A / A* questions

2018

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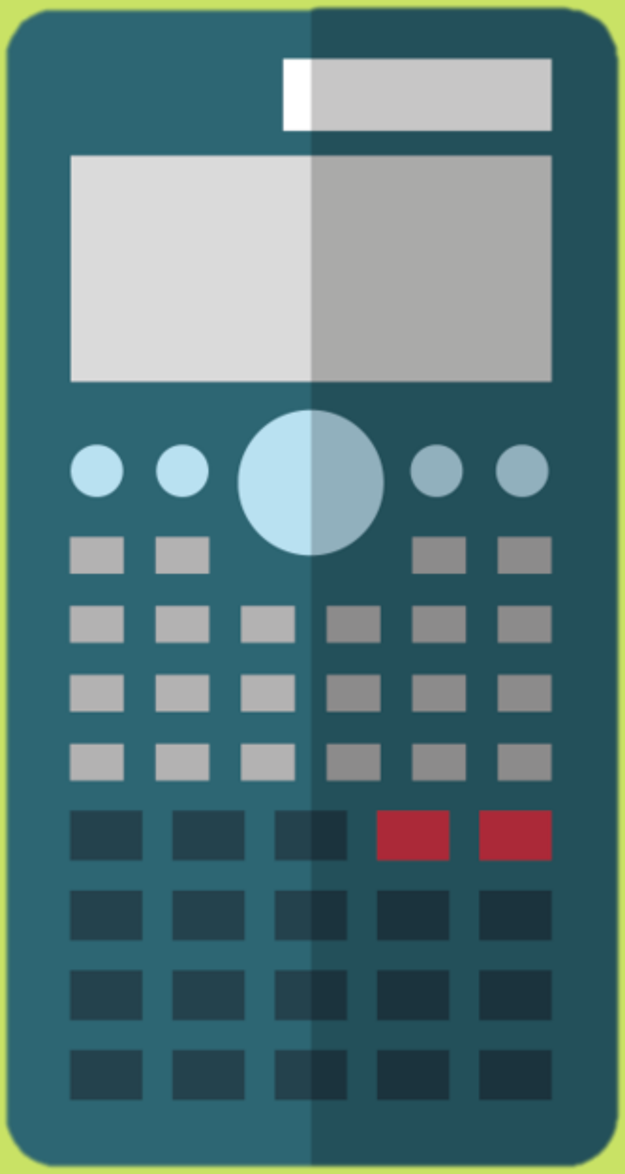

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1 "We eat more ice cream as the temperature rises."

What type of correlation is this?

.... [1]

2 Write 0.000 052 3 in standard form.

.... [1]

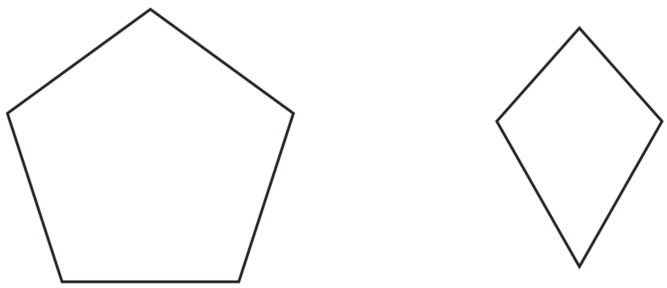
3 Calculate $\sqrt{17.8} - 1.3^{2.5}$.

.... [1]

4 Write the recurring decimal $0.\dot{8}$ as a fraction.

.... [1]

5



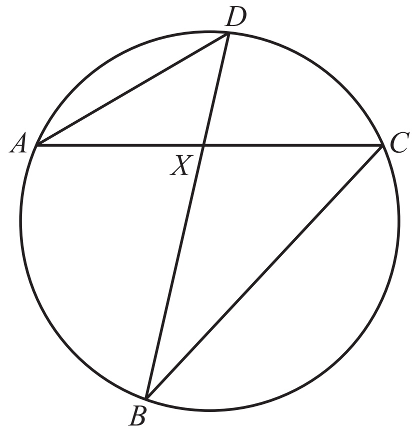
The diagram shows a regular pentagon and a kite.

Complete the following statements.

(a) The regular pentagon has .... lines of symmetry. [1]

(b) The kite has rotational symmetry of order .... [1]

14



NOT TO SCALE

A, B, C and D are points on the circumference of the circle.
AC and BD intersect at X.

(a) Complete the statement.

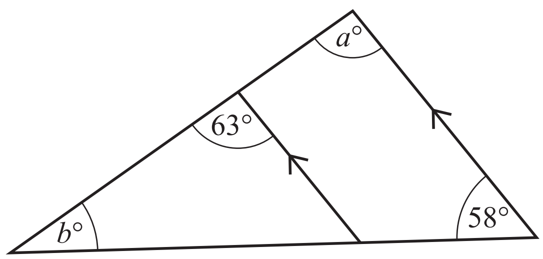
Triangle ADX is .... to triangle BCX. [1]

(b) The area of triangle ADX is $36\,\text{cm}^2$ and the area of triangle BCX is $65.61\,\text{cm}^2$.
$AX = 8.6$ cm and $DX = 7.2$ cm.

Find BX.

$BX =$ .... cm [3]

15



NOT TO SCALE

Complete the statements.

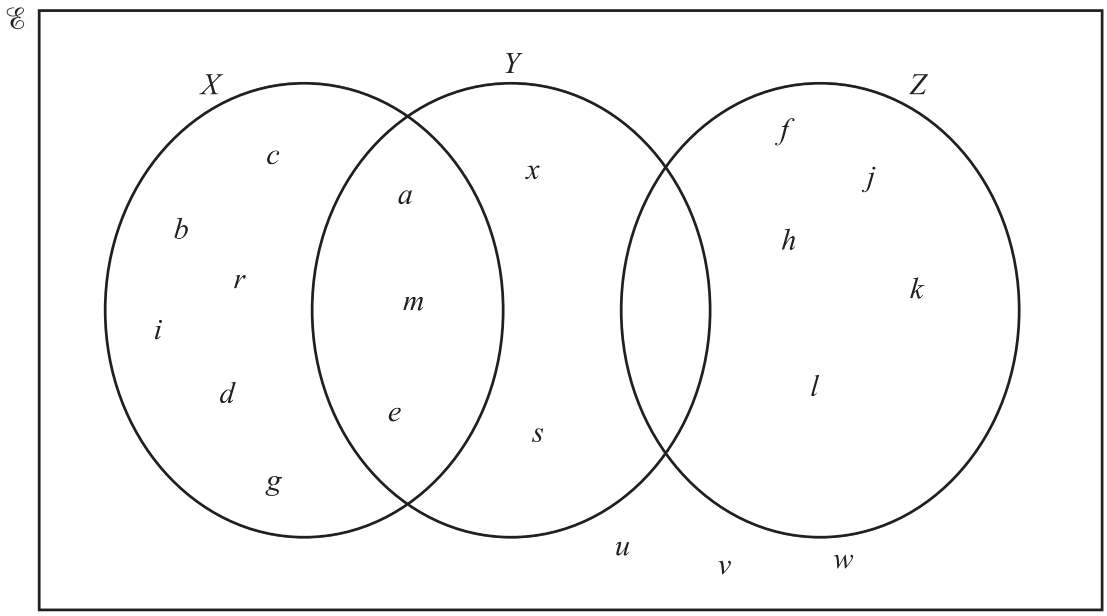
$a =$ .... because ....

....

$b =$ .... because ....

.... [4]

19



(a) Use set notation to complete the statements for the Venn diagram above.

(i) c .... X [1]

(ii) .... = { a, m, e } [1]

(iii) $Y \cap Z =$ .... [1]

(b) List the elements of $(X \cup Y \cup Z)'$.

.... [1]

(c) Find $\mathrm{n}(X' \cap Z)$.

.... [1]

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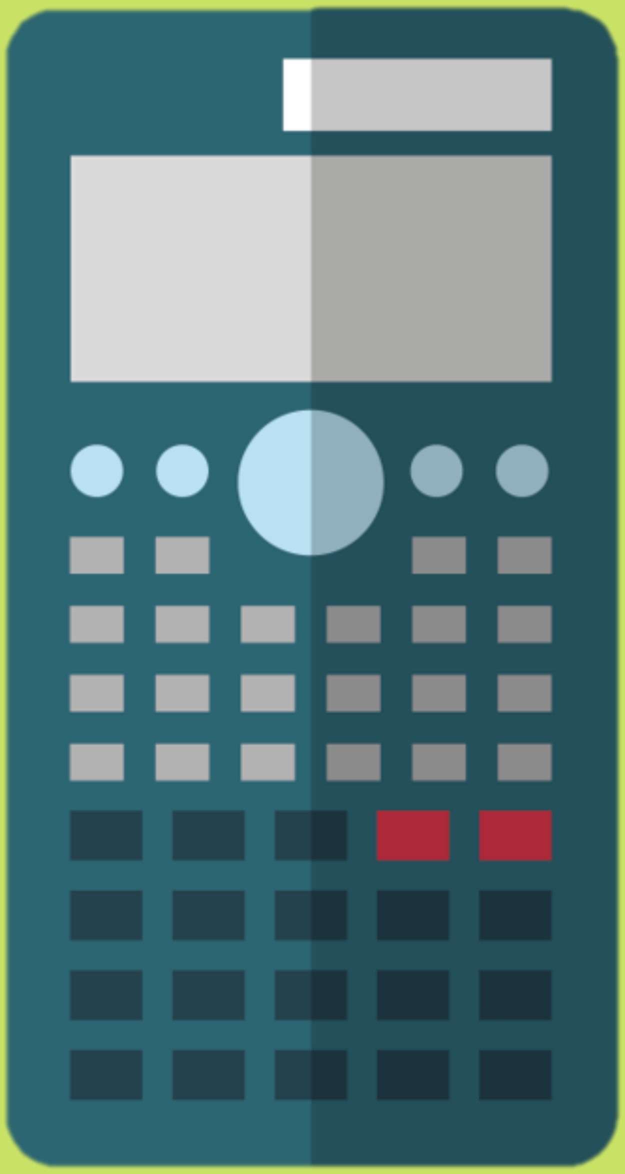

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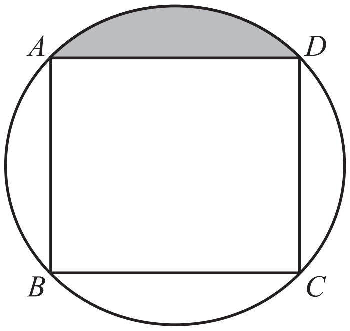


NOT TO SCALE

The vertices of a square *ABCD* lie on the circumference of a circle, radius 8 cm.

(a) Calculate the area of the square.

.... cm^2 [2]

(b) **(i)** Calculate the area of the shaded segment.

.... cm^2 [3]

(ii) Calculate the perimeter of the shaded segment.

.... cm [4]

6 Klaus buys x silver balloons and y gold balloons for a party.

He buys
- more gold balloons than silver balloons
- at least 15 silver balloons
- less than 50 gold balloons
- a total of no more than 70 balloons.

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

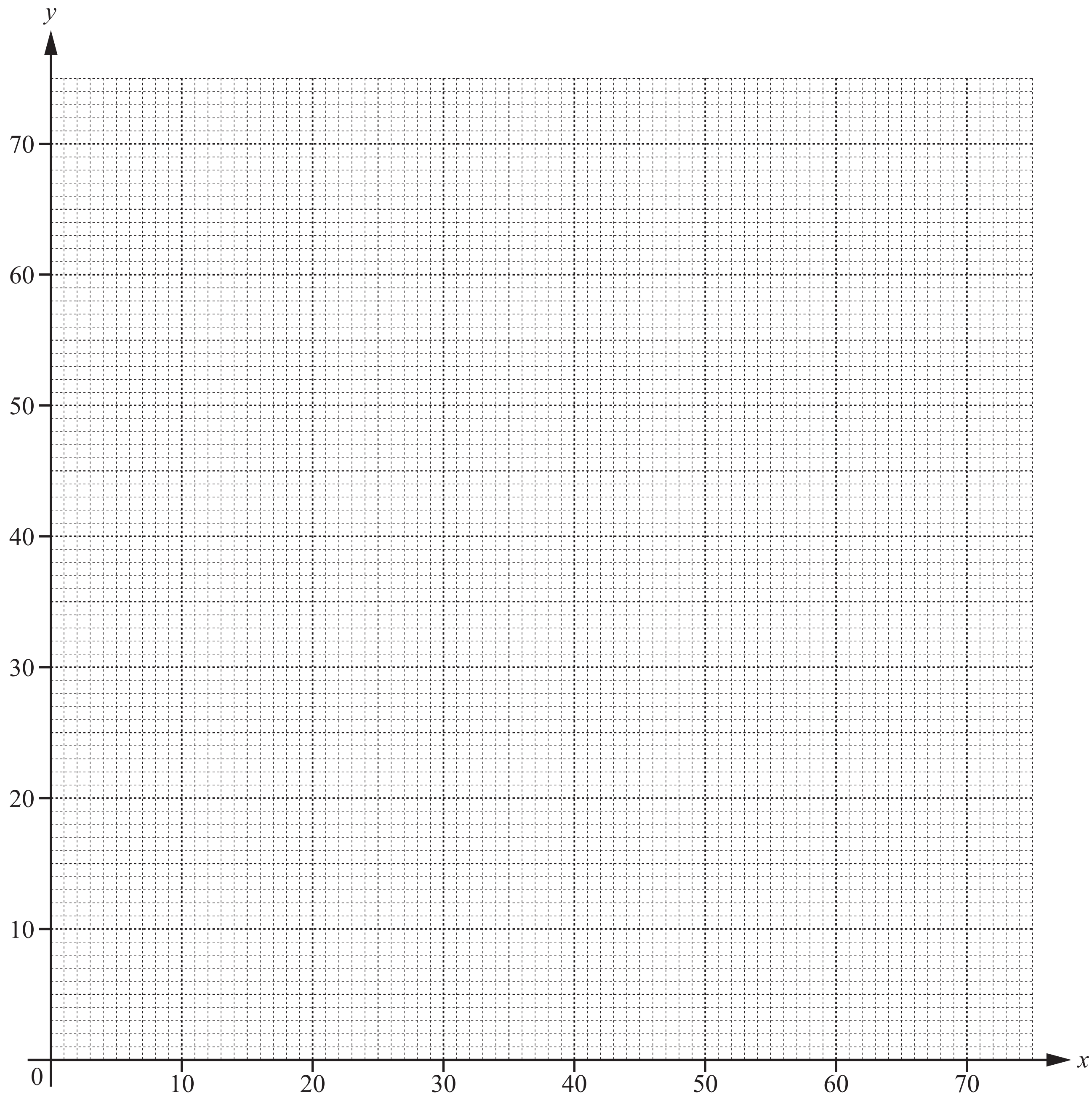
....

....

....

.... [4]

(b) On the grid, show the information from **part (a)** by drawing four straight lines and shading the unwanted regions.



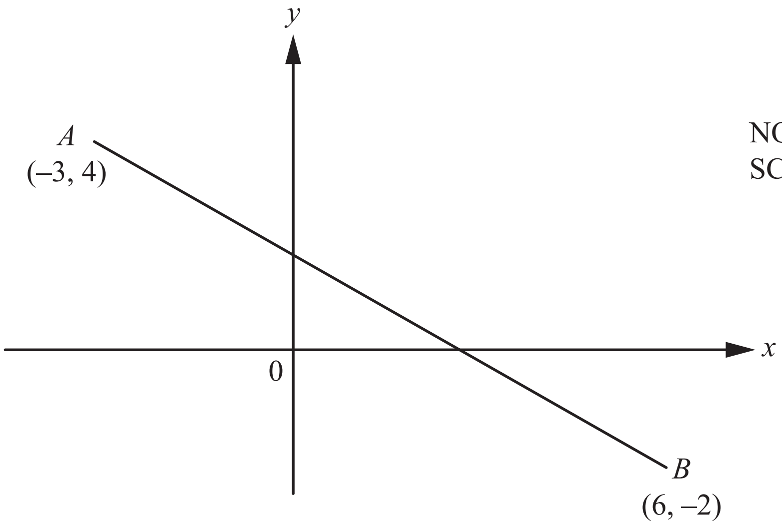
[5]

(c) Silver balloons cost \$2 and gold balloons cost \$3.

Calculate the most that Klaus could spend.

\$ .... [2]

10 **(a)**



Calculate the length of AB.

.... [3]

(b) The point P has co-ordinates $(10, 12)$ and the point Q has co-ordinates $(2, -4)$.

