area. [2]

(i) Write down the value of  $b$ .

(ii) Write down the maximum area.
- d. The range of  $A(x)$  is  $m \leq A(x) \leq n$ . [1]

Hence write down the value of  $m$  and of  $n$ .

The distance  $d$  from a point  $P(x, y)$  to the point  $A(1, -2)$  is given by  $d = \sqrt{(x - 1)^2 + (y + 2)^2}$

- a. Find the distance from  $P(100, 200)$  to A. Give your answer correct to two decimal places. [3]

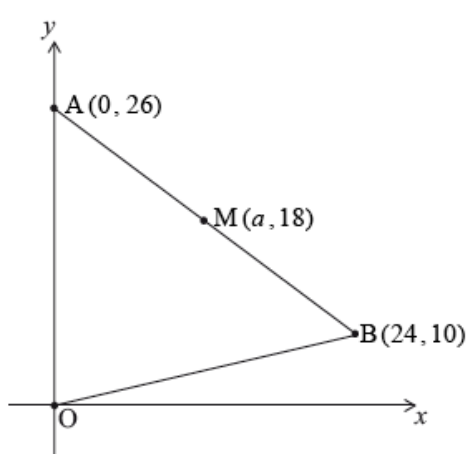
b. Write down your answer to **part (a)** correct to three significant figures.

[1]

c. Write down your answer to **part (b)** in the form  $a \times 10^k$ , where  $1 \leq a < 10$  and  $k \in \mathbb{Z}$ .

[2]

The diagram shows the points  $M(a, 18)$  and  $B(24, 10)$ . The straight line  $BM$  intersects the  $y$ -axis at  $A(0, 26)$ .  $M$  is the midpoint of the line segment  $AB$ .



a. Write down the value of  $a$ .

[1]

b. Find the gradient of the line  $AB$ .

[2]

c. Decide whether triangle  $OAM$  is a right-angled triangle. Justify your answer.

[3]

The equation of line  $L_1$  is  $y = -\frac{2}{3}x - 2$ .

Point  $P$  lies on  $L_1$  and has  $x$ -coordinate  $-6$ .

The line  $L_2$  is perpendicular to  $L_1$  and intersects  $L_1$  when  $x = -6$ .

a. Write down the gradient of  $L_1$ .

[1]

b. Find the  $y$ -coordinate of  $P$ .

[2]

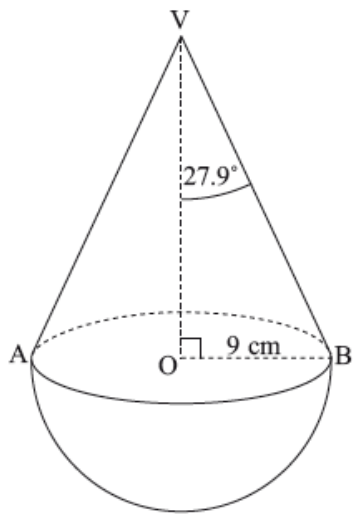
c. Determine the equation of  $L_2$ . Give your answer in the form  $ax + by + d = 0$ , where  $a$ ,  $b$  and  $d$  are integers.

[3]

A child’s wooden toy consists of a hemisphere, of radius 9 cm , attached to a cone with the same base radius. O is the centre of the base of the cone and V is vertically above O.

Angle OVB is  $27.9^\circ$ .

*Diagram not to scale.*



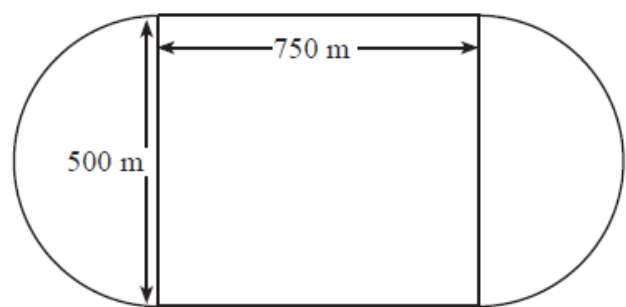
- a. Calculate OV, the height of the cone. [2]
- b. Calculate the volume of wood used to make the toy. [4]

A shipping container is a cuboid with dimensions 16 m,  $1\frac{3}{4}$  m and  $2\frac{2}{3}$  m.

- a. Calculate the **exact** volume of the container. Give your answer as a fraction. [3]
- b. Jim estimates the dimensions of the container as 15 m, 2 m and 3 m and uses these to estimate the volume of the container. [3]

Calculate the percentage error in Jim’s estimated volume of the container.

A race track is made up of a rectangular shape 750 m by 500 m with semi-circles at each end as shown in the diagram.

