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0444/41

May/June 2016

2 hours 30 minutes

Additional Materials: Geometrical instruments
Electronic calculator

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

For π , use either your calculator value or 3.142.

The total of the points for this paper is 130.

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This document consists of **19** printed pages and **1** blank page.

Formula List

For the equation

$$ax^2 + bx + c = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Lateral surface area, A , of cylinder of radius r , height h .

$$A = 2\pi rh$$

Lateral surface area, A , of cone of radius r , sloping edge l .

$$A = \pi rl$$

Surface area, A , of sphere of radius r .

$$A = 4\pi r^2$$

Volume, V , of pyramid, base area A , height h .

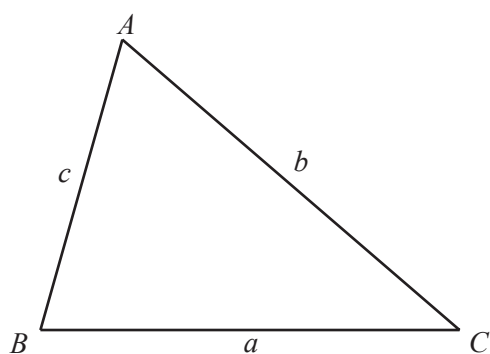
$$V = \frac{1}{3}Ah$$

Volume, V , of cone of radius r , height h .

$$V = \frac{1}{3}\pi r^2 h$$

Volume, V , of sphere of radius r .

