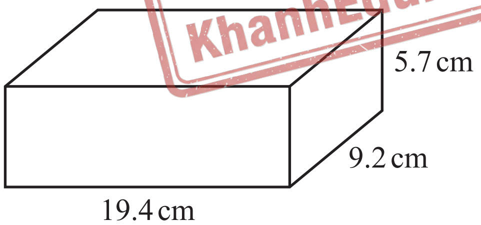
1 **(a)**



NOT TO SCALE

The diagram shows a brick in the shape of a cuboid.

(i) Calculate the total surface area of the brick.

$2(19.4 \times 9.2) + 2(5.7 \times 9.2) + 2(19.4 \times 5.7)$

........683........ cm^2 [3]

(ii) The density of the brick is 1.9 g/cm^3.
Work out the mass of the brick.
Give your answer in kilograms.
[Density = mass ÷ volume]

mass = density × volume
= $1.9 \times (19.4 \times 5.7 \times 9.2)$
≈ 1933 gram
≈ 1.93 kg

........1.93........ kg [3]

(b) 9000 bricks are needed to build a house.
200 bricks cost \$175.
Work out the cost of the bricks needed to build 5 houses.

5 houses → 9000 × 5 = 45000 bricks ?

200 bricks \$175

$\frac{45000 \times 175}{200}$

\$ ....39375........ [3]

(c) Saskia builds a wall using 1500 bricks.
She can build at the rate of 40 bricks each hour.
She works for 9 hours each day.
Saskia starts work on 6 July and works every day until the wall is completed.
Find the date when she completes the wall.

She needs $\frac{1500}{40} = 37.5$ hours to build the wall

$37.5\text{ h} = \frac{37.5}{60}$ days $= 4\frac{1}{6}$ days → round up to 5 days

........10 July........ [3]

(d) Rafa has a cylindrical tank.
The cylinder has a height of 105 cm and a diameter of 45 cm.

Calculate the capacity of the tank in litres.

Capacity = $V_{cylinder} = \pi \times \left(\frac{45}{2}\right)^2 \times 105$

$\approx 166\,995 \text{ cm}^3$

$\approx 167\ \ell$

..........167.......... litres [3]

2 Bob, Chao and Mei take part in a run for charity.

(a) Their times to complete the run are in the ratio Bob : Chao : Mei = 4 : 5 : 7.

(i) Find Chao's time as a percentage of Mei's time.

$\frac{C}{M} = \frac{5}{7} = 71.4\%$

$\Rightarrow C = 71.4\%\ C$

..........71.4.......... % [1]

(ii) Bob's time for the run is 55 minutes 40 seconds.

Find Mei's time for the run.
Give your answer in minutes and seconds.

$B = 55 \text{ mins } 40 \text{ s} = 55\frac{40}{60} \text{ mins}$

$\frac{B}{M} = \frac{4}{7} \Rightarrow M = 55\frac{40}{60} : \frac{4}{7} = 97\frac{5}{12} \text{ mins}$

$= 97 \text{ mins } 25 \text{ s}$

..........97.... min ....25.... s [3]

(b) Chao collects $47.50 for charity.

(i) Bob collects 28% more than Chao.
Find the amount Bob collects.

$47.50 + 47.50 \times 28\%$

$ ......60.8...................................... [2]

(ii) Chao collects 60% less than Mei.
Find how much more money Mei collects than Chao.

$M - 60\% M = 47.50$

$0.4 M = 47.50$

$M = 118.75$

$M - C = 118.75 - 47.50$

$ ....71.25......................... [3]

(c) When running, Chao has a stride length of 70 cm, correct to the nearest 5 cm.
Chao runs a distance of 11.2 km, correct to the nearest 0.1 km.
Work out the minimum $\underbrace{\text{number of strides}}_{n}$ that Chao could take to complete this distance.

$$n_{min} = \frac{\text{distance}_{min}}{\text{stride length}_{max}}$$

$$= \frac{\left(11.2 - \frac{0.1}{2}\right) km}{\left(70 + \frac{5}{2}\right) cm}$$

$$= \frac{11.15\ km}{72.5\ cm} = \frac{1115000\ cm}{72.5\ cm} \approx 15379.31 \rightarrow \text{round up to } 15380$$