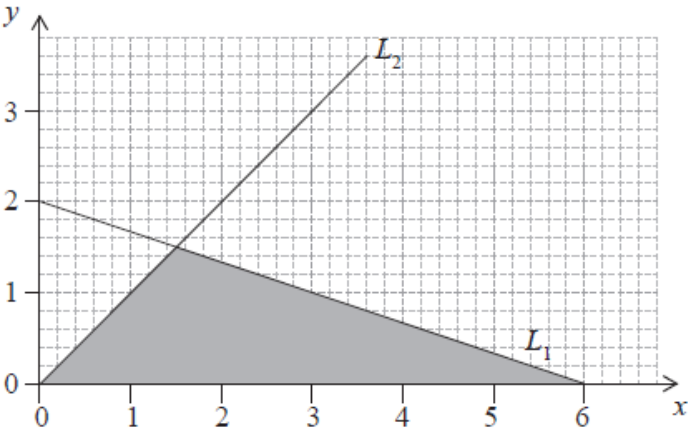


Michael drives around the track once at an average speed of  $140\text{ kmh}^{-1}$ .



- a. Calculate the distance that Michael travels. [2]
- b. Calculate how long Michael takes in **seconds**. [4]
- 

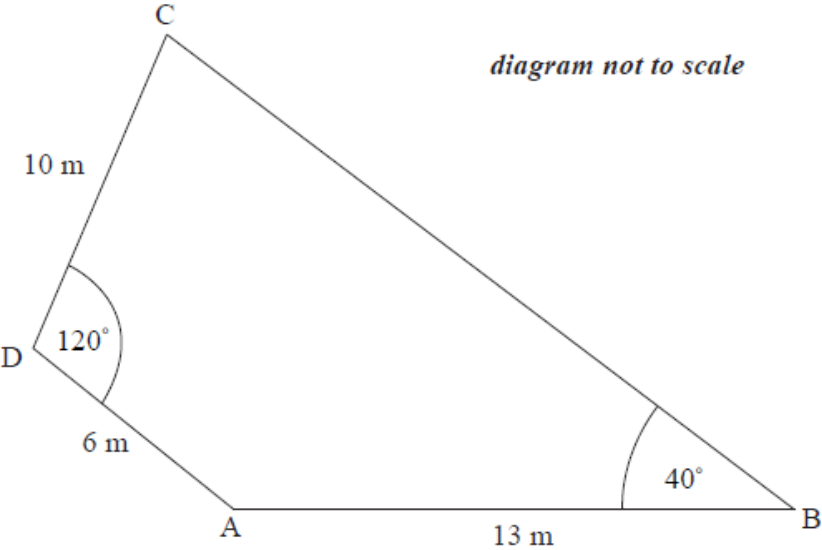
The diagram shows the straight lines  $L_1$  and  $L_2$  . The equation of  $L_2$  is  $y = x$  .



- a. Find [3]
- (i) the gradient of  $L_1$  ;

(ii) the equation of  $L_1$  .
- b. Find the area of the shaded triangle. [2]
- 

The diagram shows quadrilateral ABCD in which  $AB = 13\text{ m}$  ,  $AD = 6\text{ m}$  and  $DC = 10\text{ m}$ . Angle  $ADC = 120^\circ$  and angle  $ABC = 40^\circ$  .



- a. Calculate the length of AC. [3]

b. Calculate the size of angle ACB. [3]

In a television show there is a transparent box completely filled with identical cubes. Participants have to estimate the number of cubes in the box.  
The box is 50 cm wide, 100 cm long and 40 cm tall.

a. Find the volume of the box. [2]

b. Joaquin estimates the volume of one cube to be  $500\text{ cm}^3$ . He uses this value to estimate the number of cubes in the box. [2]  
Find Joaquin's estimated number of cubes in the box.

c. The actual number of cubes in the box is 350. [2]  
Find the percentage error in Joaquin's estimated number of cubes in the box.

The equation of a curve is given as  $y = 2x^2 - 5x + 4$ .

a. Find  $\frac{dy}{dx}$ . [2]

b. The equation of the line  $L$  is  $6x + 2y = -1$ . [4]  
Find the  $x$ -coordinate of the point on the curve  $y = 2x^2 - 5x + 4$  where the tangent is parallel to  $L$ .

The volume of a sphere is  $V = \sqrt{\frac{S^3}{36\pi}}$ , where  $S$  is its surface area.

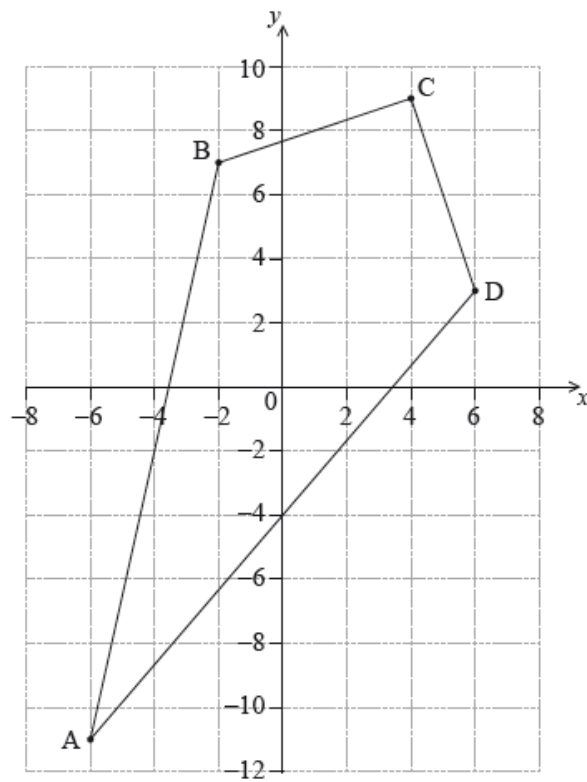
The surface area of a sphere is  $500\text{ cm}^2$ .