$$V = \frac{4}{3}\pi r^3$$

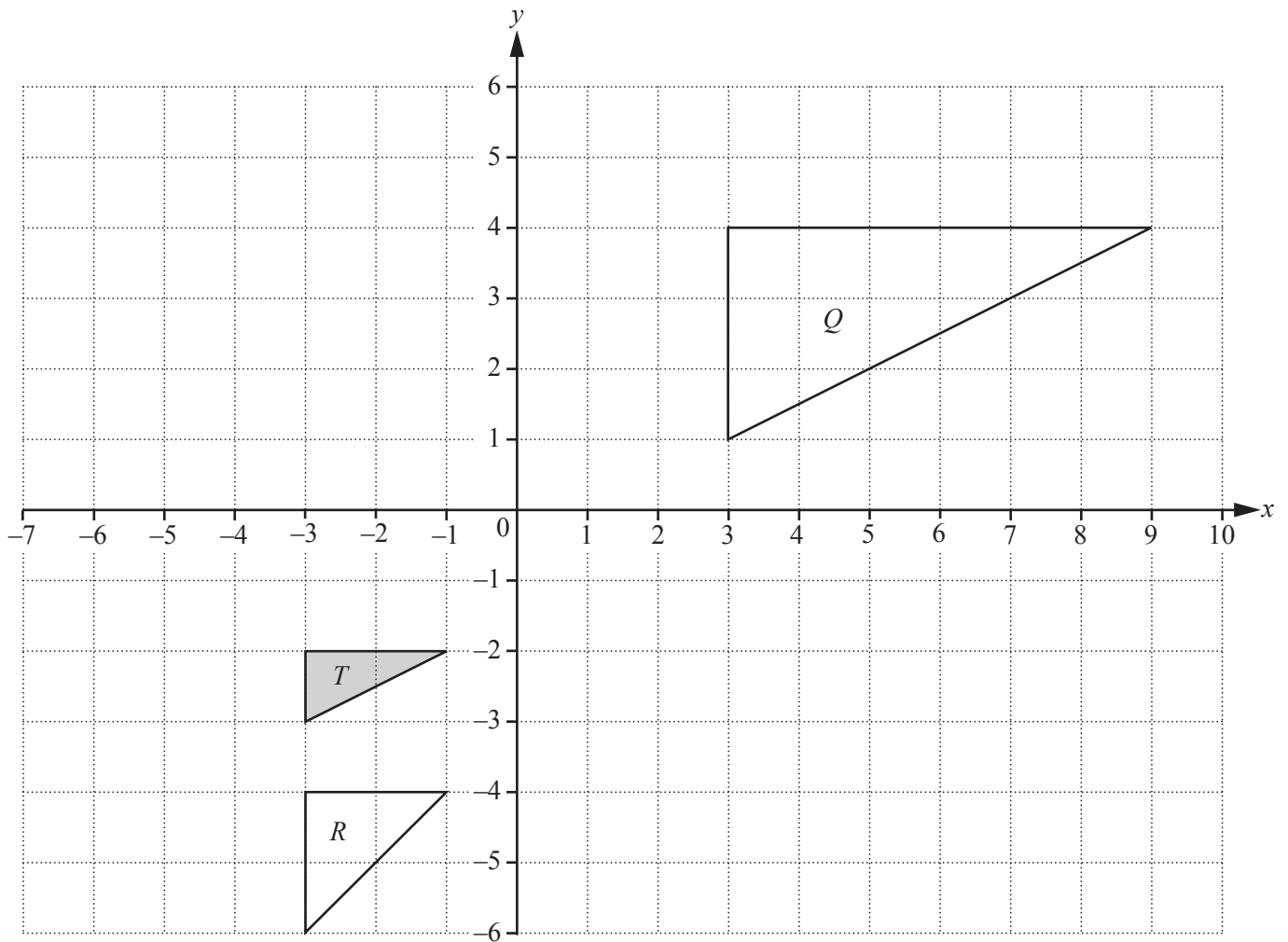


$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$\text{Area} = \frac{1}{2}bc \sin A$$

1



(a) Draw the image of triangle T after a translation by the vector $\begin{pmatrix} 5 \\ -2 \end{pmatrix}$. [2]

(b) Draw the image of triangle T after a reflection in the line $y = 1$. [2]

(c) Describe fully the **single** transformation that maps triangle T onto triangle Q .

..... [3]

(d) Describe fully the **single** transformation that maps triangle T onto triangle R .

..... [3]

- 2 (a) Kristian and Stephanie share some money in the ratio 3 : 2.
Kristian receives \$72.

(i) Work out how much Stephanie receives.

\$ [2]

(ii) Kristian spends 45% of his \$72 on a computer game.

Calculate the price of the computer game.

\$ [1]

(iii) Kristian also buys a meal for \$8.40 .

Calculate the fraction of the \$72 Kristian has left after buying the computer game and the meal.
Give your answer in its lowest terms.

..... [2]

(iv) Stephanie buys a book in a sale for \$19.20 .
This sale price is after a reduction of 20%.

Calculate the original price of the book.

\$ [3]

- (b) Boris invests \$550 at a rate of 2% per year simple interest.

Calculate the amount Boris has after 10 years.

\$ [3]

- (c) Marlene invests \$550 at a rate of 1.9% per year compound interest.

Calculate the amount Marlene has after 10 years.

\$ [2]