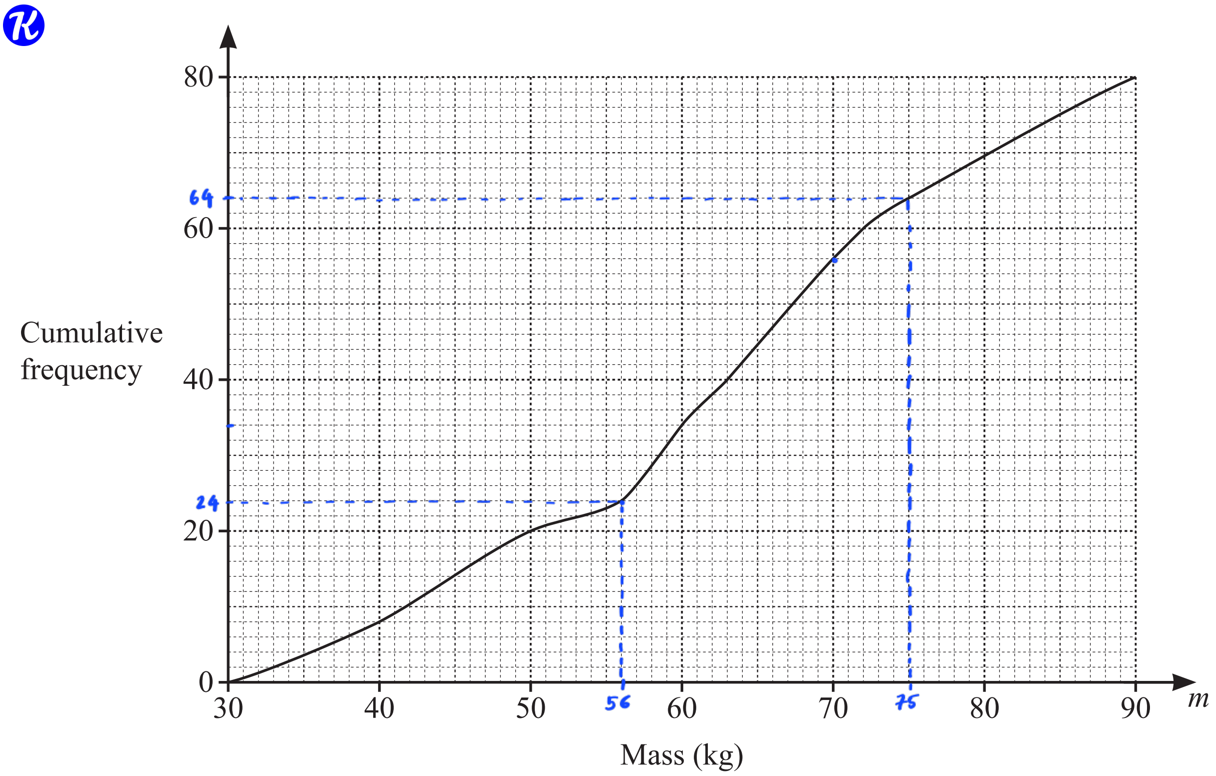
........15380.......................... [4]

(d) In 2015, a charity raised a total of $1.6 million.
After 2015, this amount increased exponentially by 2.4% each year for the next 5 years.
Work out the amount raised by the charity in 2020.

$$1.6\left(1 + \frac{2.4}{100}\right)^5 \approx 1.80$$

$ .....1.80...................million [2]

3 The cumulative frequency diagram shows information about the mass, m kg, of each of 80 boys.



(b) Use the cumulative frequency diagram to find an estimate of

(i) the 30th percentile,

$80 \times 30\% = 24 \longrightarrow 56$

.................56................. kg [2]

(ii) the number of boys with a mass greater than 75 kg.

$80 - 64 = 16$

.................16..................... [2]

(c) **(i)** Use the cumulative frequency diagram to complete this frequency table.

Mid value	35	45	55	65	75	85
Mass (m kg)	$30 < m \leqslant 40$	$40 < m \leqslant 50$	$50 < m \leqslant 60$	$60 < m \leqslant 70$	$70 < m \leqslant 80$	$80 < m \leqslant 90$
Frequency	8	12	14	22	14	10
cumulative frequency	8	20	34	56		

[1]

(ii) Calculate an estimate of the mean mass of the boys.

$$\frac{(35 \times 8) + (45 \times 12) + (55 \times 14) + (65 \times 22) + (75 \times 14) + (85 \times 10)}{80}$$

.... 61.5 .... kg [4]

(iii) Two boys are chosen at random from those with a mass greater than 70 kg.

Find the probability that one of them has a mass greater than 80 kg and the other has a mass of 80 kg or less.

$P(m > 80) \times P(m \leq 80) \times 2$

$$\frac{10}{24} \times \frac{14}{23} = \frac{35}{69}$$

.... $\frac{35}{69}$ .... [3]

4 **(a)** Solve.

(i) $6(7-2x)=3x-8$

$42 - 12x = 3x - 8$
$50 = 15x$
$\frac{10}{3} = x$

$x =$ ....$\frac{10}{3}$.... [3]

(ii) $\frac{2x}{x-5}=\frac{2}{3}$

$(2x) \times 3 = 2(x-5)$
$6x = 2x - 10$
$4x = -10$
$x = -2.5$

$x =$ ....-2.5.... [3]

(b) Factorise completely.