a. Calculate the volume of the sphere. Give your answer correct to **two decimal places**. [3]

b. Write down your answer to (a) correct to the nearest integer. [1]

c. Write down your answer to (b) in the form  $a \times 10^n$ , where  $1 \leq a < 10$  and  $n \in \mathbb{Z}$ . [2]

The four points A(−6, −11) , B(−2, 7) , C(4, 9) and D(6, 3) define the vertices of a kite.



a. Calculate the distance between points B and D.

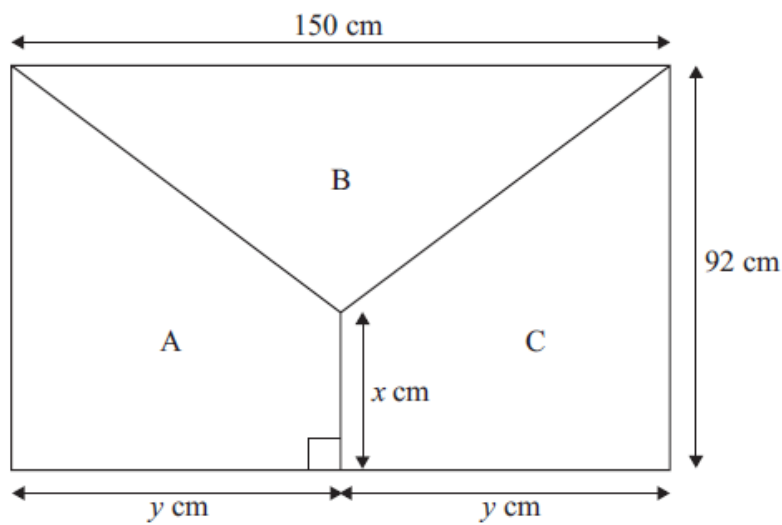
[2]

b. The distance between points A and C is  $\sqrt{500}$ .

[4]

Calculate the area of the kite ABCD.

The diagram below represents a rectangular flag with dimensions 150 cm by 92 cm. The flag is divided into three regions A, B and C.



*diagram not to scale*

a. Write down the total area of the flag.

[1]

b. Write down the value of  $y$ .

[1]

c. The areas of regions A, B, and C are equal.

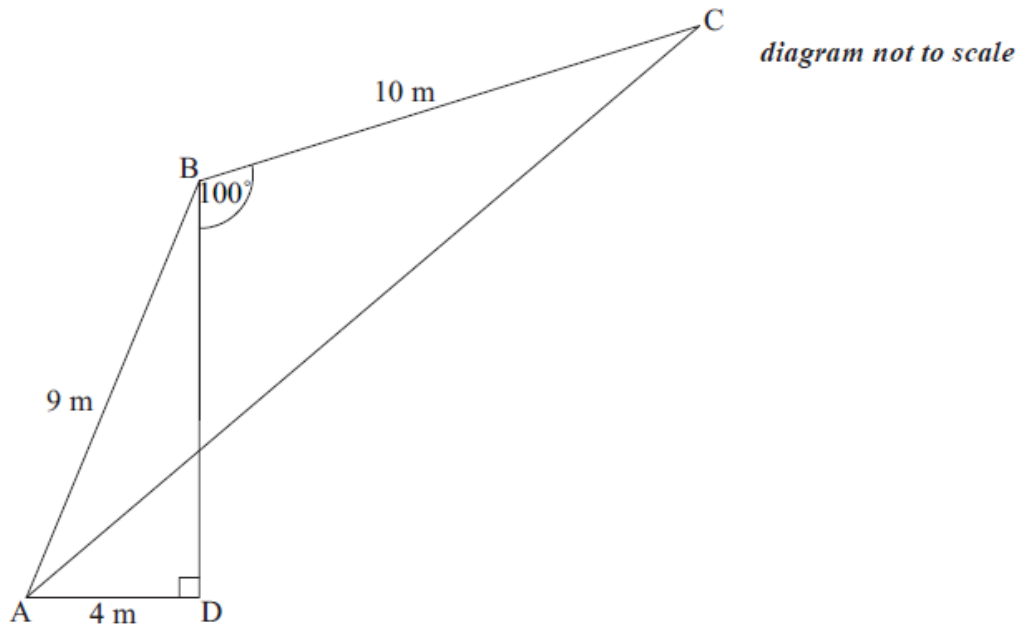
[1]

Write down the area of region A.

d. Using your answers to **parts (b) and (c)**, find the value of  $x$ .

[3]

In the diagram,  $AD = 4\text{ m}$ ,  $AB = 9\text{ m}$ ,  $BC = 10\text{ m}$ ,  $\angle BDA = 90^\circ$  and  $\angle DBC = 100^\circ$ .



a. Calculate the size of  $\angle ABC$ .