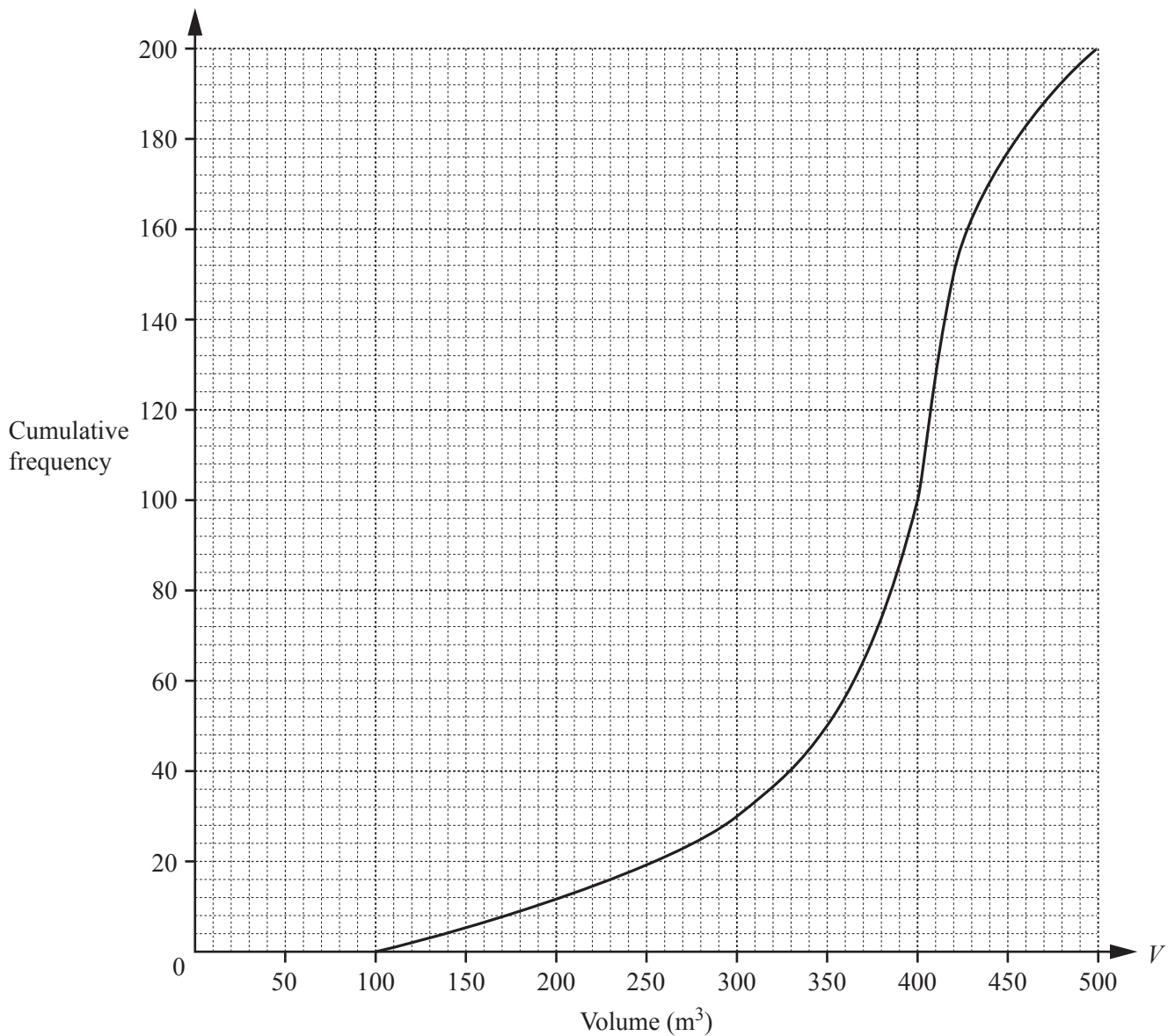
- (d) Hans invests \$550 at a rate of $x\%$ per year compound interest.

At the end of 10 years he has a total amount of \$638.30, correct to the nearest cent.

Find the value of x .

$x =$ [3]

- 3 (a) 200 students estimate the volume, $V \text{ m}^3$, of a classroom. The cumulative frequency diagram shows their results.



Find

- (i) the median,

..... m^3 [1]

- (ii) the lower quartile,

..... m^3 [1]

- (iii) the inter-quartile range,

..... m^3 [1]

- (iv) the number of students who estimate that the volume is greater than 300 m^3 .

..... [2]

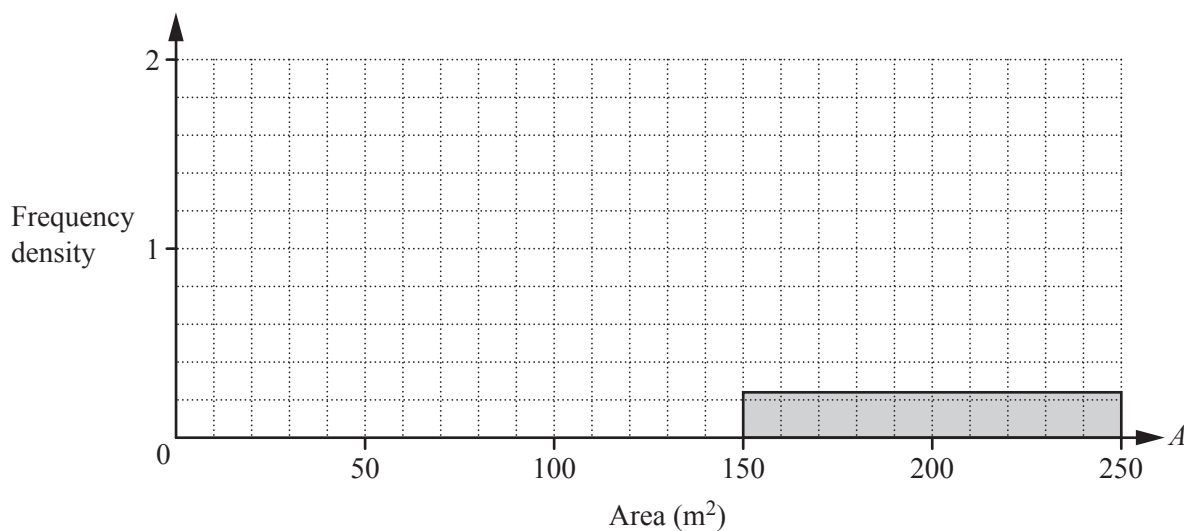
- (b) The 200 students also estimate the total area, $A \text{ m}^2$, of the windows in the classroom. The results are shown in the table.