Find

(i) the co-ordinates of the mid-point of the line PQ,

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

(ii) the gradient of the line PQ,

.... [2]

(iii) the equation of a line perpendicular to PQ that passes through the point $(2, 3)$.

.... [3]

11 The table shows the first five terms of sequences A, B and C.

Sequence	1st term	2nd term	3rd term	4th term	5th term	6th term
A	0	1	4	9	16	
B	4	5	6	7	8	
C	-4	-4	-2	2	8	

(a) Complete the table. [3]

(b) Find an expression for the nth term of

(i) sequence A,

.... [2]

(ii) sequence B.

.... [1]

(c) Find the value of n when the nth term of sequence A is 576.

n = ... [2]

(d) **(i)** Find an expression for the nth term of sequence C.
Give your answer in its simplest form.

.... [3]

(ii) Find the value of the 30th term of sequence C.

.... [2]

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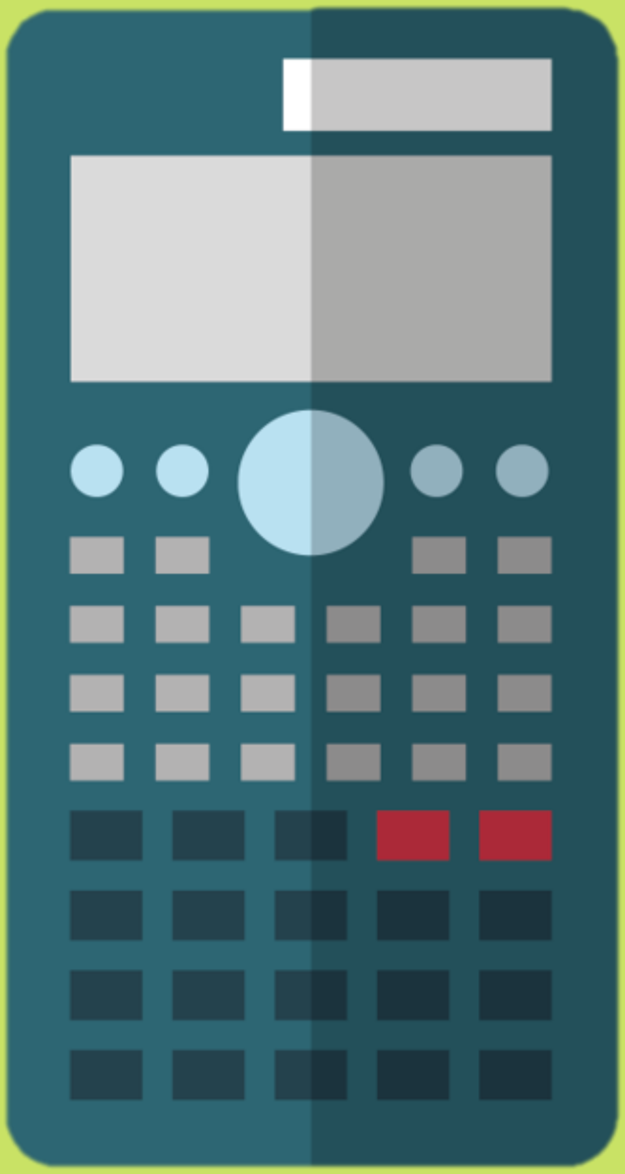

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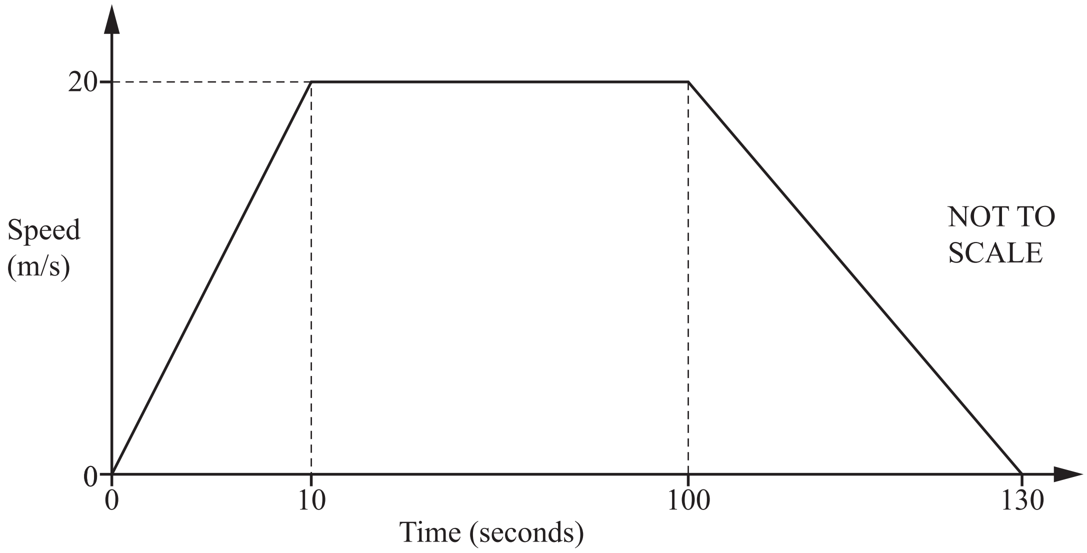

The speed–time graph shows information about the journey of a tram between two stations.

(a) Calculate the distance between the two stations.

.... m [3]

(b) Calculate the average speed of the tram for the whole journey.

.... m/s [1]

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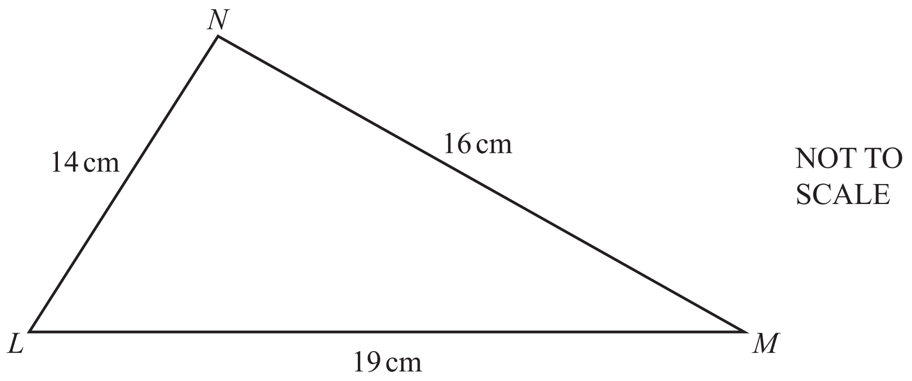


Calculate angle *LMN*.

Angle *LMN* = ... [4]

20 **(a)** A box contains 3 blue pens, 4 red pens and 8 green pens only.
A pen is chosen at random from the box.

Find the probability that this pen is green.

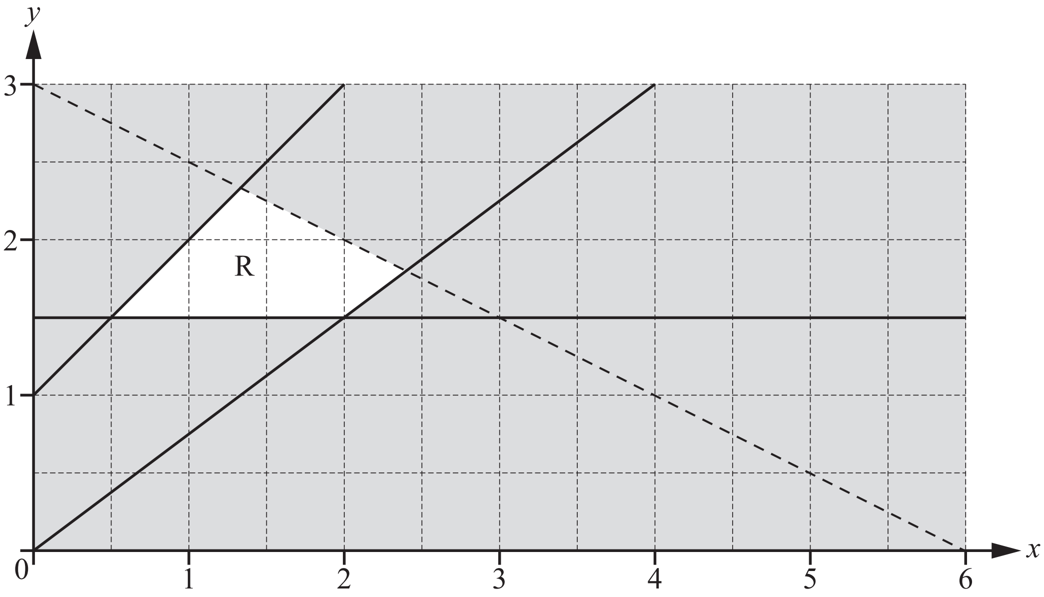
.... [1]

(b) Another box contains 7 black pens and 8 orange pens only.
Two pens are chosen at random from this box without replacement.

Calculate the probability that at least one orange pen is chosen.

.... [3]

21



There are four inequalities that define the region R.
One of these is $y \leqslant x + 1$.

Find the other three inequalities.

....

....

.... [4]

24 **(a)** Point A has co-ordinates (1, 0) and point B has co-ordinates (2, 5).

Calculate the angle between the line AB and the x-axis.

.... [3]

(b) The line PQ has equation $y = 3x - 8$ and point P has co-ordinates (6, 10).

Find the equation of the line that passes through P and is perpendicular to PQ.
Give your answer in the form $y = mx + c$.

$y =$ .... [3]

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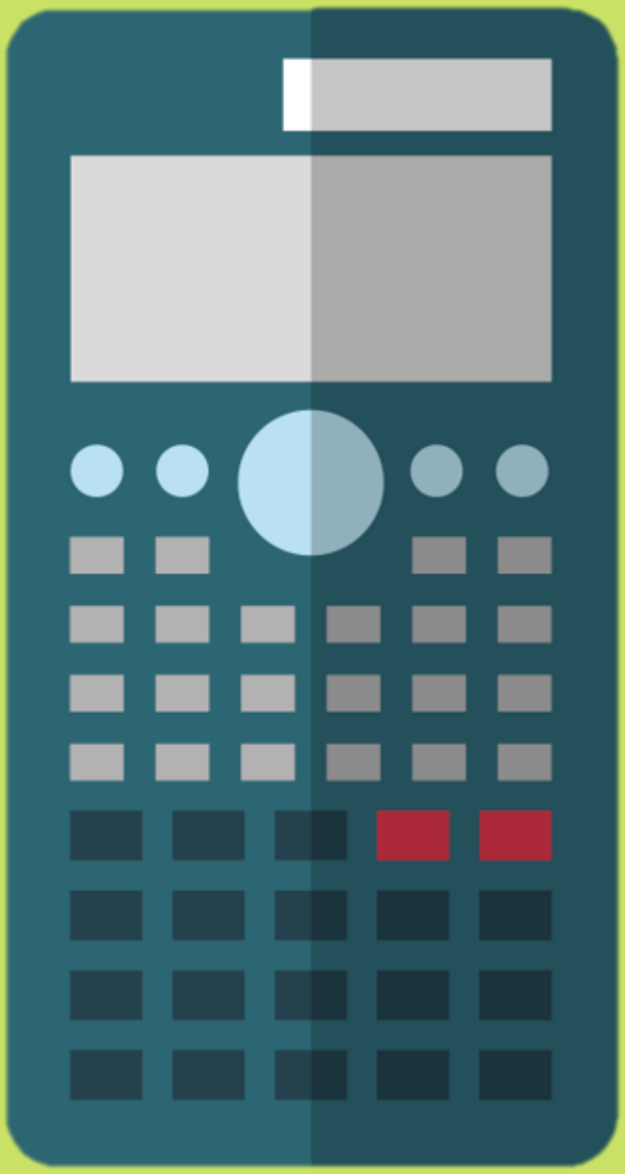

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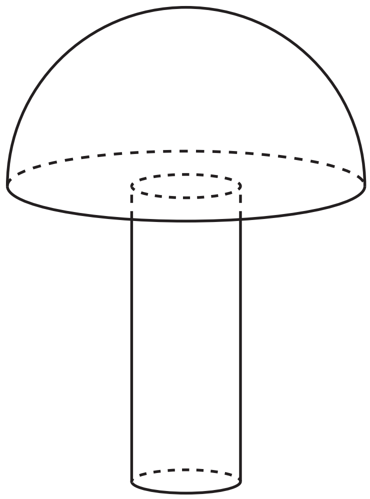
6 A solid hemisphere has volume $230\,\text{cm}^3$.

(a) Calculate the radius of the hemisphere.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

.... cm [3]

(b) A solid cylinder with radius 1.6 cm is attached to the hemisphere to make a toy.



NOT TO SCALE

The total volume of the toy is $300\,\text{cm}^3$.

(i) Calculate the height of the cylinder.

.... cm [3]

(ii) A mathematically similar toy has volume 19 200 cm^3.

Calculate the radius of the cylinder for this toy.

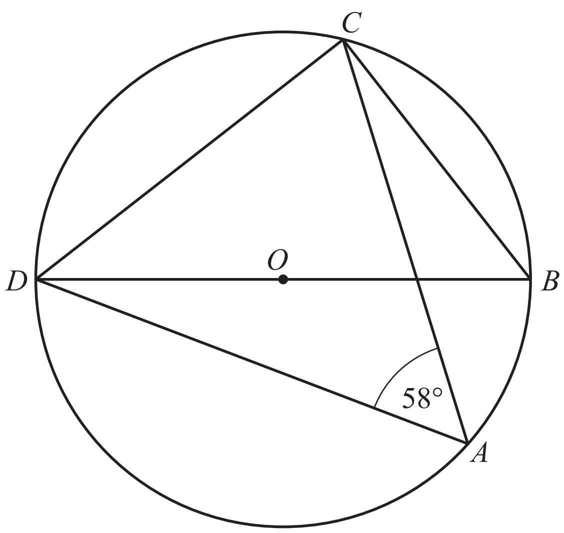
.... cm [3]

8 **(a)** The exterior angle of a regular polygon is $x°$ and the interior angle is $8x°$.

Calculate the number of sides of the polygon.

.... [3]

(b)

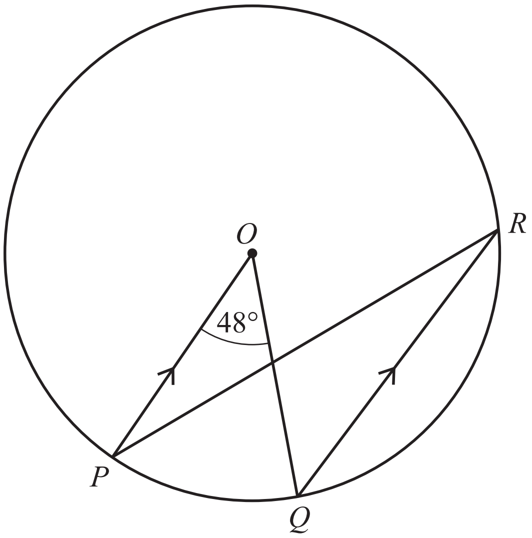


A, B, C and D are points on the circumference of the circle, centre O.
DOB is a straight line and angle $DAC = 58°$.

Find angle CDB.

Angle CDB = ... [3]

(c)



P, Q and R are points on the circumference of the circle, centre O.
PO is parallel to QR and angle $POQ = 48°$.

(i) Find angle OPR.

Angle OPR = ... [2]

(ii) The radius of the circle is 5.4 cm.

Calculate the length of the **major** arc PQ.

.... cm [3]

10 **(a)** In 2017, the membership fee for a sports club was \$79.50 .
This was an increase of 6% on the fee in 2016.

Calculate the fee in 2016.

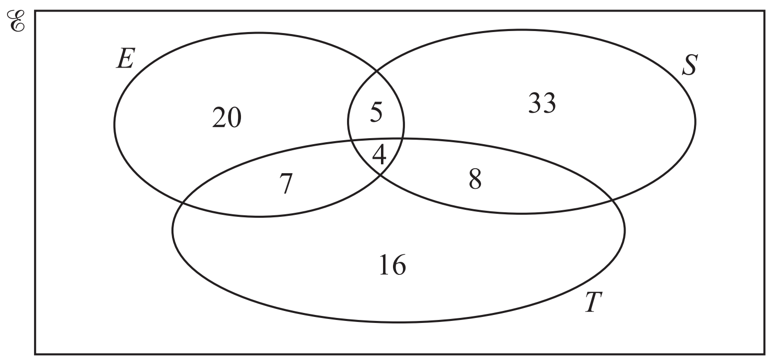
\$ .... [3]

(b) On one day, the number of members using the exercise machines was 40, correct to the nearest 10.
Each member used a machine for 30 minutes, correct to the nearest 5 minutes.