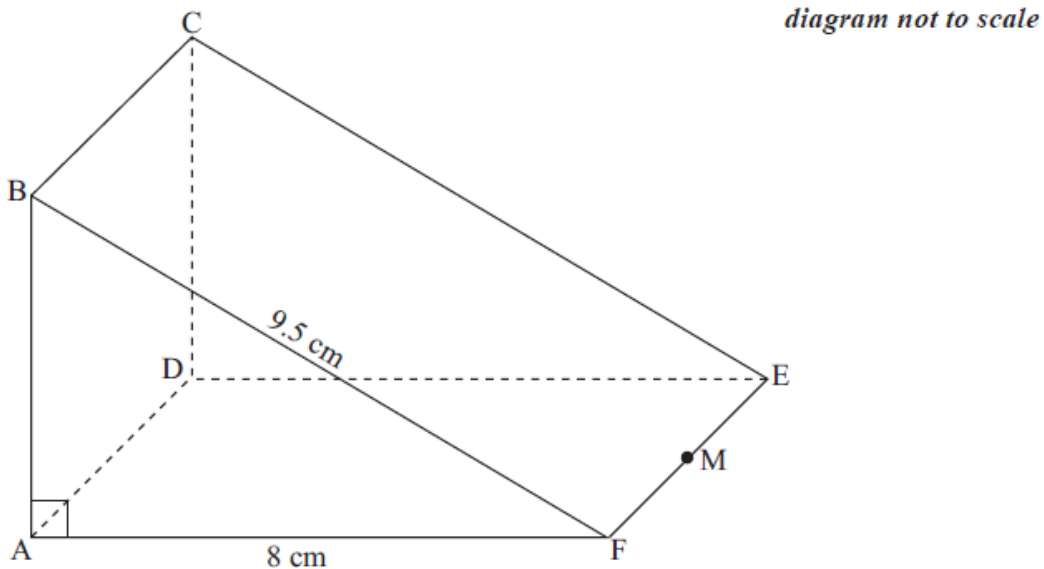
[3]

b. Calculate the length of AC.

[3]

The diagram shows a right triangular prism, ABCDEF, in which the face ABCD is a square.

$AF = 8\text{ cm}$ ,  $BF = 9.5\text{ cm}$ , and angle BAF is  $90^\circ$ .



- a. Calculate the length of AB .[2]
- b. M is the midpoint of EF .[2]  
Calculate the length of BM .
- c. M is the midpoint of EF .[2]  
Find the size of the angle between BM and the face ADEF .
- 

Tennis balls are sold in cylindrical tubes that contain four balls. The radius of each tennis ball is 3.15 cm and the radius of the tube is 3.2 cm. The length of the tube is 26 cm.

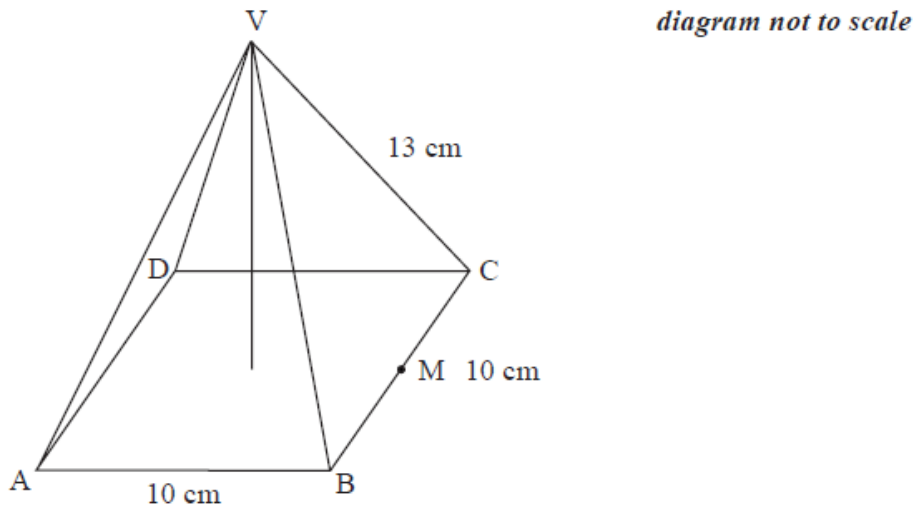
- a. Find the volume of one tennis ball.[2]
- b. Calculate the volume of the empty space in the tube when four tennis balls have been placed in it.[4]
- 

Consider the statement  $p$ :

“If a quadrilateral is a square then the four sides of the quadrilateral are equal”.

- a. Write down the inverse of statement  $p$  in words.[2]
- b. Write down the converse of statement  $p$  in words.[2]
- c. Determine whether the converse of statement  $p$  is always true. Give an example to justify your answer.[2]
- 

The diagram shows a pyramid VABCD which has a square base of length 10 cm and edges of length 13 cm. M is the midpoint of the side BC.