Area ($A \text{ m}^2$)	$20 < A \leq 60$	$60 < A \leq 100$	$100 < A \leq 150$	$150 < A \leq 250$
Frequency	32	64	80	24

- (i) Calculate an estimate of the mean.
Show all your working.

..... m^2 [4]

- (ii) Complete the histogram to show the information in the table.



[4]

- (iii) Two of the 200 students are chosen at random.

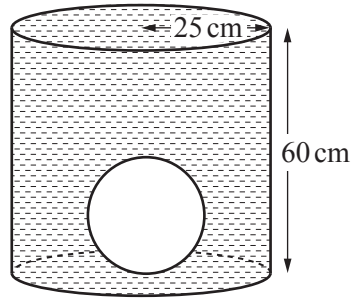
Find the probability that they both estimate that the area is greater than 100 m^2 .

..... [2]

- 4 (a) Calculate the volume of a metal sphere of radius 15 cm and show that it rounds to $14\,140\text{ cm}^3$, correct to 4 significant figures.

[2]

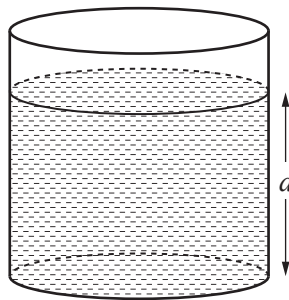
- (b) (i) The sphere is placed inside an empty cylindrical tank of radius 25 cm and height 60 cm. The tank is filled with water.

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Calculate the volume of water required to fill the tank.

..... cm^3 [3]

- (ii) The sphere is removed from the tank.

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Calculate the depth, d , of water in the tank.

$d =$ cm [2]

(c) The sphere is melted down and the metal is made into a solid cone of height 54 cm.

(i) Calculate the radius of the cone.

..... cm [3]

(ii) Calculate the **total** surface area of the cone.

..... cm² [4]