Calculate the lower bound for the number of minutes the exercise machines were used on this day.

.... min [2]

(c) On another day, the number of members using the exercise machines (E), the swimming pool (S) and the tennis courts (T) is shown on the Venn diagram.



(i) Find the number of members using only the tennis courts.

.... [1]

(ii) Find the number of members using the swimming pool.

.... [1]

(iii) A member using the swimming pool is chosen at random.

Find the probability that this member also uses the tennis courts and the exercise machines.

.... [2]

(iv) Find $n(T \cap (E \cup S))$.

.... [1]

11 (a) $\overrightarrow{OA} = \begin{pmatrix} 4 \\ 3 \end{pmatrix}$ $\overrightarrow{AB} = \begin{pmatrix} 8 \\ -7 \end{pmatrix}$ $\overrightarrow{AC} = \begin{pmatrix} -3 \\ 6 \end{pmatrix}$

Find

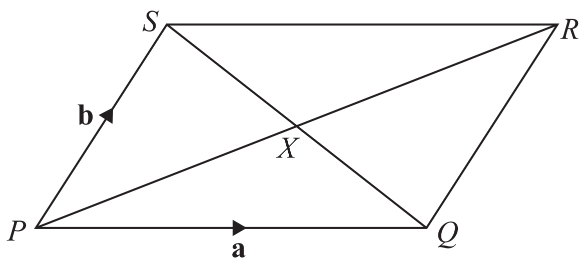
(i) $|\overrightarrow{OB}|$,

$|\overrightarrow{OB}|$ = ... [3]

(ii) $\overrightarrow{BC}$.

$\overrightarrow{BC} = \begin{pmatrix} \\ \\ \end{pmatrix}$ [2]

(b)



NOT TO SCALE

PQRS is a parallelogram with diagonals *PR* and *SQ* intersecting at *X*.
$\overrightarrow{PQ} = \mathbf{a}$ and $\overrightarrow{PS} = \mathbf{b}$.

Find $\overrightarrow{QX}$ in terms of **a** and **b**.
Give your answer in its simplest form.

$\overrightarrow{QX}$ = ... [2]

(c) $\mathbf{M} = \begin{pmatrix} 2 & 5 \\ 1 & 8 \end{pmatrix}$

Calculate

(i) $\mathbf{M}^2$,

$\mathbf{M}^2 = \begin{pmatrix} & \\ & \end{pmatrix}$ [2]

(ii) $\mathbf{M}^{-1}$.

$\mathbf{M}^{-1} = \begin{pmatrix} & \\ & \end{pmatrix}$ [2]

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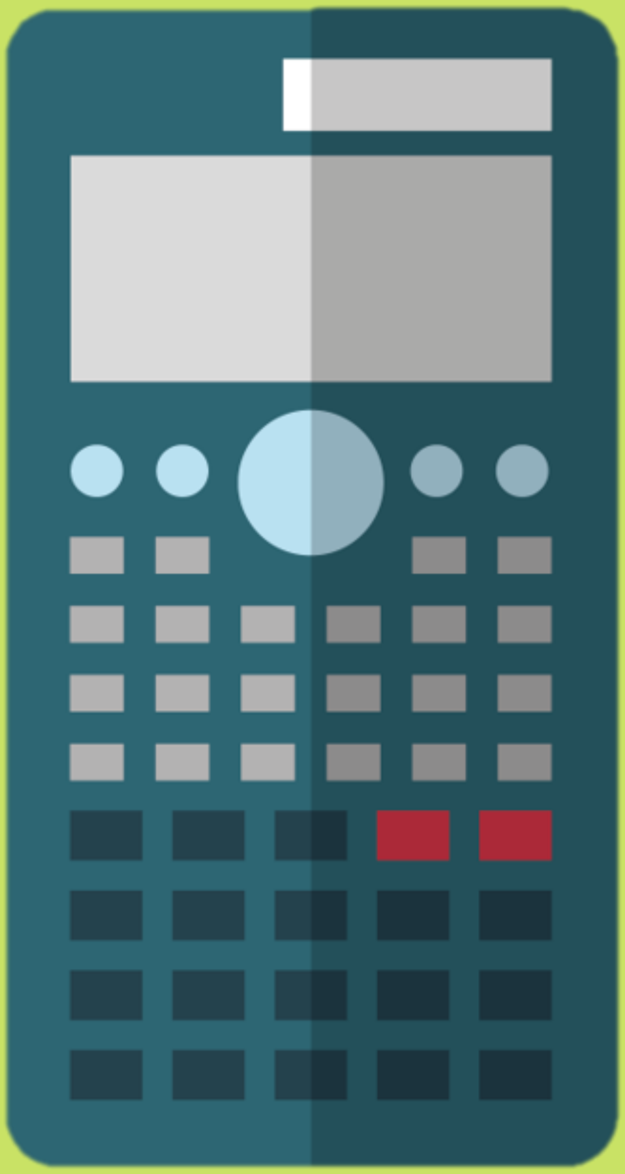

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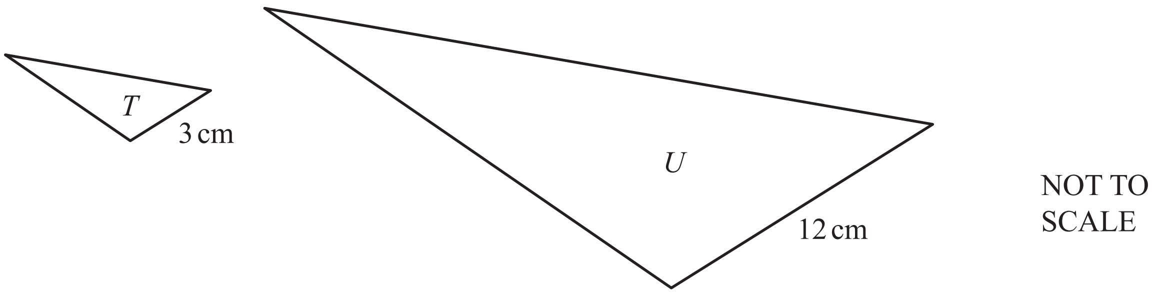


The diagram shows two mathematically similar triangles, *T* and *U*.
Two corresponding side lengths are 3 cm and 12 cm.
The area of triangle *T* is 5 cm^2.

Find the area of triangle *U*.

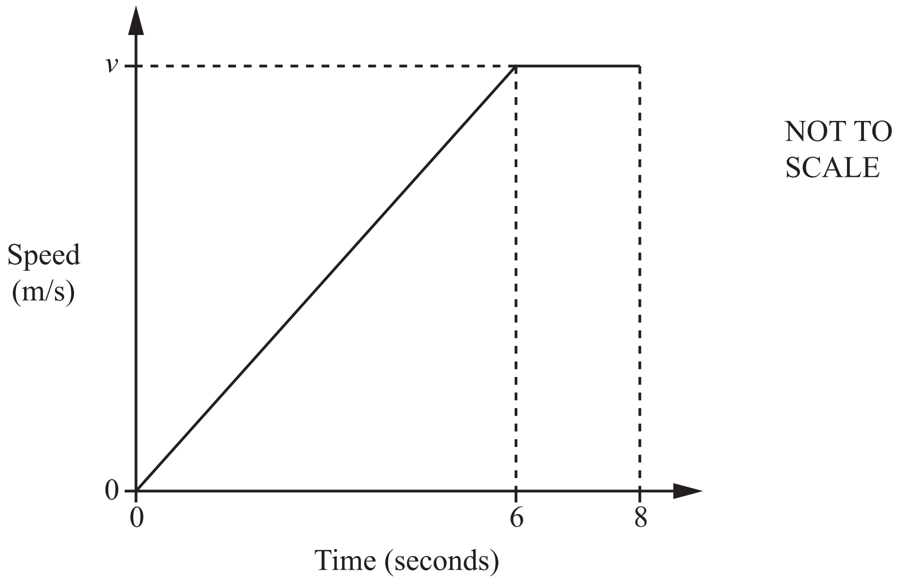
.... cm^2 [2]

12 Anna walks 31 km at a speed of 5 km/h.
Both values are correct to the nearest whole number.

Work out the upper bound of the time taken for Anna's walk.

.... hours [2]

17 The diagram shows information about the first 8 seconds of a car journey.



The car travels with constant acceleration reaching a speed of v m/s after 6 seconds.
The car then travels at a constant speed of v m/s for a further 2 seconds.
The car travels a total distance of 150 metres.

Work out the value of v.

v = ... [3]

18 A ball falls d metres in t seconds.
d is directly proportional to the square of t.
The ball falls 44.1 m in 3 seconds.

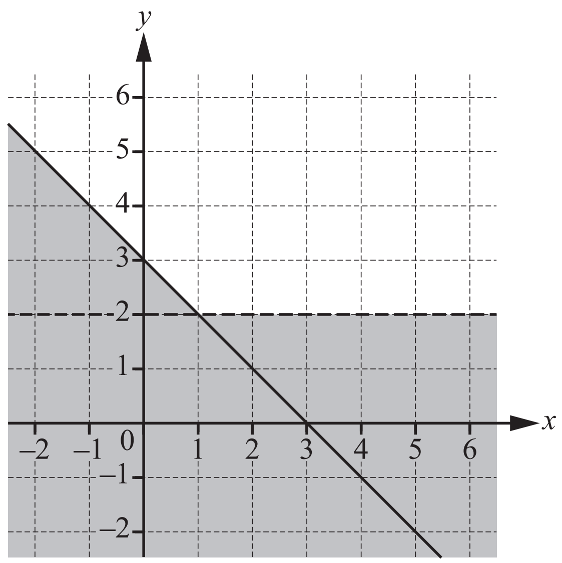
(a) Find a formula for d in terms of t.

d = ... [2]

(b) Calculate the distance the ball falls in 2 seconds.

.... m [1]

19

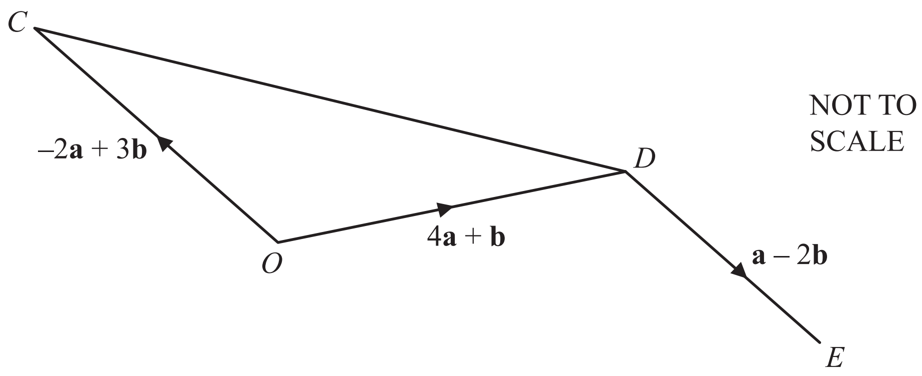


Find the two inequalities that define the region on the grid that is **not** shaded.

....

.... [3]

22



In the diagram, O is the origin, $\overrightarrow{OC} = -2\mathbf{a} + 3\mathbf{b}$ and $\overrightarrow{OD} = 4\mathbf{a} + \mathbf{b}$.

(a) Find $\overrightarrow{CD}$, in terms of $\mathbf{a}$ and $\mathbf{b}$, in its simplest form.

$\overrightarrow{CD} =$ .... [2]

(b) $\overrightarrow{DE} = \mathbf{a} - 2\mathbf{b}$

Find the position vector of E, in terms of $\mathbf{a}$ and $\mathbf{b}$, in its simplest form.

.... [2]

25 P is the point (16, 9) and Q is the point (22, 24).

(a) Find the equation of the line perpendicular to PQ that passes through the point (5, 1).
Give your answer in the form $y = mx + c$.

$y =$ .... [4]

(b) N is the point on PQ such that $PN = 2NQ$.

Find the co-ordinates of N.

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

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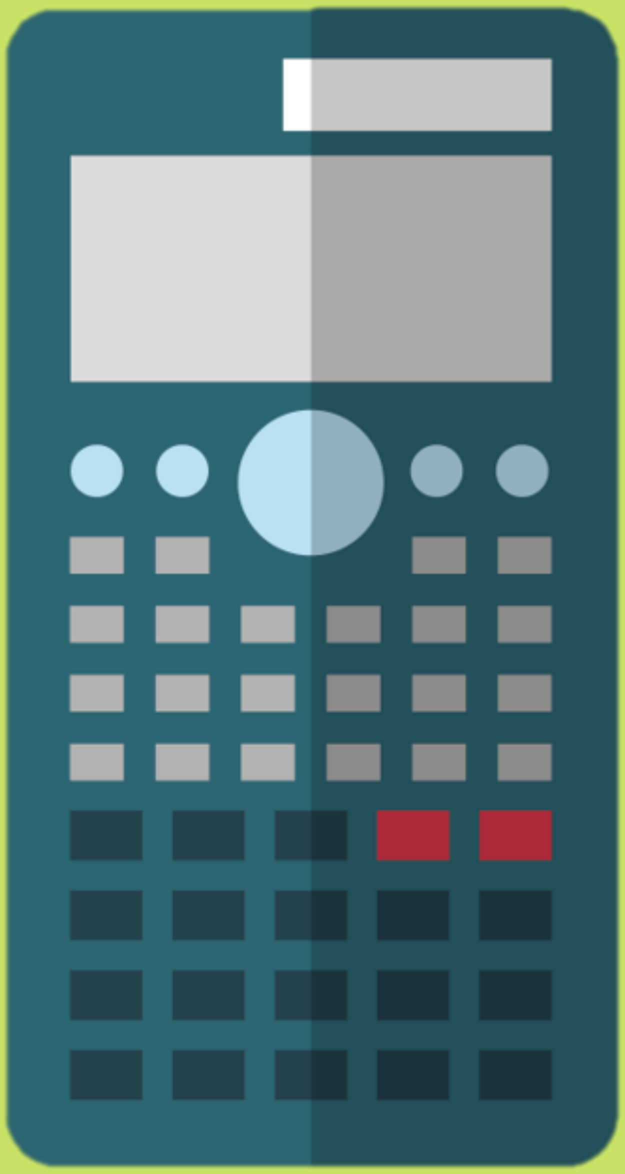

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1 **(a)** Here is a list of ingredients to make 20 biscuits.

260 g of butter 500 g of sugar 650 g of flour 425 g of rice

(i) Find the mass of rice as a percentage of the mass of sugar.

.... % [1]

(ii) Find the mass of butter needed to make 35 of these biscuits.

.... g [2]

(iii) Michel has 2 kg of each ingredient.

Work out the greatest number of these biscuits that he can make.

.... [3]

(b) A company makes these biscuits at a cost of \$1.35 per packet.
These biscuits are sold for \$1.89 per packet.

(i) Calculate the percentage profit the company makes on each packet.

.... % [3]

(ii) The selling price of \$1.89 has increased by 8% from last year.

Calculate the selling price last year.

\$ .... [3]

(c) Over a period of 3 years, the company's sales of biscuits increased from 15.6 million packets to 20.8 million packets.
The sales increased exponentially by the same percentage each year.

Calculate the percentage increase **each year**.

.... % [3]

(d) The people who work for the company are in the following age groups.

Group A	Group B	Group C
Under 30 years	30 to 50 years	Over 50 years

The ratio of the number in group A to the number in group B is 7 : 10.
The ratio of the number in group B to the number in group C is 4 : 3.

(i) Find the ratio of the number in group A to the number in group C.
Give your answer in its simplest form.

.... : .... [3]

(ii) There are 45 people in group C.

Find the total number of people who work for the company.