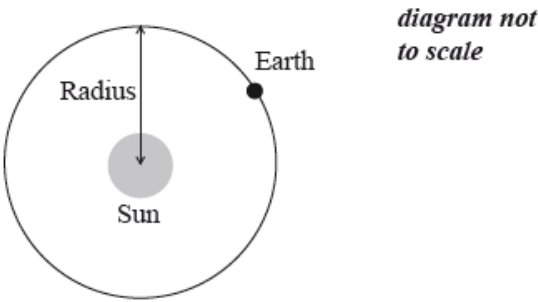


- a. Calculate the length of VM.

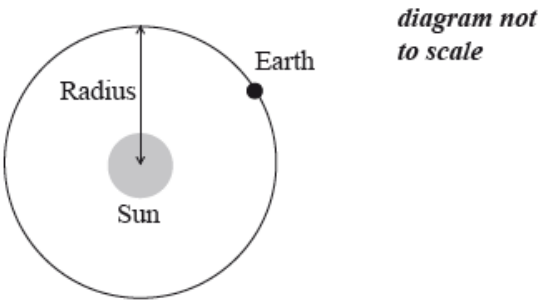
[2]
- b. Calculate the vertical height of the pyramid.

[2]

The average radius of the orbit of the Earth around the Sun is 150 million kilometres.



The average radius of the orbit of the Earth around the Sun is 150 million kilometres.



- a. Write down this radius, in kilometres, in the form  $a \times 10^k$ , where  $1 \leq a < 10$ ,  $k \in \mathbb{Z}$ .

[2]
- b. The Earth travels around the Sun in one orbit. It takes one year for the Earth to complete one orbit.

[2]

Calculate the distance, in kilometres, the Earth travels around the Sun in one orbit, assuming that the orbit is a circle.
- c. Today is Anna’s 17th birthday.

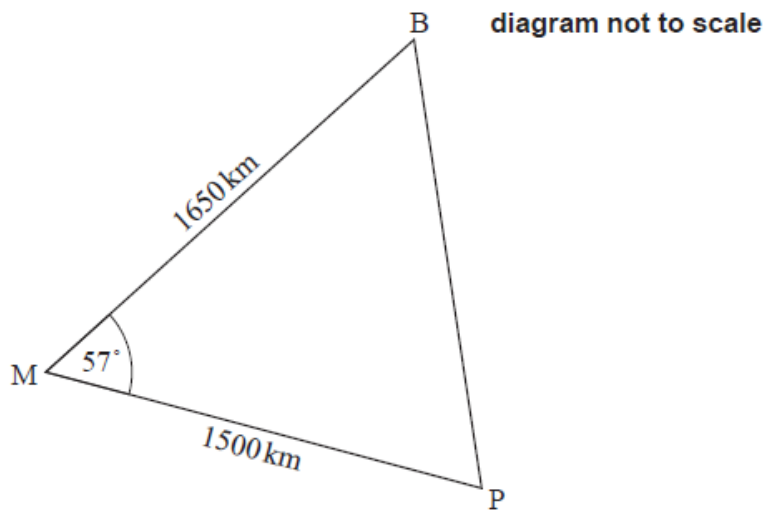
[2]

Calculate the total distance that Anna has travelled around the Sun, since she was born.

- a. When Bermuda (B), Puerto Rico (P), and Miami (M) are joined on a map using straight lines, a triangle is formed. This triangle is known as the Bermuda triangle.

[3]

According to the map, the distance MB is 1650 km, the distance MP is 1500 km and angle BMP is  $57^\circ$ .



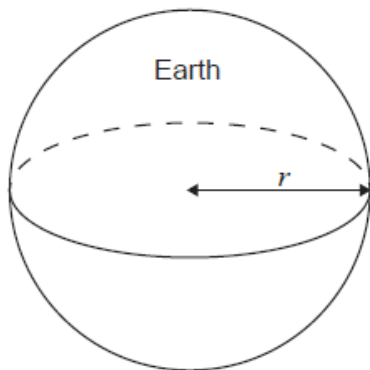
Calculate the distance from Bermuda to Puerto Rico, BP.

- b. Calculate the area of the Bermuda triangle.

[3]

- a. Assume that the Earth is a sphere with a radius,  $r$ , of  $6.38 \times 10^3$  km .

[4]



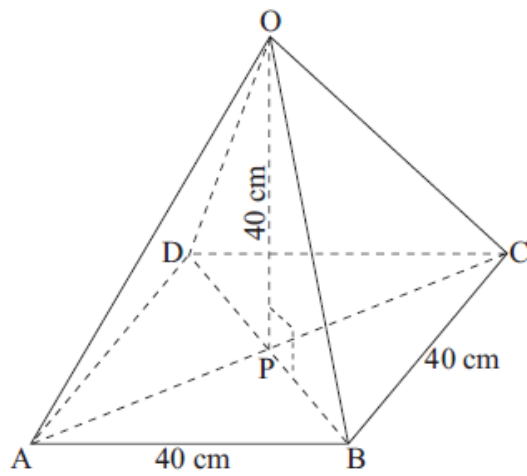
- Calculate the surface area of the Earth in  $\text{km}^2$ .
- Write down your answer to part (a)(i) in the form  $a \times 10^k$ , where  $1 \leq a < 10$  and  $k \in \mathbb{Z}$ .