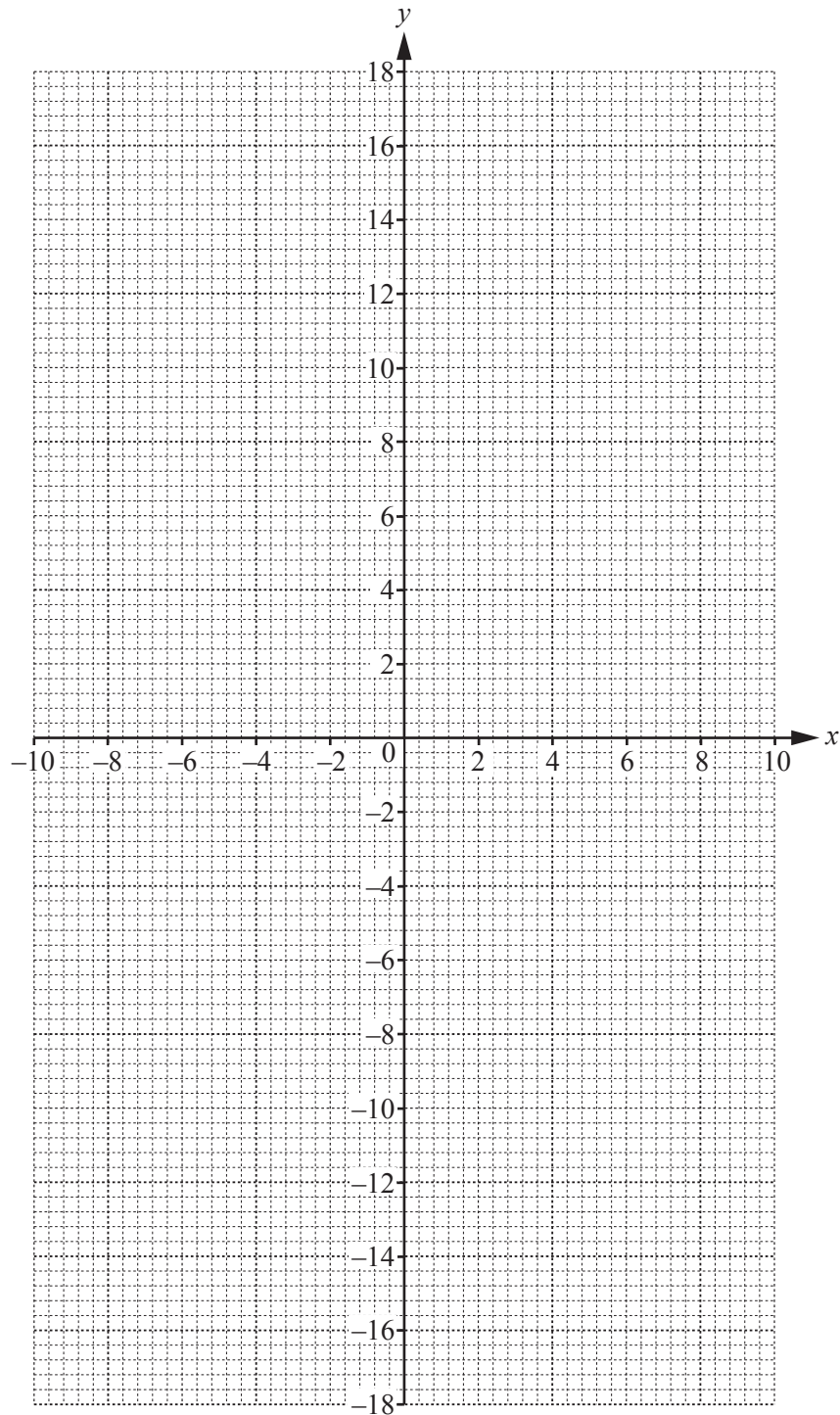
5 $f(x) = \frac{20}{x} + x, \quad x \neq 0$

(a) Complete the table.

x	-10	-8	-5	-2	-1.6		1.6	2	5	8	10
$f(x)$	-12	-10.5	-9	-12	-14.1		14.1	12			12

[2]

(b) On the grid, draw the graph of $y = f(x)$ for $-10 \leq x \leq -1.6$ and $1.6 \leq x \leq 10$.



[5]

- (c) Using your graph, solve the equation $f(x) = 11$.

$x = \dots\dots\dots$ or $x = \dots\dots\dots$ [2]

- (d) k is a prime number and $f(x) = k$ has no solutions.

Find the possible values of k .

$\dots\dots\dots$ [2]

- (e) The slope of the graph of $y = f(x)$ at the point $(2, 12)$ is -4 .

Write down the co-ordinates of the other point on the graph of $y = f(x)$ where the slope is -4 .

$(\dots\dots\dots, \dots\dots\dots)$ [1]

- (f) (i) The equation $f(x) = x^2$ can be written as $x^3 + px^2 + q = 0$.

Show that $p = -1$ and $q = -20$.

[2]

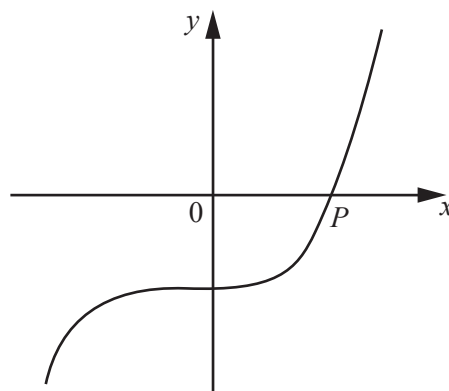
- (ii) On the grid opposite, draw the graph of $y = x^2$ for $-4 \leq x \leq 4$.

[2]

- (iii) Using your graphs, solve the equation $x^3 - x^2 - 20 = 0$.