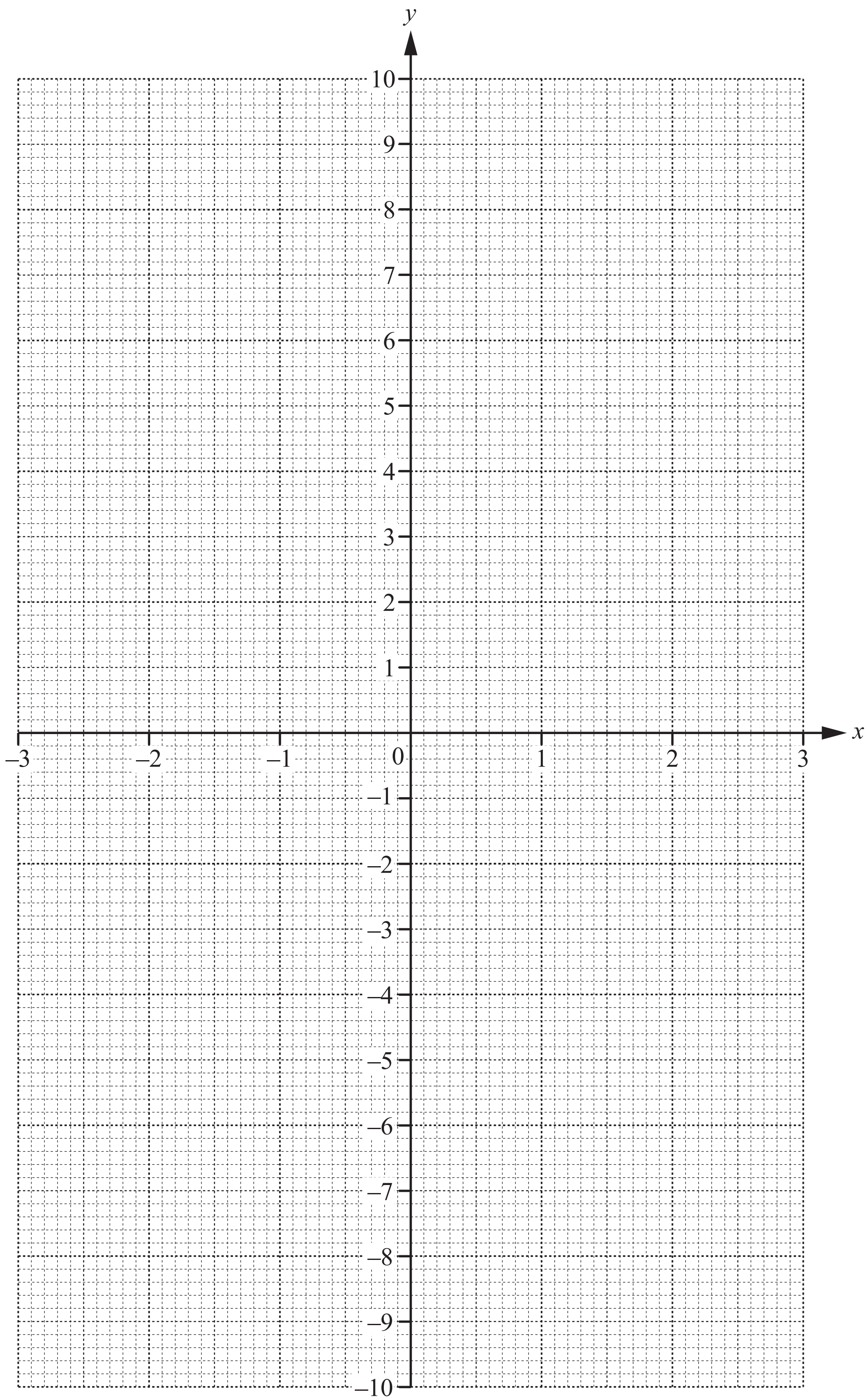
.... [3]

6 **(a)** Complete the table of values for $y = \frac{x^3}{3} - \frac{1}{2x^2}$, $x \neq 0$.

x	-3	-2	-1	-0.5	-0.3		0.3	0.5	1	2	3
y	-9.1	-2.8	-0.8		-5.6		-5.5	-2.0			8.9

[3]

(b) On the grid, draw the graph of $y = \frac{x^3}{3} - \frac{1}{2x^2}$ for $-3 \leqslant x \leqslant -0.3$ and $0.3 \leqslant x \leqslant 3$.



[5]

(c) **(i)** By drawing a suitable tangent, find an estimate of the gradient of the curve at $x = -2$.

.... [3]

(ii) Write down the equation of the tangent to the curve at $x = -2$.
Give your answer in the form $y = mx + c$.

$y =$ .... [2]

(d) Use your graph to solve the equations.

(i) $\dfrac{x^3}{3} - \dfrac{1}{2x^2} = 0$

$x =$ .... [1]

(ii) $\dfrac{x^3}{3} - \dfrac{1}{2x^2} + 4 = 0$

$x =$ .... or $x =$ .... or $x =$ .... [3]

(e) The equation $\dfrac{x^3}{3} - \dfrac{1}{2x^2} + 4 = 0$ can be written in the form $ax^n + bx^{n-3} - 3 = 0$.

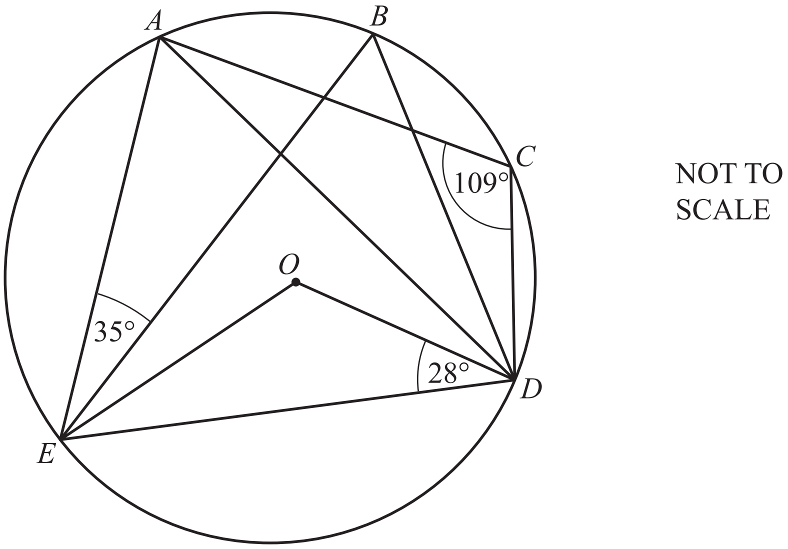
Find the value of a, the value of b and the value of n.

$a =$ ....

$b =$ ....

$n =$ .... [3]

9 **(a)**



A, B, C, D and E lie on the circle, centre O.
Angle $AEB = 35°$, angle $ODE = 28°$ and angle $ACD = 109°$.

(i) Work out the following angles, giving reasons for your answers.

(a) Angle EBD = ... because ....

....

.... [3]

(b) Angle EAD = ... because ....

.... [2]

(ii) Work out angle BEO.

Angle BEO = ... [3]

(b) In a regular polygon, the interior angle is 11 times the exterior angle.

(i) Work out the number of sides of this polygon.

.... [3]

(ii) Find the sum of the interior angles of this polygon.

.... [2]

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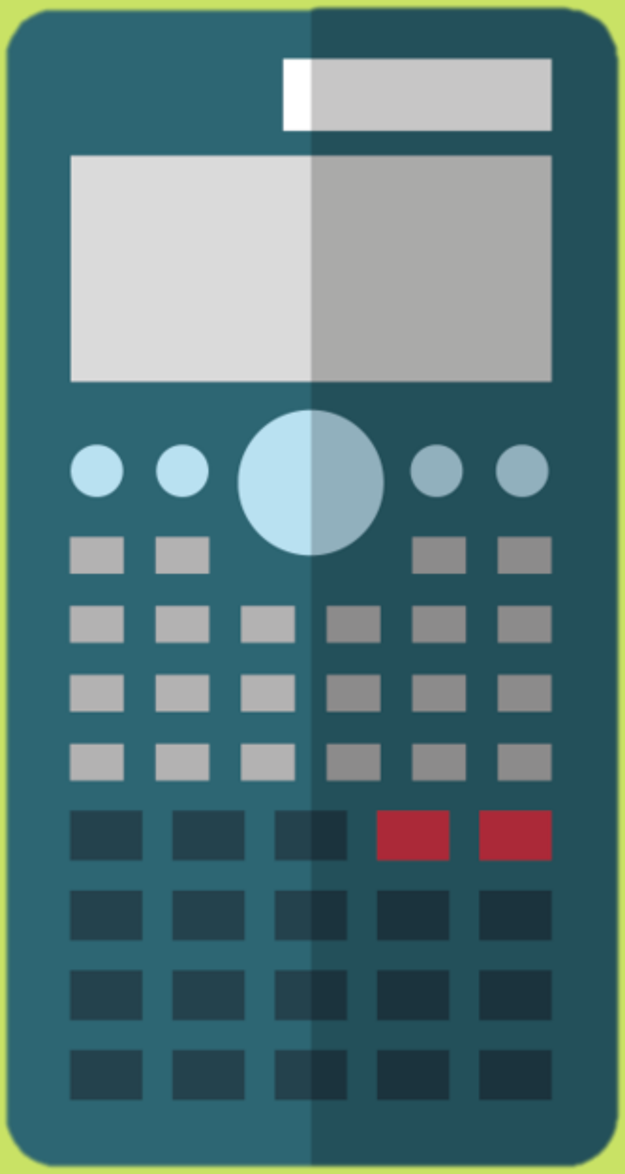

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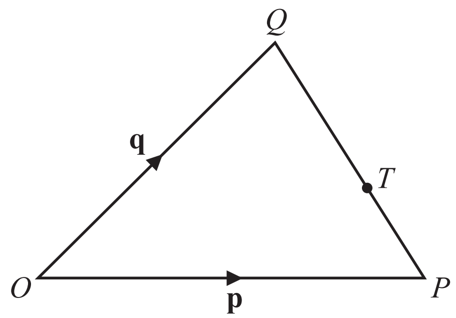


NOT TO SCALE

O is the origin, $\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OQ} = \mathbf{q}$.
$QT : TP = 2 : 1$

Find the position vector of T.
Give your answer in terms of **p** and **q**, in its simplest form.

.... [2]

15 **Without using a calculator**, work out $\frac{2}{3} \div 1\frac{1}{5}$.

You must show all your working and give your answer as a fraction in its simplest form.

.... [3]

16 **(a)** The length of the side of a square is 12 cm, correct to the nearest centimetre.

Calculate the upper bound for the perimeter of the square.

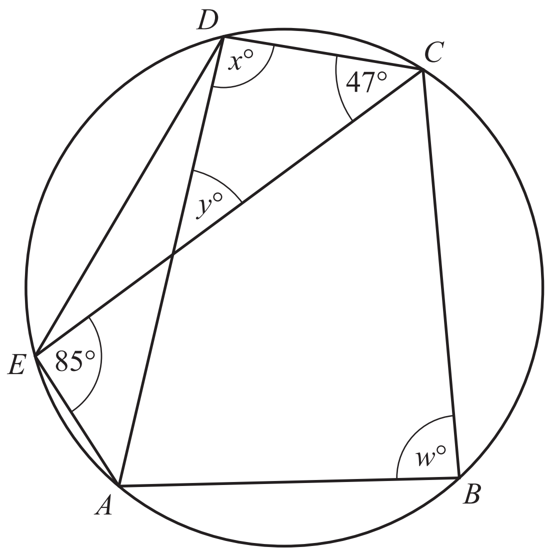
.... cm [2]

(b) Jo measures the length of a rope and records her measurement correct to the nearest ten centimetres.
The upper bound for her measurement is 12.35 m.

Write down the measurement she records.

.... m [1]

20



NOT TO SCALE

The points A, B, C, D and E lie on the circumference of the circle.
Angle $DCE = 47°$ and angle $CEA = 85°$.

Find the values of w, x and y.

$w =$ ....

$x =$ ....

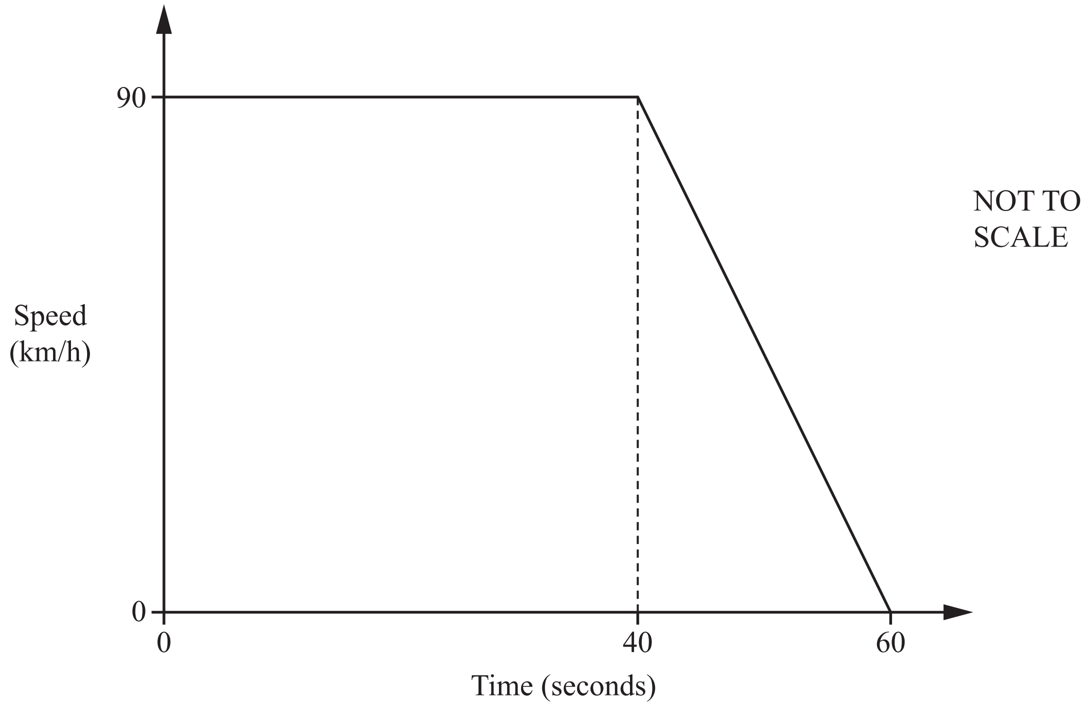
$y =$ .... [3]

21 Write as a single fraction in its simplest form.

$$\frac{1}{y-1}-\frac{1}{y}$$

.... [3]

24



The diagram shows the speed–time graph for 60 seconds of a car journey.

(a) Change 90 km/h to m/s.

.... m/s [2]

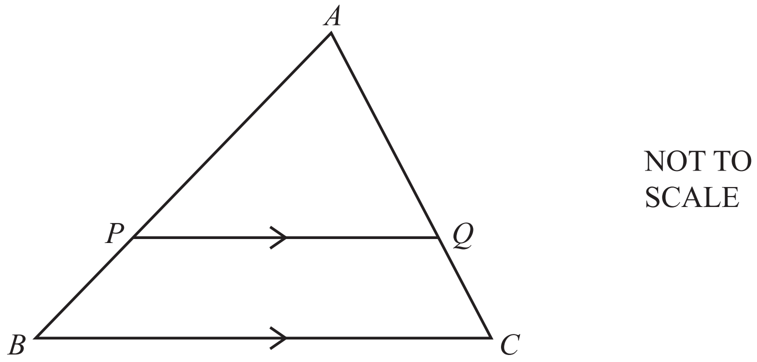
(b) Find the deceleration of the car in m/s^2.

.... m/s^2 [1]

(c) Find the distance travelled, in metres, in the 60 seconds.

.... m [2]

25 (a)

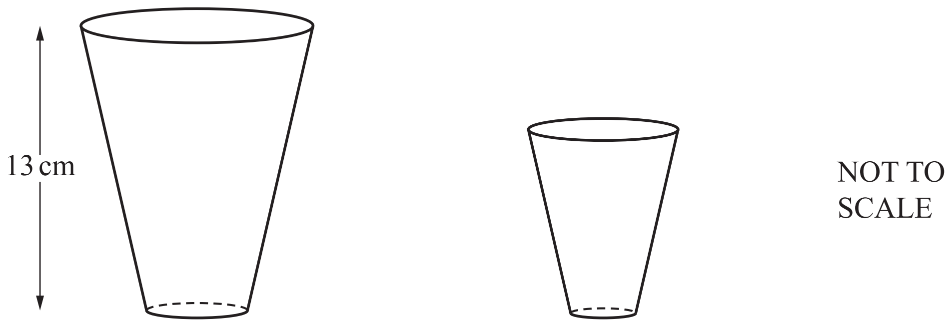


In the diagram, PQ is parallel to BC.
APB and AQC are straight lines.
$PQ = 8$ cm, $BC = 10$ cm and $AB = 9$ cm.

Calculate PB.

$PB =$ .... cm [2]

(b)



The diagram shows two glasses which are mathematically similar.
The larger glass has a capacity of 0.5 litres and the smaller glass has a capacity of 0.25 litres.
The height of the larger glass is 13 cm.