- b. The surface area of the Earth that is covered by water is approximately  $3.61 \times 10^8 \text{ km}^2$  .

[2]

Calculate the percentage of the surface area of the Earth that is covered by water.

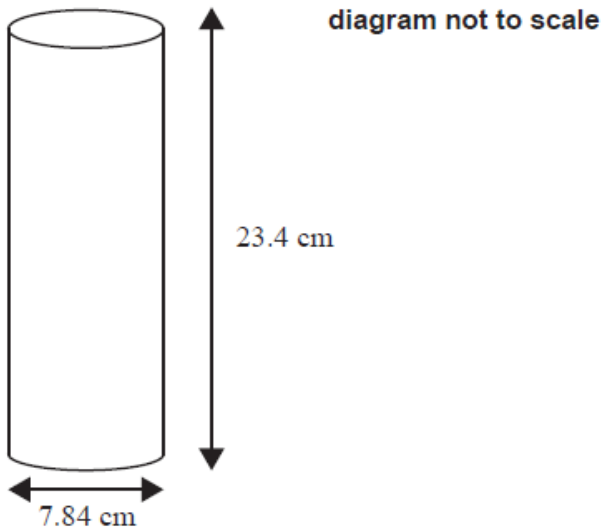
The right pyramid shown in the diagram has a square base with sides of length 40 cm. The height of the pyramid is also 40 cm.



*diagram not to scale*

- a. Find the length of OB. [4]
- b. Find the size of angle OBP. [2]

- a. A snack container has a cylindrical shape. The diameter of the base is 7.84 cm. The height of the container is 23.4 cm. This is shown in the following diagram. [1]



Write down the radius, in cm, of the base of the container.

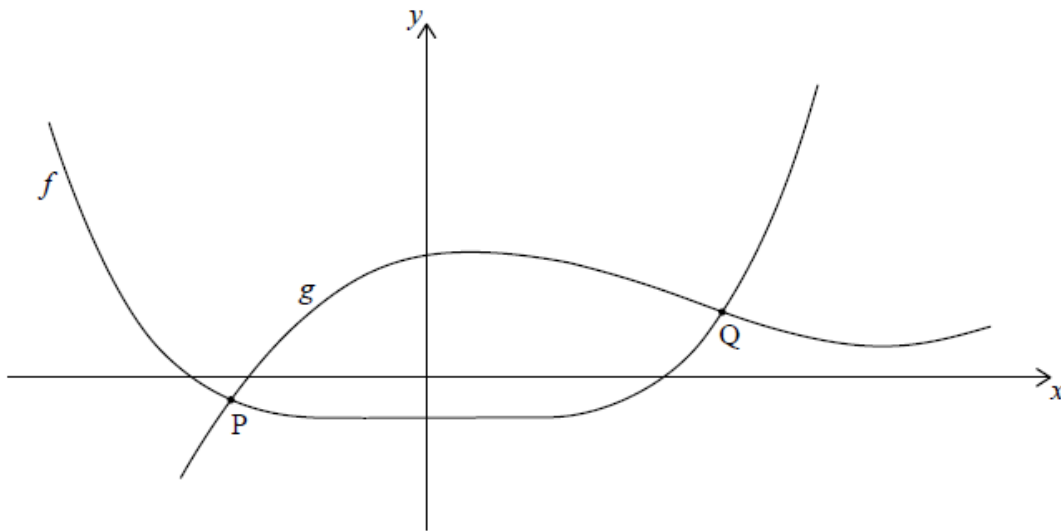
- b. Calculate the area of the base of the container. [2]
- c. Dan is going to paint the curved surface and the base of the snack container. [3]

Calculate the area to be painted.

Consider the functions  $f(x) = x^4 - 2$  and  $g(x) = x^3 - 4x^2 + 2x + 6$

The functions intersect at points P and Q. Part of the graph of  $y = f(x)$  and part of the graph of  $y = g(x)$  are shown on the diagram.

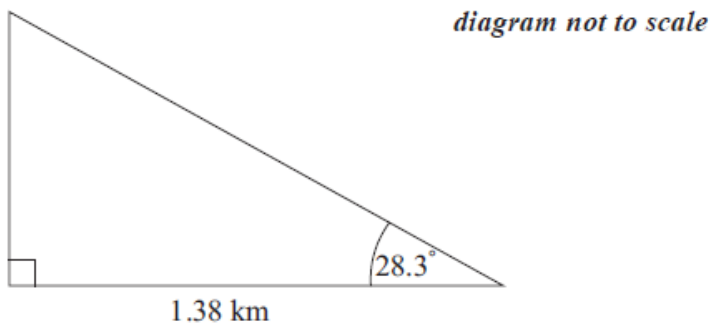




- Find the range of  $f$ . [2]
- Write down the  $x$ -coordinate of P and the  $x$ -coordinate of Q. [2]
- Write down the values of  $x$  for which  $f(x) > g(x)$ . [2]

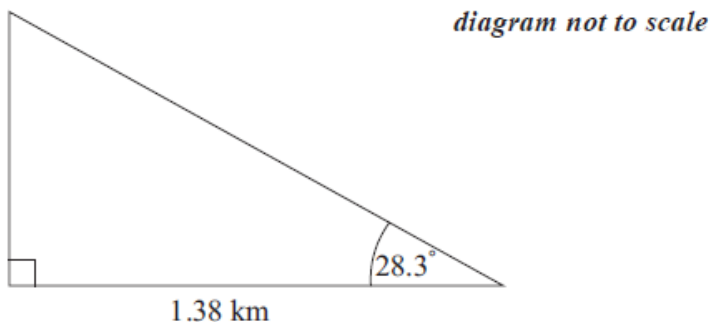
José stands 1.38 kilometres from a vertical cliff.