$x = \dots\dots\dots$ [1]

- (iv)



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The diagram shows a **sketch** of the graph of $y = x^3 - x^2 - 20$.
 P is the point $(n, 0)$.

Write down the value of n .

$n = \dots\dots\dots$ [1]

6 (a)

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The perimeter of the rectangle is 80 cm.
The area of the rectangle is $A \text{ cm}^2$.

(i) Show that $x^2 - 40x + A = 0$.

[3]

(ii) When $A = 300$, solve, by factoring, the equation $x^2 - 40x + A = 0$.

$x = \dots\dots\dots$ or $x = \dots\dots\dots$ [3]

(iii) When $A = 200$, solve, by using the quadratic formula, the equation $x^2 - 40x + A = 0$.
Show all your working and give your answers correct to 2 decimal places.

$x = \dots\dots\dots$ or $x = \dots\dots\dots$ [4]

- (b) A car completes a 200 km journey with an average speed of x km/h.
The car completes the return journey of 200 km with an average speed of $(x + 10)$ km/h.

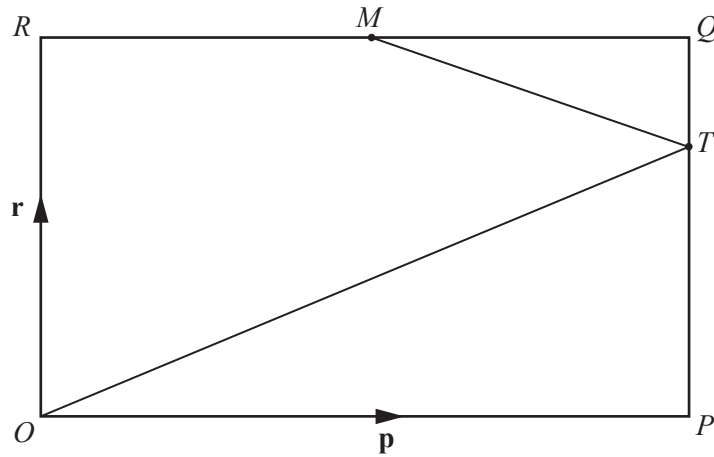
(i) Show that the difference between the time taken for each of the two journeys is $\frac{2000}{x(x+10)}$ hours.

[3]

- (ii) Find the difference between the time taken for each of the two journeys when $x = 80$.
Give your answer in **minutes** and **seconds**.

..... min s [3]

7

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$OPQR$ is a rectangle and O is the origin.
 M is the midpoint of RQ and $PT : TQ = 2 : 1$.
 $\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OR} = \mathbf{r}$.

(a) Find, in terms of $\mathbf{p}$ and/or $\mathbf{r}$, in its simplest form

(i) $\overrightarrow{MQ}$,

$$\overrightarrow{MQ} = \dots\dots\dots [1]$$

(ii) $\overrightarrow{MT}$,

$$\overrightarrow{MT} = \dots\dots\dots [1]$$

(iii) $\overrightarrow{OT}$.

$$\overrightarrow{OT} = \dots\dots\dots [1]$$

(b) RQ and OT are extended to meet at U .

Find the position vector of U in terms of $\mathbf{p}$ and $\mathbf{r}$.
 Give your answer in its simplest form.

$$\dots\dots\dots [2]$$

(c) $\overrightarrow{MT} = \begin{pmatrix} 2k \\ -k \end{pmatrix}$ and $|\overrightarrow{MT}| = \sqrt{180}$.

Find the positive value of k .

$k = \dots\dots\dots [3]$

8

$$f(x) = 2x + 1$$

$$g(x) = x^2 + 4$$

$$h(x) = 2^x$$

- (a) Solve the equation $f(x) = g(1)$.

$$x = \dots\dots\dots [2]$$

- (b) Find the value of $f(h(3))$.

$$\dots\dots\dots [2]$$

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

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

- (d) Find $g(f(x))$ in its simplest form.

$$\dots\dots\dots [3]$$

- (e) Solve the equation $h^{-1}(x) = 0.5$.