Calculate the height of the smaller glass.

.... cm [3]

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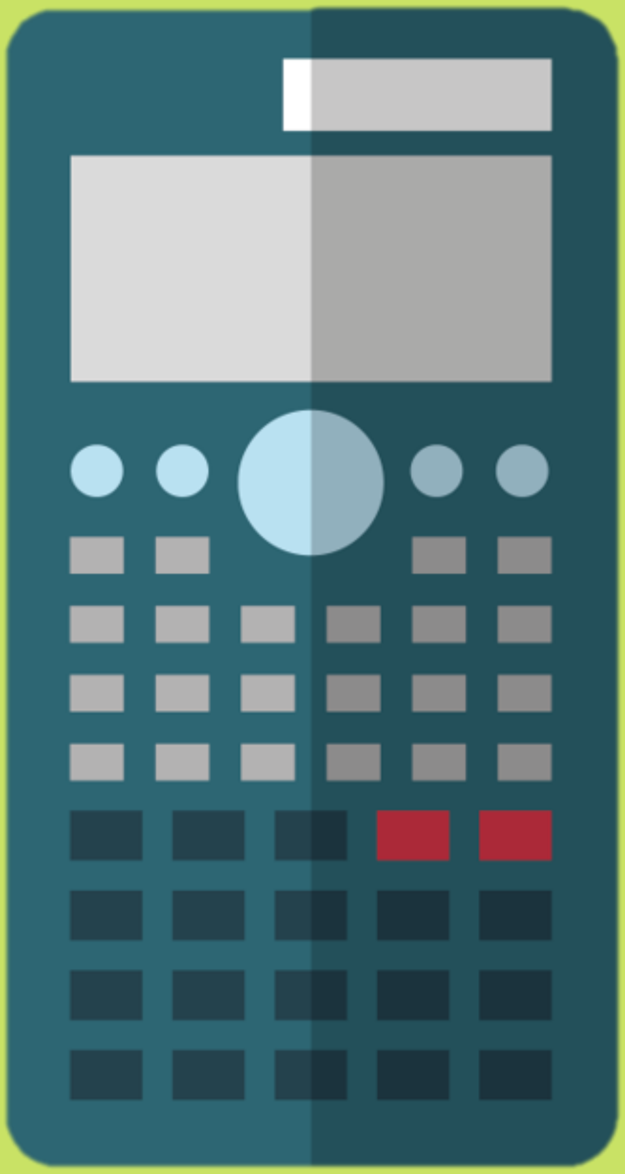

Q8Maths

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1 **(a)** Rowena buys and sells clothes.

(i) She buys a jacket for \$40 and sells it for \$45.40 .

Calculate the percentage profit.

.... % [3]

(ii) She sells a dress for \$42.60 after making a profit of 20% on the cost price.

Calculate the cost price.

\$ .... [3]

(b) Sara invests \$500 for 15 years at a rate of 2% per year simple interest.

Calculate the total interest Sara receives.

\$ .... [2]

(c) Tomas has two cars.

(i) The value, today, of one car is \$21 000.
The value of this car **decreases** exponentially by 18% each year.

Calculate the value of this car after 5 years.
Give your answer correct to the nearest hundred dollars.

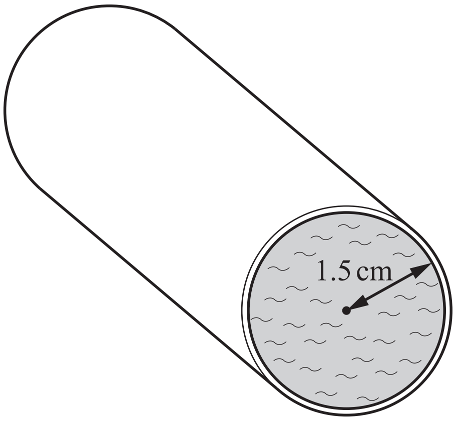
\$ .... [3]

(ii) The value, today, of the other car is \$15 000.
The value of this car **increases** exponentially by x% each year.
After 12 years the value of the car will be \$42 190.

Calculate the value of x.

x = ... [3]

7 **(a)**



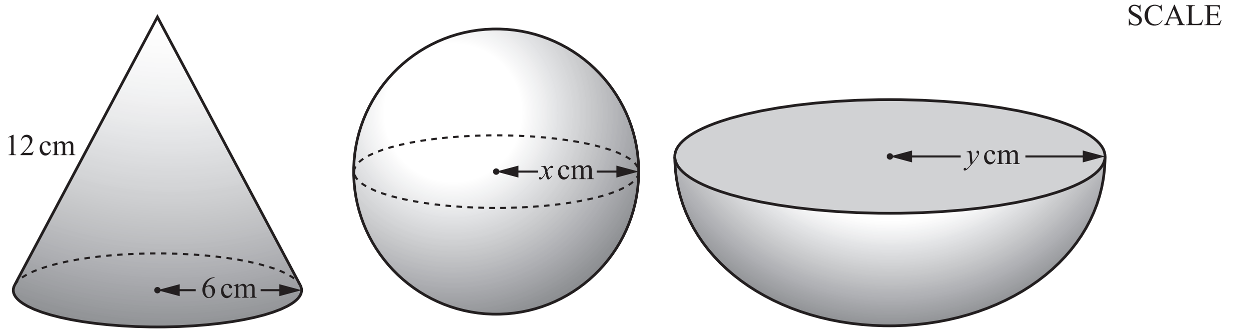
NOT TO SCALE

Water flows through a cylindrical pipe at a speed of 8 cm/s.
The radius of the circular cross-section is 1.5 cm and the pipe is always completely full of water.

Calculate the amount of water that flows through the pipe in 1 hour.
Give your answer in litres.

.... litres [4]

(b)



The diagram shows three solids.
The base radius of the cone is 6 cm and the slant height is 12 cm.
The radius of the sphere is x cm and the radius of the hemisphere is y cm.
The **total** surface area of each solid is the same.

(i) Show that the total surface area of the cone is $108\pi\ \text{cm}^2$.

[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi r l$.]

[2]

(ii) Find the value of x and the value of y.

[The surface area, A, of a sphere with radius r is $A = 4\pi r^2$.]

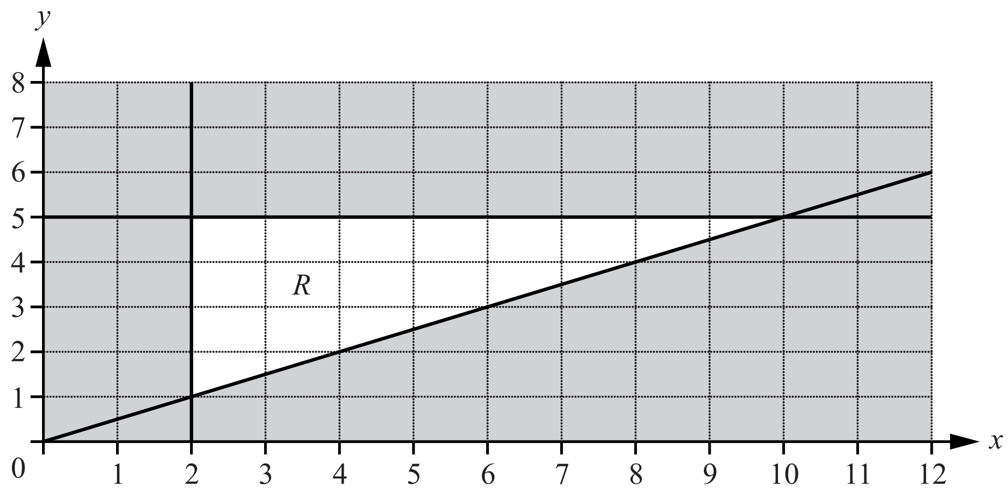
x = ...

y = ... [4]

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.

....

....

.... [4]

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

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

10 **(a)** $f(x) = 2x - 3$ $g(x) = x^2 + 1$

(i) Find gg(2).

.... [2]

(ii) Find $g(x+2)$, giving your answer in its simplest form.

.... [2]

(iii) Find x when $f(x) = 7$.

x = ... [2]

(iv) Find $f^{-1}(x)$.

$f^{-1}(x)$ = ... [2]

(b) $h(x) = x^x$, $x > 0$

(i) Calculate h(0.3).
Give your answer correct to 2 decimal places.

.... [2]

(ii) Find x when $h(x) = 256$.

$x =$ .... [1]

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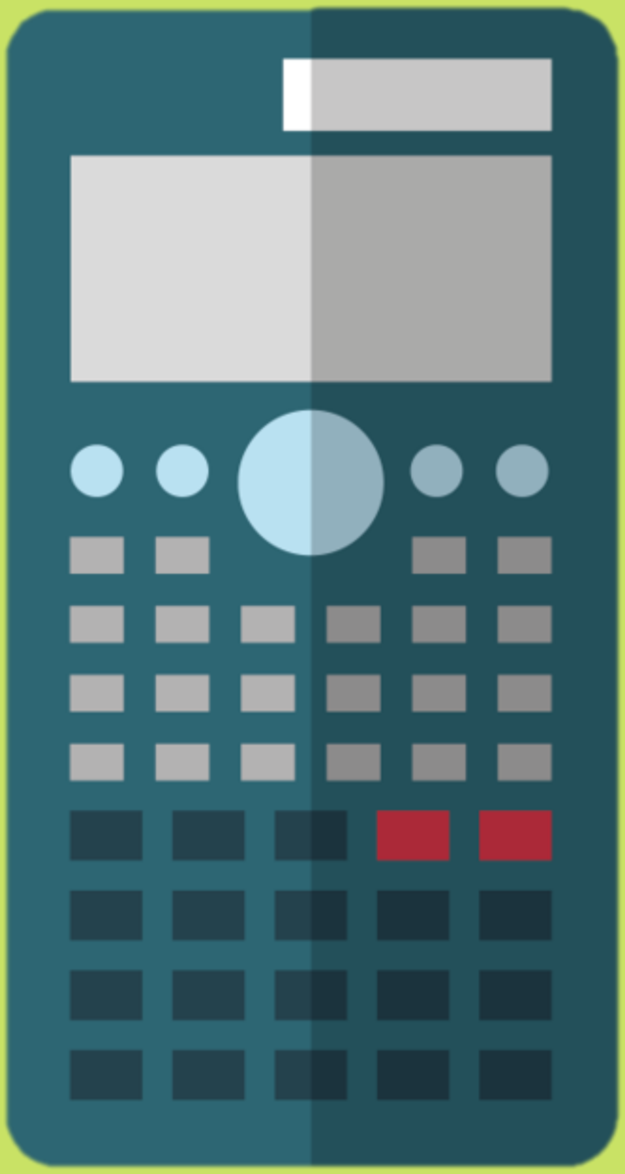
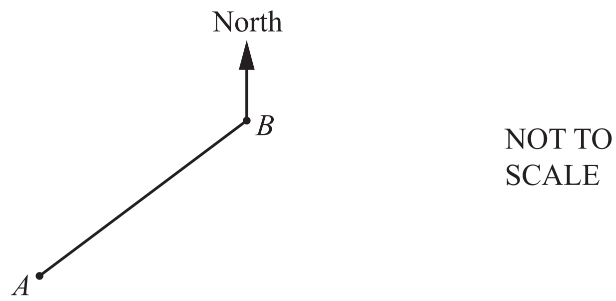


5 Expand and simplify.

$$(3x-7)(2x+9)$$

.... [2]

6



The bearing of A from B is 227°.

Find the bearing of B from A.

.... [2]

7 y is inversely proportional to x^3.
When $x = 2$, $y = 0.5$.

Find y in terms of x.

$y =$ .... [2]

8 Saafia has a barrel containing 6000 millilitres of oil, correct to the nearest 100 ml.
She uses the oil to fill bottles which each hold exactly 50 ml.

Calculate the upper bound for the number of bottles she can fill.

.... [2]

9 Jan invests \$800 at a rate of 3% per year simple interest.

Calculate the value of her investment at the end of 4 years.

\$ .... [3]

10 A water tank in the shape of a cuboid has length 1.5 metres and width 1 metre.
The water in the tank is 60 centimetres deep.

Calculate the number of litres of water in the tank.

.... litres [3]

11 These are the first five terms in a sequence.

8 11 14 17 20

(a) Find the next term.

.... [1]

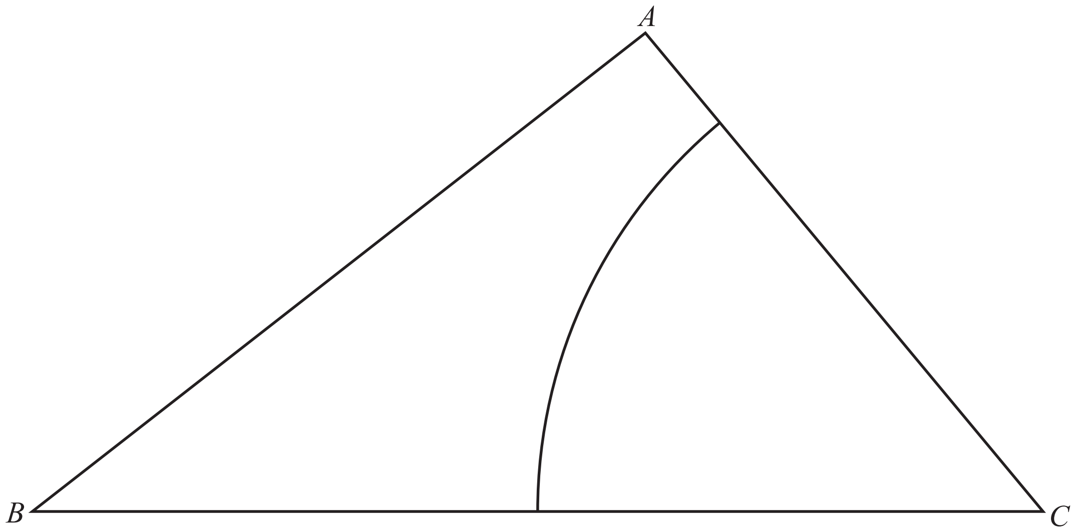
(b) Find an expression for the nth term.

.... [2]

12 Find the integer values of n that satisfy the inequality $15 \leqslant 4n < 28$.

.... [3]

13



The diagram shows a triangle *ABC* and an arc with centre *C* and radius 6.5 cm.

(a) **Using a straight edge and compasses only**, construct the locus of points inside the triangle that are equidistant from *BA* and *BC*. [2]

(b) Shade the region inside the triangle that is

- more than 6.5 cm from *C*

and

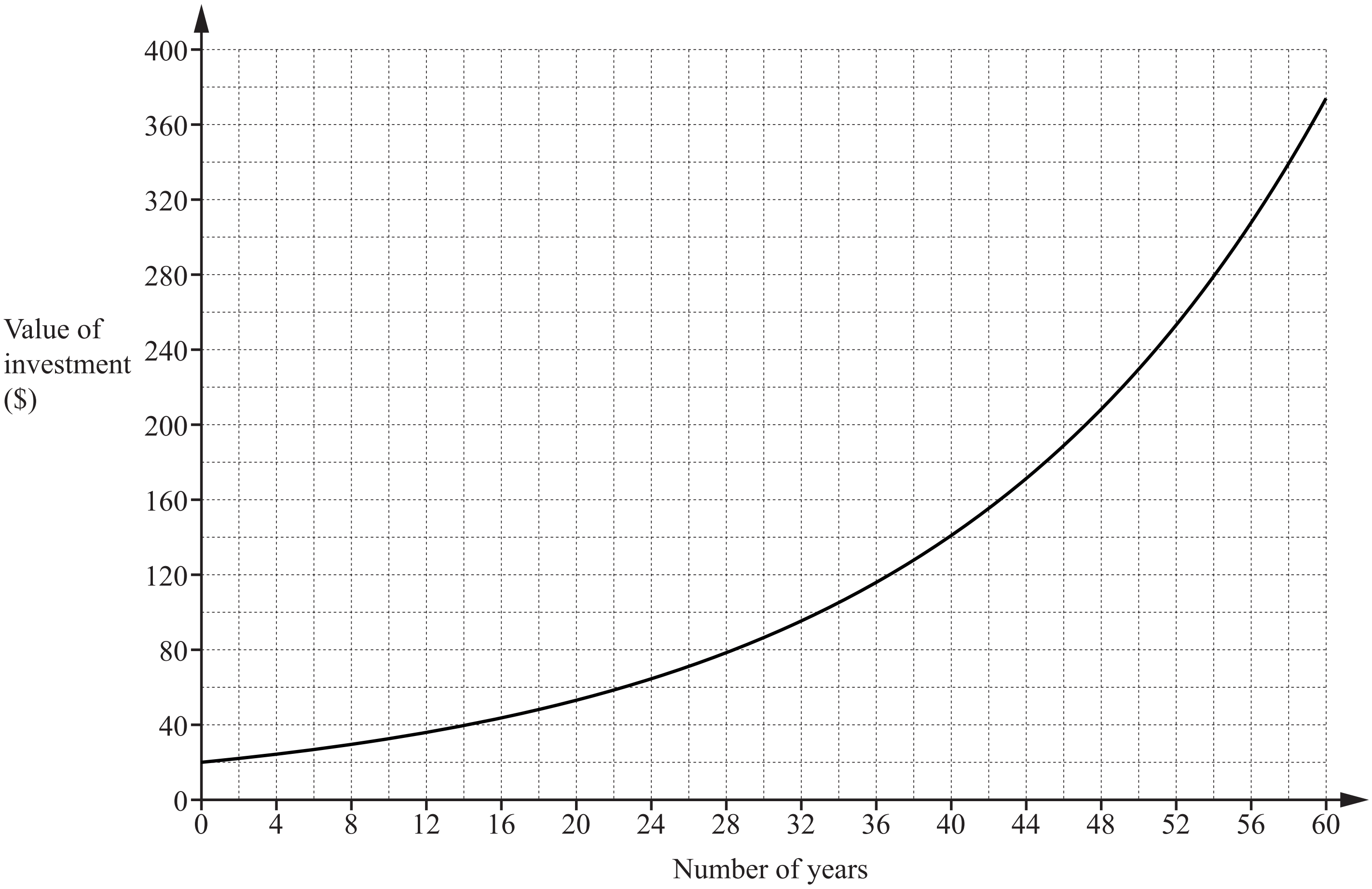
- nearer to *BA* than to *BC*. [1]

14 **Without using your calculator**, work out $\frac{3}{8} \div 2\frac{1}{4}$.