- Express this distance in metres. [1]
- José estimates the angle between the horizontal and the top of the cliff as  $28.3^\circ$  and uses it to find the height of the cliff. [3]



Find the height of the cliff according to José's calculation. **Express your answer in metres, to the nearest whole metre.**

- José estimates the angle between the horizontal and the top of the cliff as  $28.3^\circ$  and uses it to find the height of the cliff. [2]

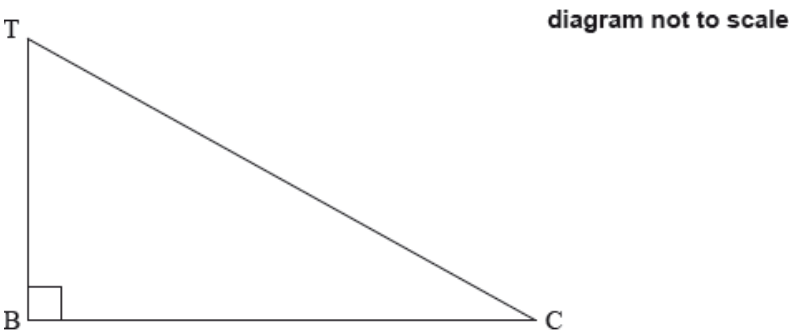


The actual height of the cliff is 718 metres. Calculate the percentage error made by José when calculating the height of the cliff.

Fabián stands on top of a building, T, which is on a horizontal street.

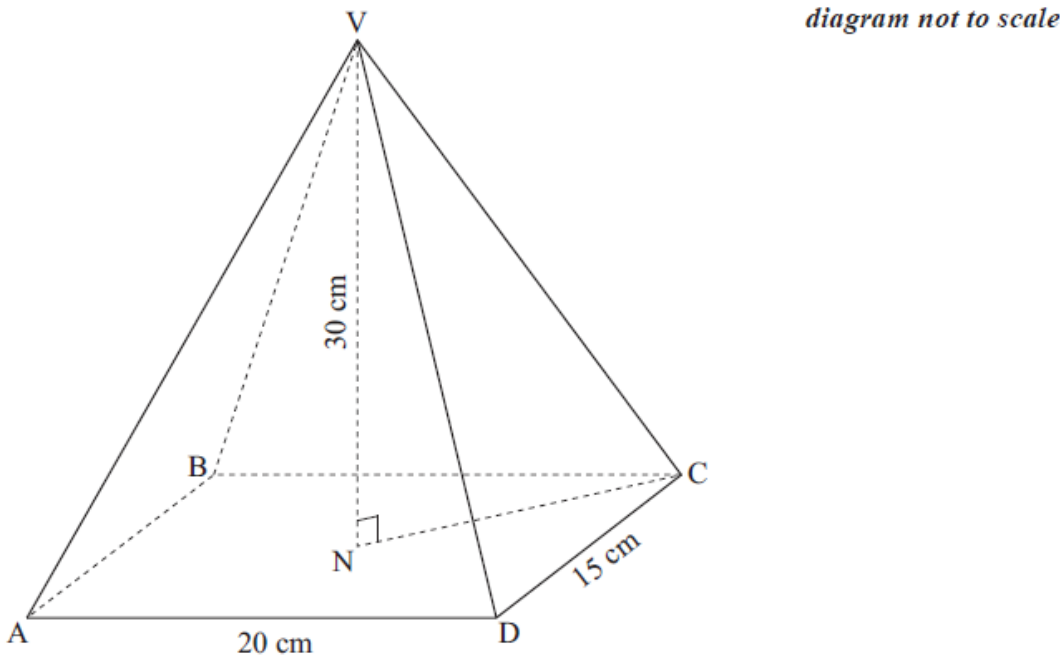
He observes a car, C, on the street, at an angle of depression of  $30^\circ$ . The base of the building is at B. The height of the building is 80 metres.

The following diagram indicates the positions of T, B and C.