(i) $2x^2-288y^2$

$2(x^2 - 144y^2)$
$2[x^2 - (12y)^2]$

....$2(x-12y)(x+12y)$.... [3]

(ii) $5x^2+17x-40$

$5x^2 - 8x + 25x - 40$
$x(5x-8) + 5(5x-8)$

....$(x+5)(5x-8)$.... [2]

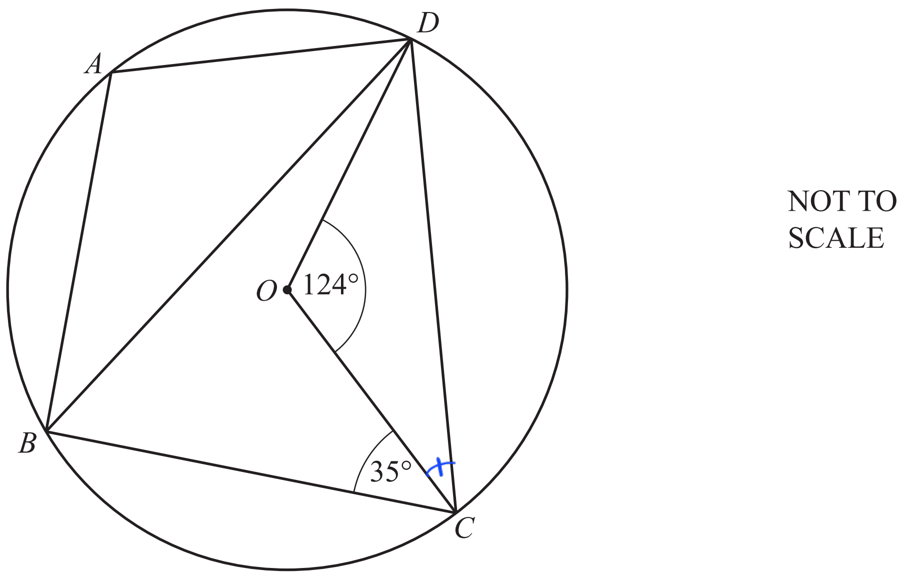
(c) Solve $x^3+4x^2-17x=x^3-9$.
You must show all your working and give your answers correct to 2 decimal places.

$4x^2 - 17x + 9 = 0$

$$x = \frac{-(-17) \pm \sqrt{(-17)^2 - 4 \times 4 \times 9}}{2 \times 4}$$

$x =$ ....0.62.... or $x =$ ....3.63.... [5]

5 (a)



A, B, C and D are points on a circle, centre O.
Angle $COD = 124°$ and angle $BCO = 35°$.

(i) Work out angle CBD.
Give a geometrical reason for your answer.

Angle CBD = $\frac{124°}{2} = 62°$ because angle at center is twice angle at circumference [2]

(ii) Work out angle BAD.
Give a geometrical reason for each step of your working.

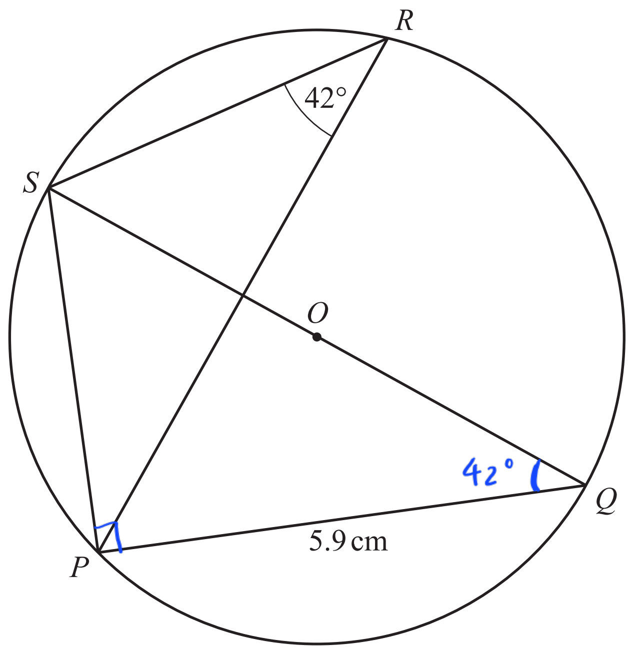
$\triangle OCD$ is isosceles

$\Rightarrow \widehat{OCD} = \frac{180° - 124°}{2} = 28°$

$\Rightarrow \widehat{BCD} = 35° + 28° = 63°$

Angle BAD = 117° because opposite angles in a cyclic quadrilateral add up to 180° [4]

(b)



NOT TO SCALE

P, Q, R and S are points on a circle, centre O.
QS is a diameter.
Angle $PRS = 42°$ and $PQ = 5.9$ cm.