You must show all your working and give your answer as a fraction in its simplest form.

.... [3]

21



When Heidi was born, her grandfather invested some money in an account that paid compound interest.
The graph shows the exponential growth of this investment.

(a) Use the graph to find

(i) the original amount of money invested,

$ .... [1]

(ii) the number of years it took for the original amount to double,

.... years [1]

(iii) the value of the investment after 54 years.

$ .... [1]

(b) This account earned compound interest at a rate of r% per year.

Use your answers to **part (a)(i)** and **part (a)(ii)** to write down an equation in terms of r.
You do not have to solve your equation.

.... [2]

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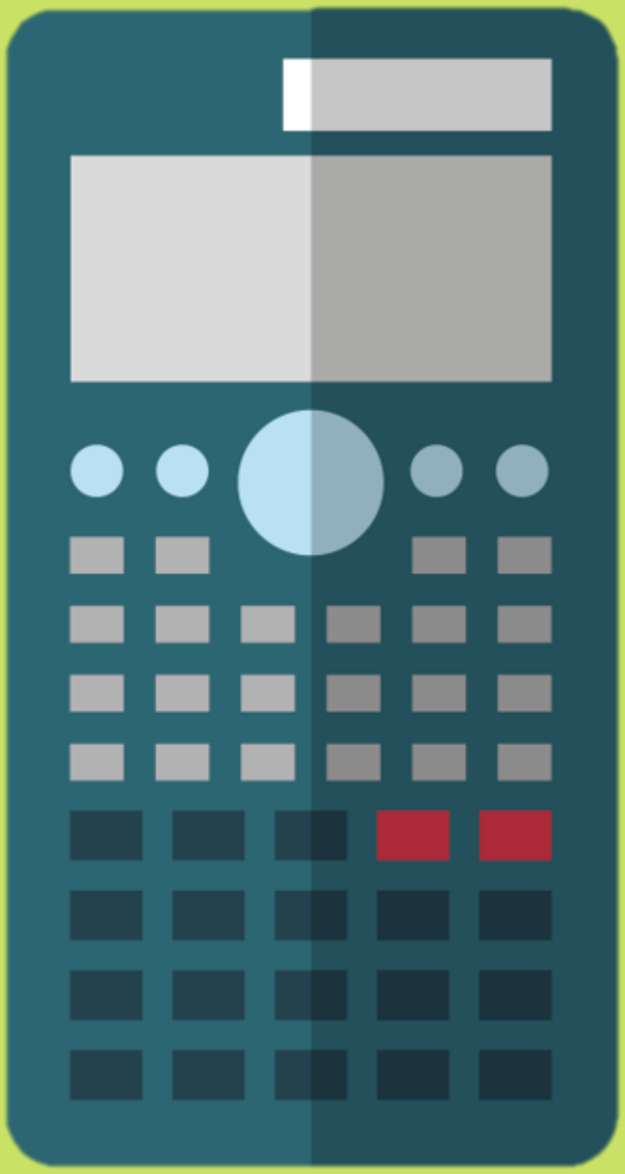
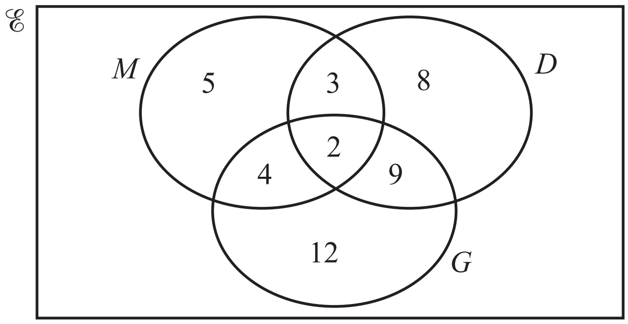


6 **(a)**



The Venn diagram above shows information about the number of students who study Music (M), Drama (D) and Geography (G).

(i) How many students study Music?

.... [1]

(ii) How many students study exactly two subjects?

.... [1]

(iii) Two students are chosen at random from those who study Drama.

Calculate the probability that they both also study Music.

.... [3]

(iv) In the Venn diagram above, shade $M \cap D'$. [1]

(b) **(i)**

$\mathscr{E} = \{x : x \text{ is an integer and } 1 \leqslant x \leqslant 10\}$

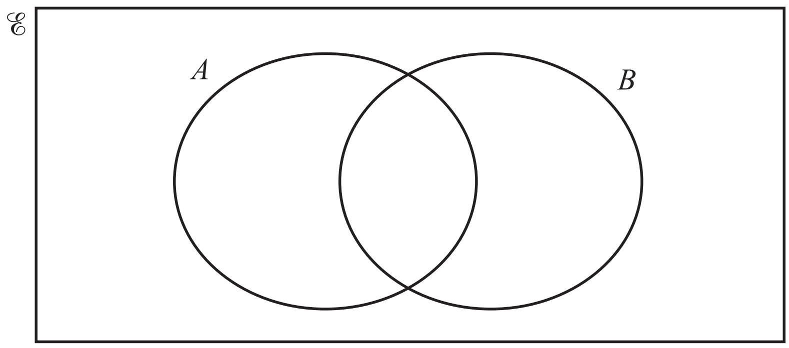
$A = \{x : x \text{ is even}\}$

$4 \in A \cap B$

$\mathrm{n}(A \cap B) = 1$

$(A \cup B)' = \{1, 7, 9\}$

Complete the Venn diagram below using this information.

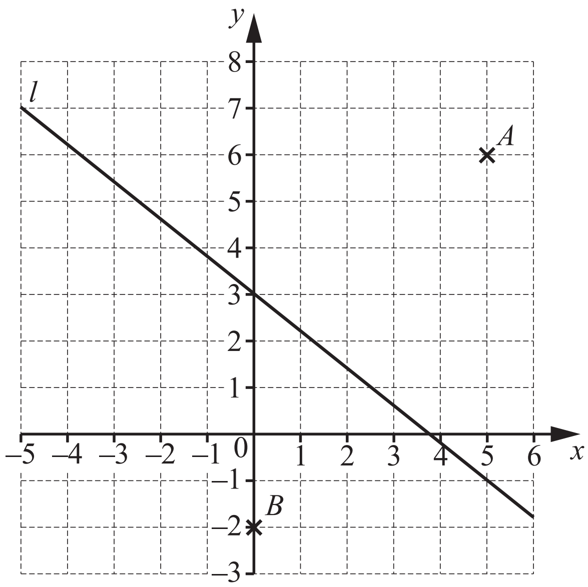


[4]

(ii) Use your Venn diagram to complete the statement.

$B = \{$..$\}$ [1]

8



(a) Write down the co-ordinates of A.

(.................... , ...) [1]

(b) Find the equation of line l in the form $y = mx + c$.

$y =$ .... [3]

(c) Write down the equation of the line parallel to line l that passes through the point B.

.... [2]

(d) C is the point (8, 14).

(i) Write down the equation of the line perpendicular to line l that passes through the point C.

.... [3]

(ii) Calculate the length of AC.

.... [3]

(iii) Find the co-ordinates of the mid-point of BC.

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

9 Paulo and Jim each buy sacks of rice but from different shops.
Paulo pays \$72 for sacks costing \$$m$ each.
Jim pays \$72 for sacks costing \$(m + 0.9) each.

(a) **(i)** Find an expression, in terms of m, for the number of sacks Paulo buys.

.... [1]

(ii) Find an expression, in terms of m, for the number of sacks Jim buys.

.... [1]

(b) Paulo buys 4 more sacks than Jim.

Write down an equation, in terms of m, and show that it simplifies to $10m^2 + 9m - 162 = 0$.

[4]

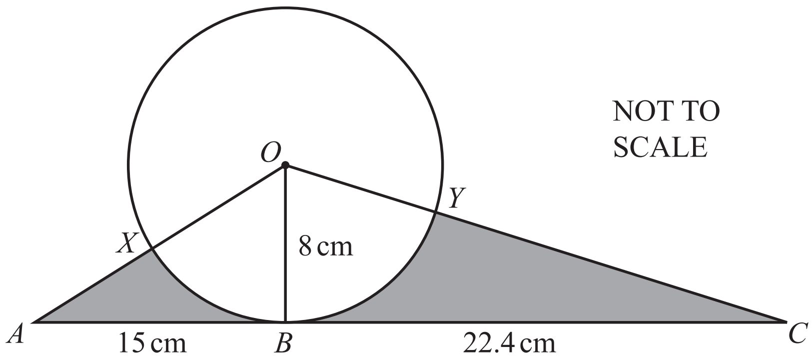
(c) **(i)** Solve $10m^2 + 9m - 162 = 0$.

m = ... or m = ... [3]

(ii) Find the number of sacks of rice that Paulo buys.

.... [1]

10



The diagram shows a circle, centre O.
The straight line ABC is a tangent to the circle at B.
$OB = 8$ cm, $AB = 15$ cm and $BC = 22.4$ cm.
AO crosses the circle at X and OC crosses the circle at Y.

(a) Calculate angle XOY.

Angle XOY = ... [5]

(b) Calculate the length of the arc XBY.

.... cm [2]

(c) Calculate the total area of the two shaded regions.

.... cm^2 [4]

Question 11 is printed on the next page.

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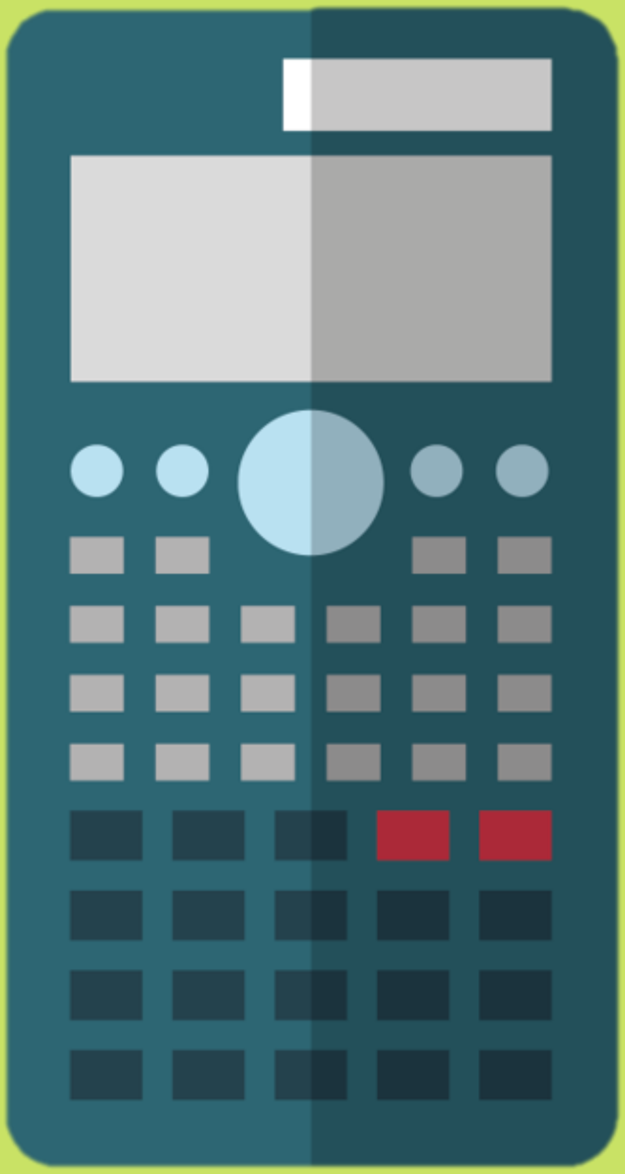

Q8Maths

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10 Find the mid-point of AB where $A = (w, r)$ and $B = (3w, t)$.
Give your answer in its simplest form in terms of w, r and t.

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

11 An equilateral triangle has side length 12 cm, correct to the nearest centimetre.

Find the lower bound and the upper bound of the perimeter of the triangle.

Lower bound = ... cm

Upper bound = ... cm [2]

12 $x°$ is an **obtuse** angle and $\sin x° = 0.43$.

Find the value of x.

x = ... [2]

13 These are the first five terms of a sequence.

$$-4 \qquad 2 \qquad 8 \qquad 14 \qquad 20$$

Find an expression for the nth term of this sequence.

.... [2]

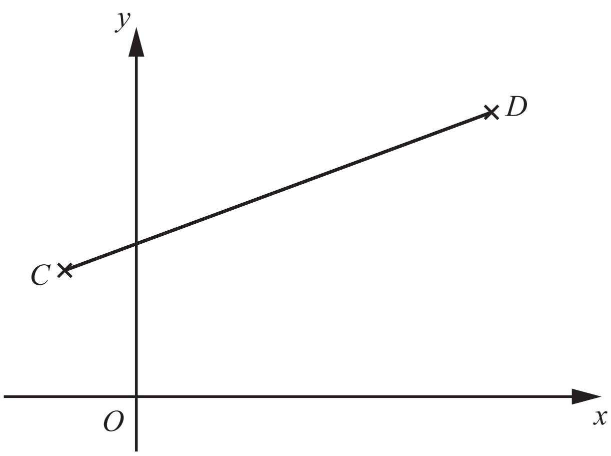
16 $x^2 - 12x + a = (x+b)^2$

Find the value of a and the value of b.

$a =$ ....

$b =$ .... [3]

17



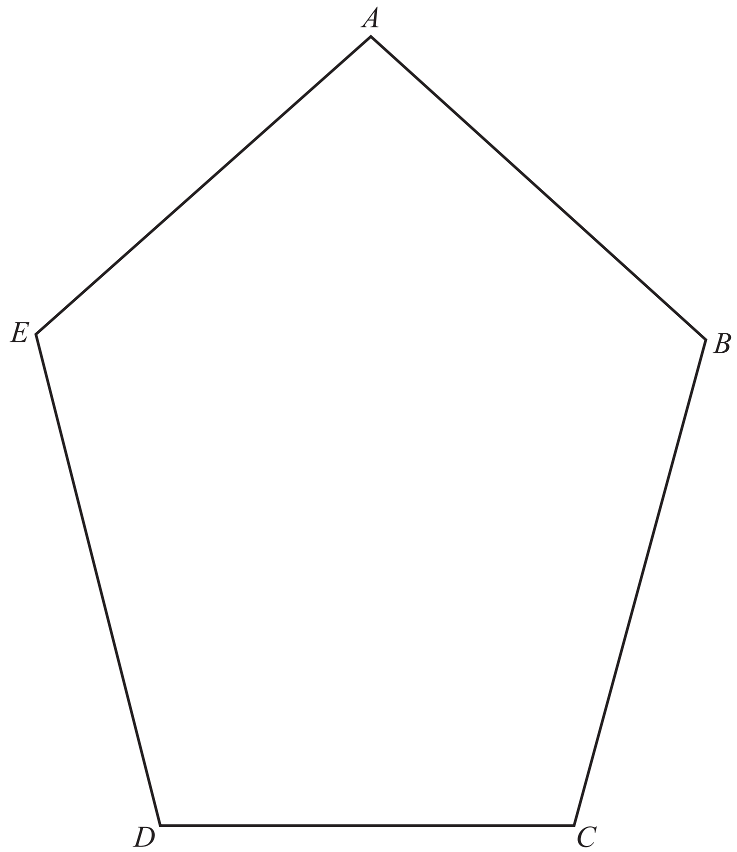
NOT TO SCALE

The diagram shows the points $C(-1, 2)$ and $D(9, 7)$.