- a. Show, in the appropriate place on the diagram, **the values** of [2]
- (i) the height of the building;
  - (ii) the angle of depression.
- b. Find the distance,  $BC$ , from the base of the building to the car. [2]
- c. Fabián estimates that the distance from the base of the building to the car is 150 metres. Calculate the percentage error of Fabián's estimate. [2]

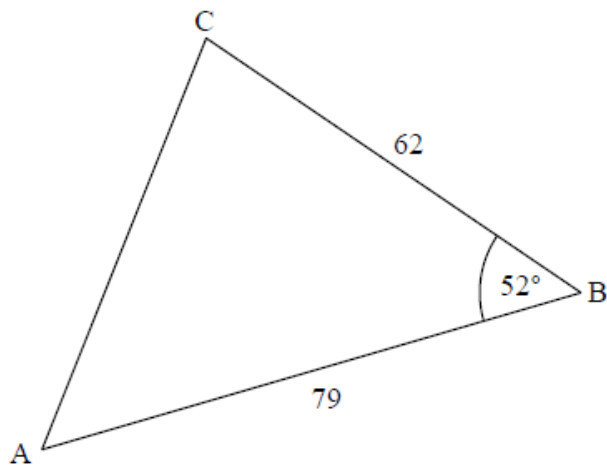
The diagram shows a rectangular based right pyramid  $VABCD$  in which  $AD = 20$  cm,  $DC = 15$  cm and the height of the pyramid,  $VN = 30$  cm.



- a. Calculate [4]
- (i) the length of AC;
  - (ii) the length of VC.
- b. Calculate the angle between VC and the base ABCD. [2]
- 

A park in the form of a triangle, ABC, is shown in the following diagram. AB is 79km and BC is 62km. Angle  $\hat{A}BC$  is  $52^\circ$ .

**diagram not to scale**



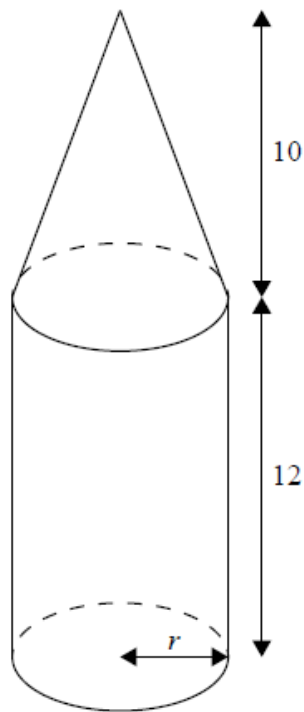
- a. Calculate the length of side AC in km. [3]
- b. Calculate the area of the park. [3]
- 

Julio is making a wooden pencil case in the shape of a large pencil. The pencil case consists of a cylinder attached to a cone, as shown.

The cylinder has a radius of  $r$  cm and a height of 12 cm.

The cone has a base radius of  $r$  cm and a height of 10 cm.

diagram not to scale



a. Find an expression for the slant height of the cone **in terms of  $r$** .

[2]

b. The total external surface area of the pencil case rounded to 3 significant figures is  $570 \text{ cm}^2$ .

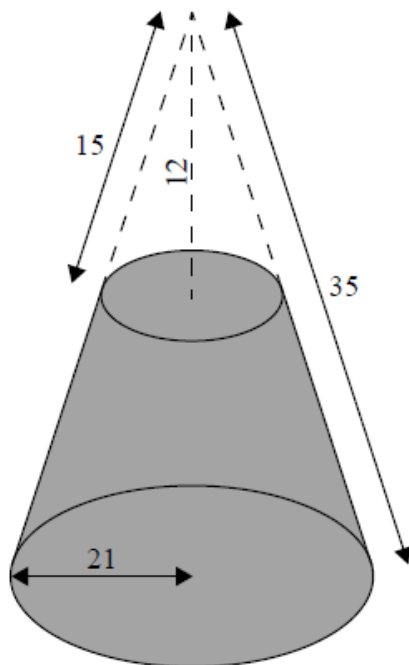
[4]

Using your graphic display calculator, calculate the value of  $r$ .

A solid right circular cone has a base radius of 21 cm and a slant height of 35 cm.

A smaller right circular cone has a height of 12 cm and a slant height of 15 cm, and is removed from the top of the larger cone, as shown in the diagram.

diagram not to scale

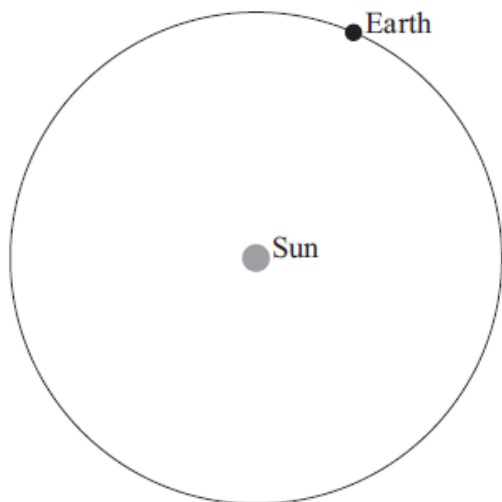




Calculate the price, in cents, of a can of HappyFin tuna.

---

The planet Earth takes one year to revolve around the Sun. Assume that a year is 365 days and the path of the Earth around the Sun is the circumference of a circle of radius 150000000 km.



*diagram not to scale*

a. Calculate the distance travelled by the Earth in **one day**.

[4]

b. Give your answer to part (a) in the form  $a \times 10^k$  where  $1 \leq a \leq 10$  and  $k \in \mathbb{Z}$ .

[2]

---