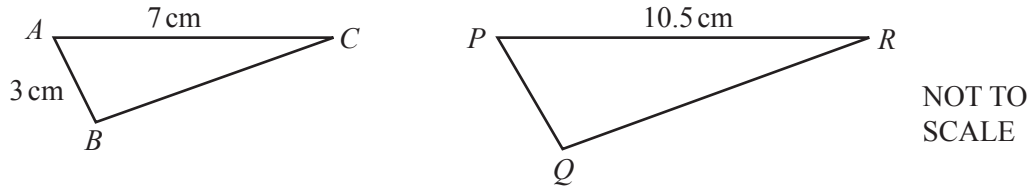
$$x = \dots\dots\dots [1]$$

- (f) $\frac{1}{h(x)} = 2^{kx}$

Write down the value of k .

$$k = \dots\dots\dots [1]$$

9



The triangles ABC and PQR are similar.

- (a) $AB = 3\text{ cm}$, $AC = 7\text{ cm}$ and $PR = 10.5\text{ cm}$.

Calculate the length of PQ .

$PQ = \dots\dots\dots\text{ cm}$ [2]

- (b) Triangle ABC is the cross section of a prism of length 12 cm .
Triangle PQR is the cross section of a prism of length 18 cm .
The volume of the smaller prism is $V\text{ cm}^3$.

- (i) Explain why the prisms are similar.

$\dots\dots\dots$
 $\dots\dots\dots$ [1]

- (ii) Find, in terms of V , the volume of the larger prism.

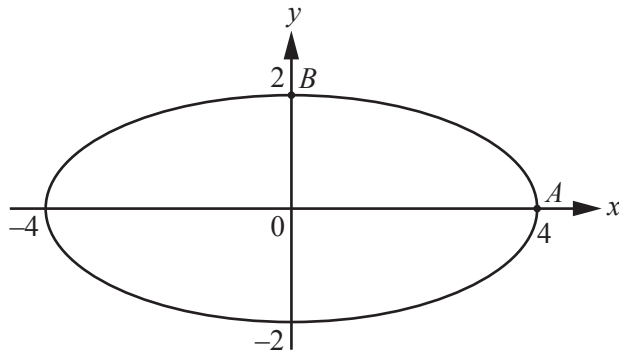
$\dots\dots\dots\text{ cm}^3$ [2]

- (c) Angle $ABC = 110^\circ$.

Calculate angle ACB .

Angle $ACB = \dots\dots\dots$ [3]

10

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The diagram shows a curve with equation $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$.

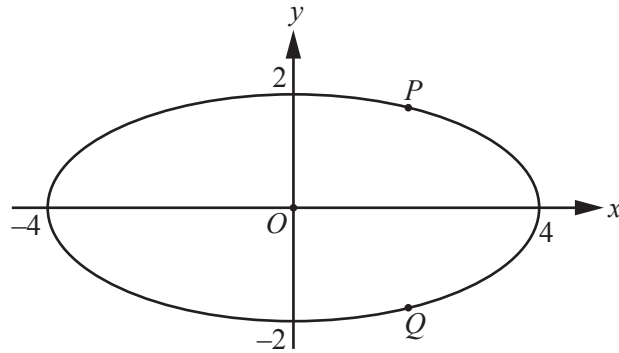
- (a) A is the point $(4, 0)$ and B is the point $(0, 2)$.
- (i) Find the equation of the straight line that passes through A and B .
Give your answer in the form $y = mx + c$.

$y = \dots\dots\dots$ [3]

- (ii) Show that $a^2 = 16$ and $b^2 = 4$.

[2]

(b)

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$P(2, k)$ and $Q(2, -k)$ are points on the curve $\frac{x^2}{16} + \frac{y^2}{4} = 1$.

(i) Find the value of k .

$k = \dots\dots\dots$ [3]

(ii) Calculate angle POQ .

Angle $POQ = \dots\dots\dots$ [3]

(c) The area enclosed by a curve with equation $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ is πab .

(i) Find the area enclosed by the curve $\frac{x^2}{16} + \frac{y^2}{4} = 1$.

Give your answer as a multiple of π .

$\dots\dots\dots$ [1]

(ii) A curve, mathematically similar to the one in the diagrams, intersects the x -axis at $(12, 0)$ and $(-12, 0)$.

Work out the area enclosed by this curve, giving your answer as a multiple of π .

$\dots\dots\dots$ [2]

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