Find the equation of the line perpendicular to CD that passes through the point (1, 3).
Give your answer in the form $y = mx + c$.

$y =$ .... [4]

19 The diagram shows a pentagon *ABCDE*.



(a) **Using a straight edge and compasses only**, construct the bisector of angle *BCD*. [2]

(b) Draw the locus of the points inside the pentagon that are 3 cm from *E*. [1]

(c) Shade the region inside the pentagon that is

- less than 3 cm from *E*

and

- nearer to *DC* than to *BC*.

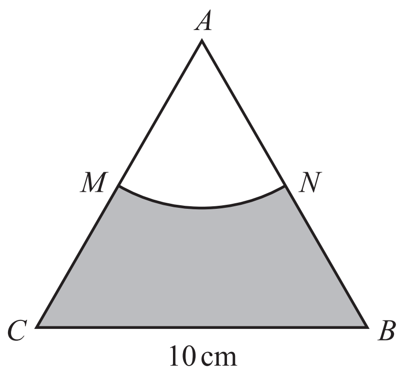
[1]

20 Make m the subject of the formula.

$$x = \frac{3m}{2-m}$$

m = ... [4]

21



NOT TO SCALE

The diagram shows an equilateral triangle ABC with sides of length 10 cm.
AMN is a sector of a circle, centre A.
M is the mid-point of AC.

Work out the area of the shaded region.

.... cm^2 [4]

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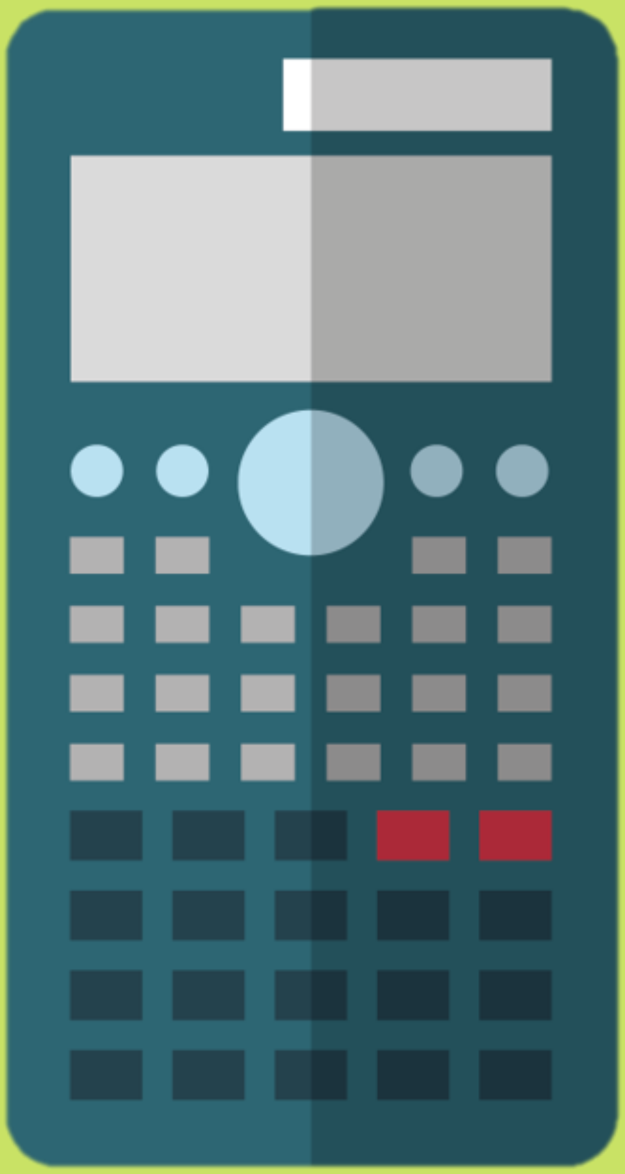

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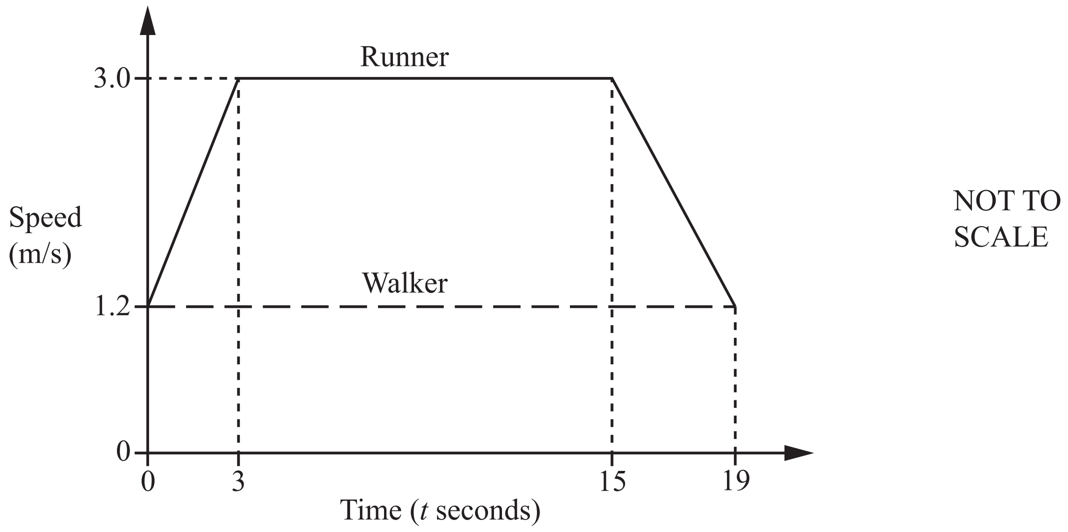
6 The diagram shows the speed−time graph for part of a journey for two people, a runner and a walker.



(a) Calculate the acceleration of the runner for the first 3 seconds.

.... m/s^2 [1]

(b) Calculate the total distance travelled by the runner in the 19 seconds.

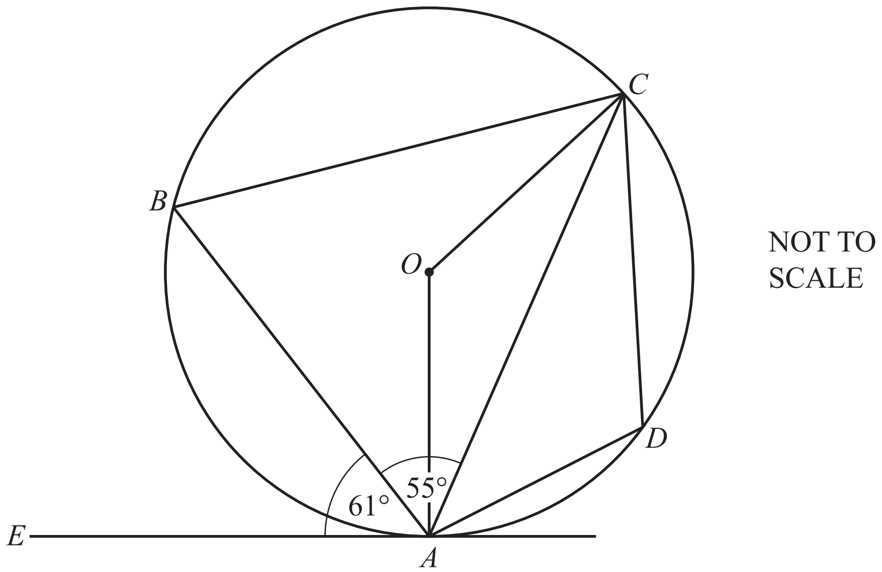
.... m [3]

(c) The runner and the walker are travelling in the same direction along the same path.
When $t = 0$, the runner is 10 metres behind the walker.

Find how far the runner is ahead of the walker when $t = 19$.

.... m [3]

7



In the diagram, A, B, C and D lie on the circle, centre O.
EA is a tangent to the circle at A.
Angle $EAB = 61°$ and angle $BAC = 55°$.

(a) Find angle BAO.

Angle BAO = ... [1]

(b) Find angle AOC.

Angle AOC =.. [2]

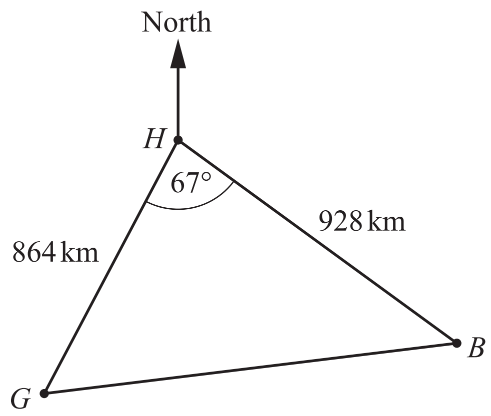
(c) Find angle ABC.

Angle ABC = ... [1]

(d) Find angle CDA.

Angle CDA = ... [1]

8 The diagram shows the positions of three cities, Geneva (G), Budapest (B) and Hamburg (H).



NOT TO SCALE

(a) A plane flies from Geneva to Hamburg.
The flight takes 2 hours 20 minutes.

Calculate the average speed in kilometres per hour.

.... km/h [2]

(b) Use the cosine rule to calculate the distance from Geneva to Budapest.

.... km [4]

(c) The bearing of Budapest from Hamburg is 133°.

(i) Find the bearing of Hamburg from Budapest.

.... [2]

(ii) Calculate the bearing of Budapest from Geneva.

.... [4]

10 **(a)** The lake behind a dam has an area of 55 hectares.
When the gates in the dam are open, water flows out at a rate of 75 000 litres per second.

(i) Show that 90 million litres of water flows out in 20 minutes.

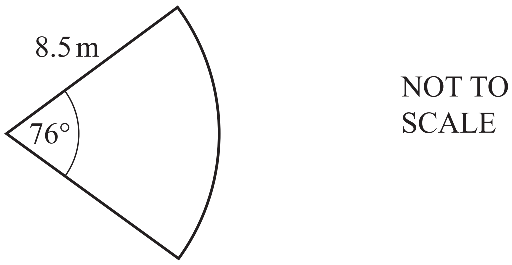
[1]

(ii) Beneath the surface, the lake has vertical sides.

Calculate the drop in the water level of the lake when the gates are open for 20 minutes.
Give your answer in centimetres.
[1 hectare = $10^4\,m^2$, 1000 litres = $1\,m^3$]

.... cm [3]

(iii)

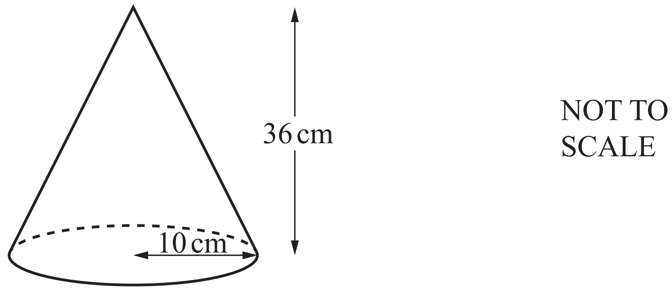


The cross-section of a gate is a sector of a circle with radius 8.5 m and angle 76°.

Calculate the perimeter of the sector.

.... m [3]

(b)



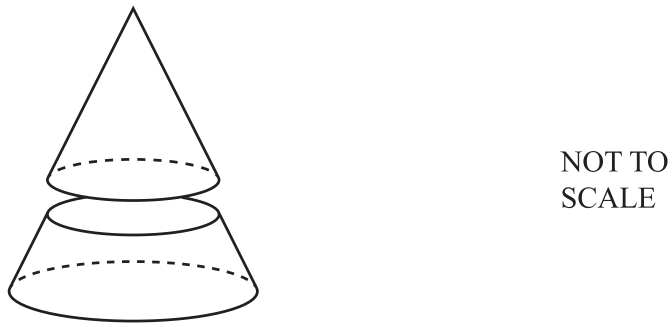
A solid metal cone has radius 10 cm and height 36 cm.

(i) Calculate the volume of this cone.

[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

.... cm^3 [2]

(ii) The cone is cut, parallel to its base, to give a smaller cone.



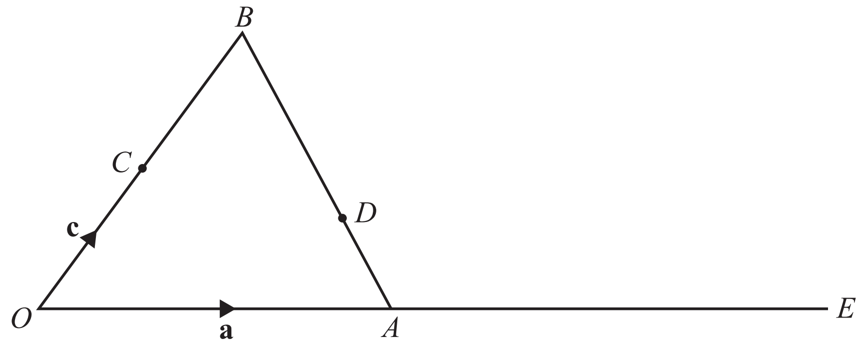
The volume of the smaller cone is half the volume of the original cone.
The smaller cone is melted down to make two different spheres.
The ratio of the radii of these two spheres is 1 : 2.

Calculate the radius of the smaller sphere.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

.... cm [4]

(b)



NOT TO SCALE

OAB is a triangle and C is the mid-point of OB.
D is on AB such that $AD : DB = 3 : 5$.
OAE is a straight line such that $OA : AE = 2 : 3$.
$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OC} = \mathbf{c}$.

(i) Find, in terms of **a** and **c**, in its simplest form,

(a) $\overrightarrow{AB}$,

$\overrightarrow{AB} =$ .... [1]

(b) $\overrightarrow{AD}$,

$\overrightarrow{AD} =$ .... [1]

(c) $\overrightarrow{CE}$,

$\overrightarrow{CE} =$ .... [1]

(d) $\overrightarrow{CD}$.

$\overrightarrow{CD} =$ .... [2]

(ii) $\overrightarrow{CE} = k\overrightarrow{CD}$

Find the value of k.

$k =$ .... [1]

Question 12 is printed on the next page.

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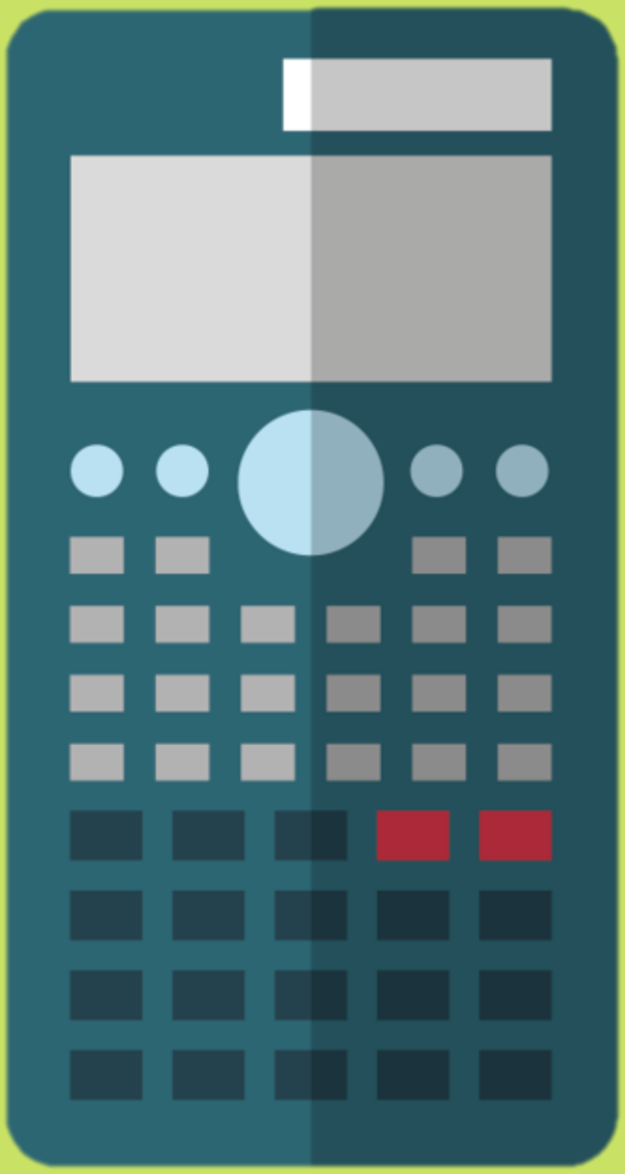


12 The area of a square is $42.5\,\text{cm}^2$, correct to the nearest $0.5\,\text{cm}^2$.

Calculate the lower bound of the length of the side of the square.

.... cm [2]

13 Change the recurring decimal $0.1\dot{8}$ to a fraction.
You must show all your working.

.... [2]

14 Describe fully the **single** transformation represented by the matrix $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$.

....

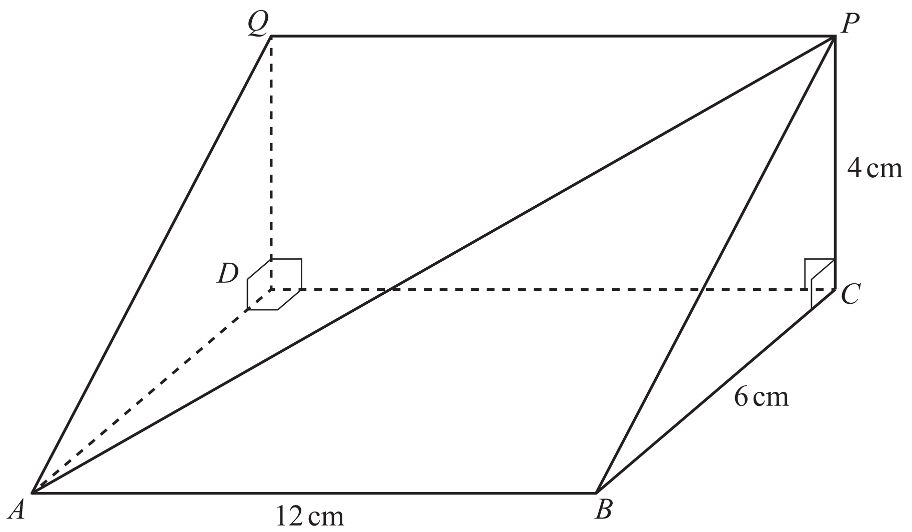
.... [2]

22 Simplify.

$$\frac{2x^2 - x - 1}{2x^2 + x}$$

.... [4]

23

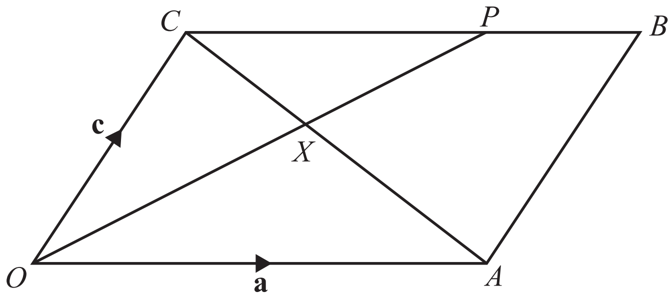


The diagram shows a triangular prism.
$AB = 12$ cm, $BC = 6$ cm, $PC = 4$ cm, angle $BCP = 90°$ and angle $QDC = 90°$.

Calculate the angle between AP and the rectangular base $ABCD$.

.... [4]

26



NOT TO SCALE

In the diagram, $OABC$ is a parallelogram.
OP and CA intersect at X and $CP : PB = 2 : 1$.
$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OC} = \mathbf{c}$.

(a) Find $\overrightarrow{OP}$, in terms of $\mathbf{a}$ and $\mathbf{c}$, in its simplest form.

$\overrightarrow{OP} =$ .... [2]

(b) $CX : XA = 2 : 3$

(i) Find $\overrightarrow{OX}$, in terms of $\mathbf{a}$ and $\mathbf{c}$, in its simplest form.

$\overrightarrow{OX} =$ .... [2]

(ii) Find $OX : XP$.

$OX : XP =$ .... : .... [2]

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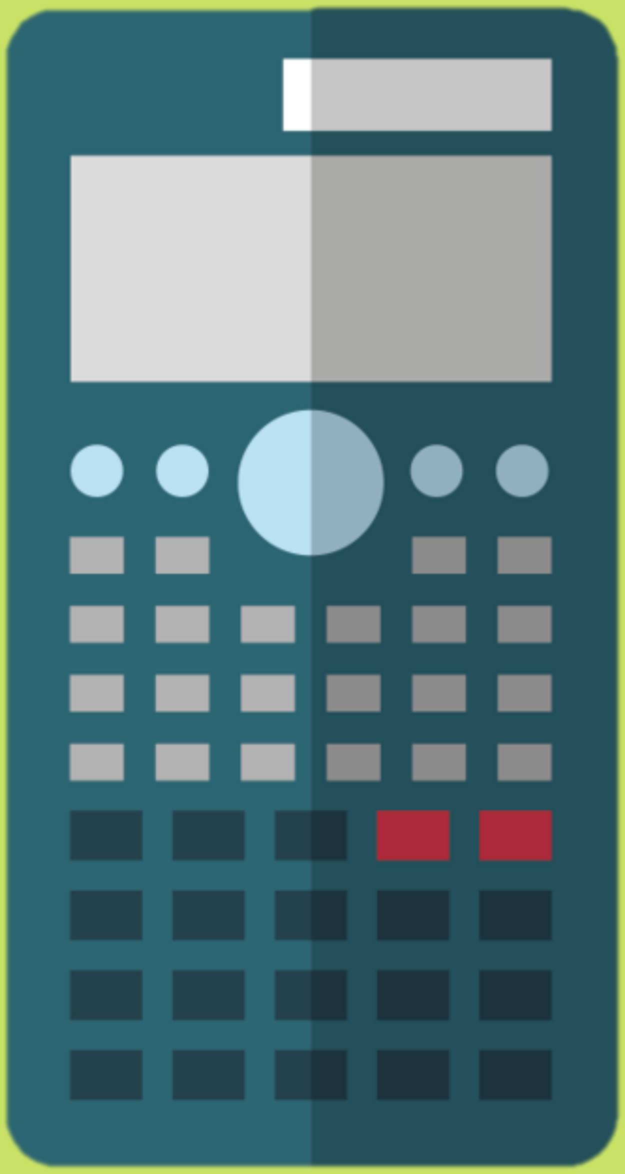

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2 **(a)** A school has 240 students.
The ratio girls : boys = 25 : 23.

(i) Show that the number of boys is 115.

[1]

(ii) One day, there are 15 girls absent and 15 boys absent.

Find the ratio girls : boys in school on this day.
Give your answer in its simplest form.

.... : .... [2]

(iii) Next year, the number of students will increase by 15%.

Calculate the number of students next year.

.... [2]

(iv) Since the school was opened, the number of students has increased by 60%.
There are now 240 students.

Calculate the number of students when the school was opened.

.... [3]

(b) The population of a city is increasing exponentially at a rate of 2% each year.
The population now is 256 000.

Calculate the population after 30 years.
Give your answer correct to the nearest thousand.

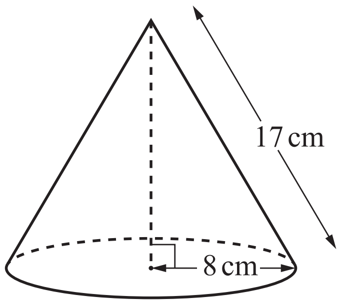
.... [3]

(c) A bacteria population increases exponentially at a rate of r% each day.
After 32 days, the population has increased by 309%.

Find the value of r.

r = ... [3]

3 (a)



NOT TO SCALE

The diagram shows a solid cone.
The radius is 8 cm and the slant height is 17 cm.

(i) Calculate the curved surface area of the cone.

[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi r l$.]

.... cm^2 [2]

(ii) Calculate the volume of the cone.

[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

.... cm^3 [4]

(iii) The cone is made of wood and 1 cm^3 of the wood has a mass of 0.8 g.

Calculate the mass of the cone.

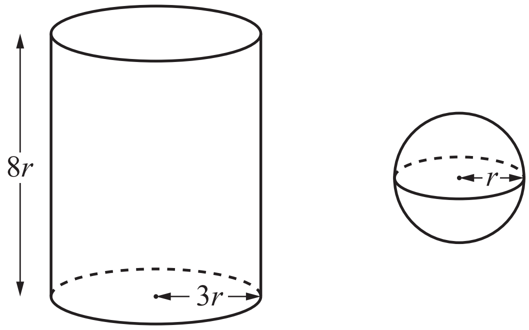
.... g [1]

(iv) The cone is placed in a box.
The total mass of the cone and the box is 1.2 kg.

Calculate the mass of the box.
Give your answer in grams.

.... g [1]

(b)



The diagram shows a solid cylinder and a solid sphere.
The cylinder has radius $3r$ and height $8r$.
The sphere has radius r.

(i) Find the volume of the sphere as a fraction of the volume of the cylinder.
Give your answer in its lowest terms.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

.... [4]

(ii) The surface area of the sphere is $81\pi\,\text{cm}^2$.

Find the **curved** surface area of the cylinder.
Give your answer in terms of π.

[The surface area, A, of a sphere with radius r is $A = 4\pi r^2$.]

.... cm^2 [4]

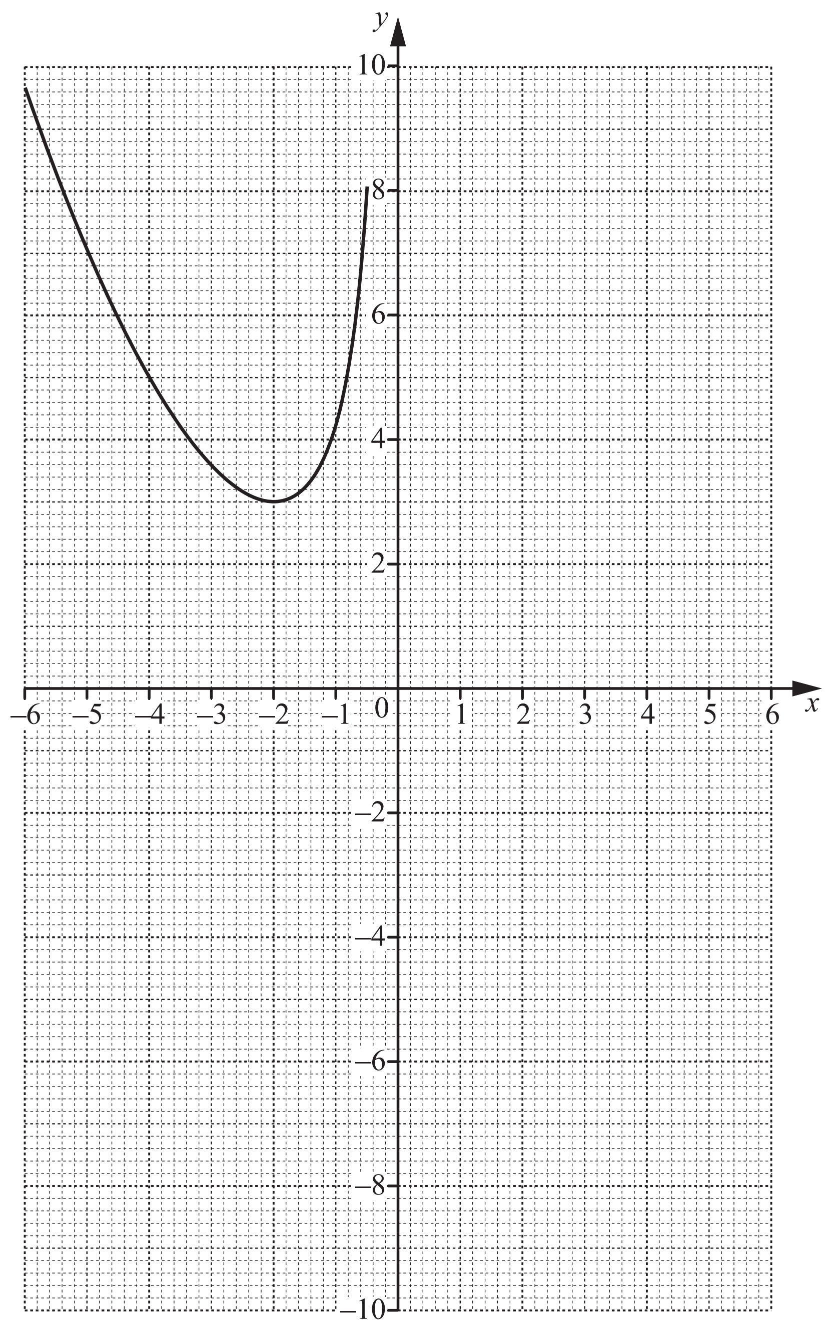
4 $\mathrm{f}(x) = \dfrac{x^2}{4} - \dfrac{4}{x}$, $x \neq 0$

(a) Complete the table for $\mathrm{f}(x)$.

x	0.5	1	2	3	4	5	6
$\mathrm{f}(x)$	–7.9	–3.8		0.9		5.5	8.3

[2]

(b) The graph of $y = \mathrm{f}(x)$ for $-6 \leqslant x \leqslant -0.5$ is drawn on the grid.



On the same grid, draw the graph of $y = \mathrm{f}(x)$ for $0.5 \leqslant x \leqslant 6$. [3]

(c) By drawing a suitable tangent, estimate the gradient of the graph of $y = f(x)$ at the point $(-4, 5)$.

.... [3]

(d) $g(x) = \frac{9}{x}$, $x \neq 0$

Complete the table for $g(x)$.

x	–4	–3	–2	–1		1	2	3	4
$g(x)$	–2.3		–4.5	–9		9	4.5		2.3

[1]

(e) On the same grid, draw the graph of $y = g(x)$ for $-4 \leqslant x \leqslant -1$ and $1 \leqslant x \leqslant 4$. [4]

(f) **(i)** Use your graphs to find the value of x when $f(x) = g(x)$.

$x =$ .... [1]

(ii) Write down an inequality to show the **positive** values of x for which $f(x) > g(x)$.

.... [1]

(g) The exact answer to **part (f)(i)** is $\sqrt[3]{k}$.

Use algebra to find the value of k.

$k =$ .... [2]

7

Bag A contains 3 black balls and 2 white balls.
Bag B contains 1 black ball and 3 white balls.

(a) A ball is taken at random from each bag.

(i) Show that a black ball is more likely to be taken from bag A than from bag B.

[1]

(ii) Find the probability that the two balls have different colours.

.... [3]

(b) The balls are returned to their original bags.
Three balls are taken at random from bag *A*, without replacement.

Find the probability that

(i) they are all black,

.... [2]

(ii) they are all white.

.... [1]

(c) The balls are returned to their original bags.

A ball is taken at random from bag *A* and its colour is recorded.
This ball is then placed in bag *B*.
A ball is then taken at random from bag *B*.

Find the probability that the ball taken from bag *B* has a different colour to the ball taken from bag *A*.

.... [3]

9 $\mathrm{f}(x) = 3x + 4$ $\mathrm{g}(x) = 2x - 1$ $\mathrm{h}(x) = 3^x$

(a) Find $\mathrm{g}\left(\frac{1}{2}\right)$.

.... [1]

(b) Find $\mathrm{fh}(-1)$.

.... [2]

(c) Find $\mathrm{g}^{-1}(x)$.

$\mathrm{g}^{-1}(x) =$ .... [2]

(d) Find $\mathrm{ff}(x)$ in its simplest form.

.... [2]

(e) Find $(\mathrm{f}(x))^2$ in the form $ax^2 + bx + c$.

.... [2]

(f) Find x when $\mathrm{h}^{-1}(x) = \mathrm{g}(2)$.

$x =$ .... [2]

10 **(a)** Find the next term and the nth term of this sequence.

$$\frac{3}{5}, \quad \frac{4}{7}, \quad \frac{5}{9}, \quad \frac{6}{11}, \quad \frac{7}{13}, \quad \ldots$$

Next term = ...

nth term = ... [3]

(b) Find the nth term of each sequence.

(i) $-1, \quad -3, \quad -5, \quad -7, \quad -9, \quad \ldots$

.... [2]

(ii) $2, \quad 9, \quad 28, \quad 65, \quad 126, \quad \ldots$

.... [2]