Calculate the circumference of the circle.

$\widehat{SQP} = \widehat{SRP} = 42°$ (angles at circumference subtend the same arc)

$\cos 42° = \frac{5.9}{SQ}$

$\Rightarrow SQ = \frac{5.9}{\cos 42°}$

$\Rightarrow$ radius $= \frac{SQ}{2} = \frac{2.95}{\cos 42°}$

$\Rightarrow$ circumference $= 2\pi \frac{2.95}{\cos 42°} \approx 24.9$

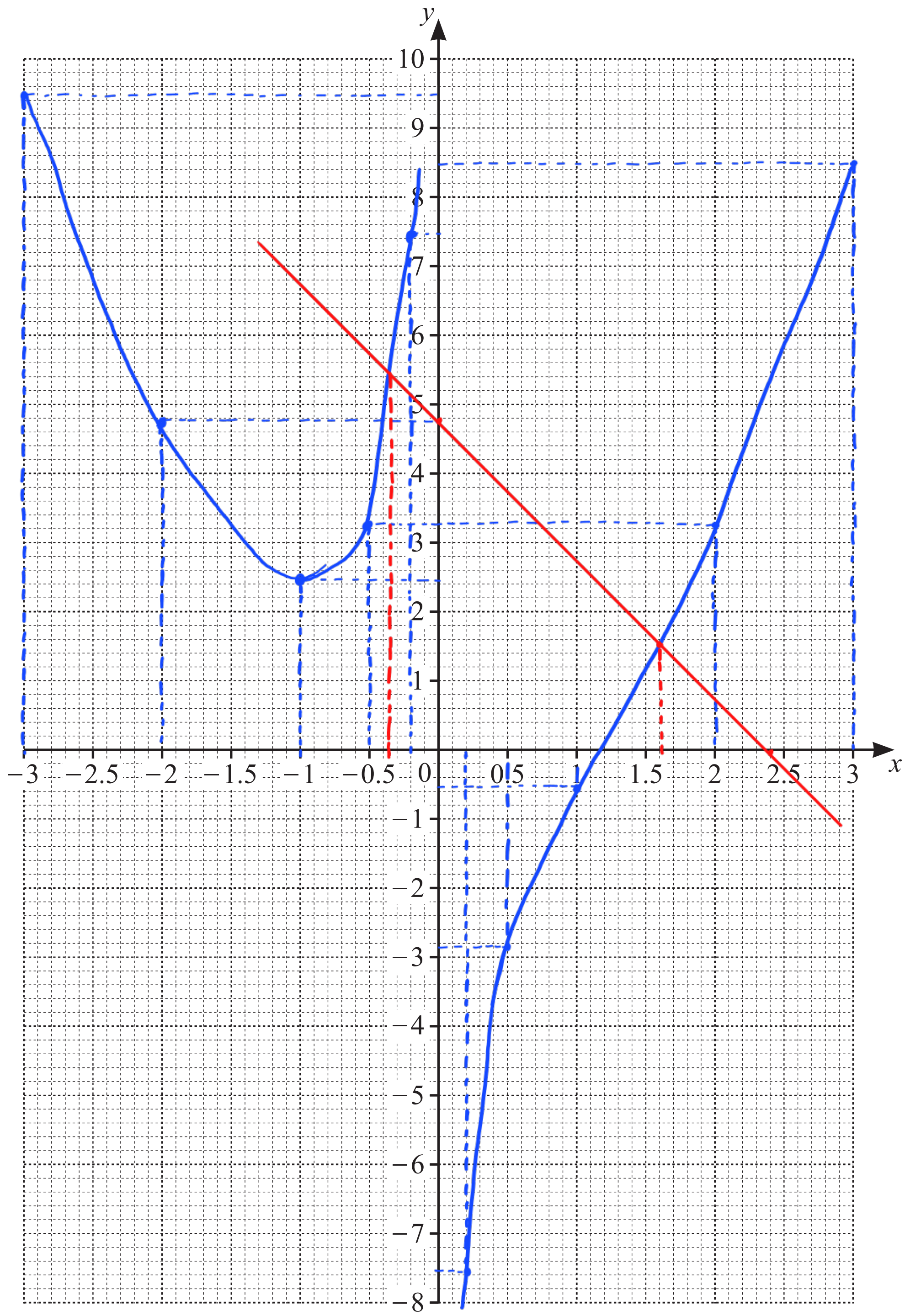
................24.9................ cm [5]

6 The table shows some values for $y = x^2 - \frac{3}{2x}$, $x \neq 0$, given correct to 1 decimal place.

x	−3	−2	−1	−0.5	−0.2		0.2	0.5	1	2	3
y	9.5	4.8	2.5	3.3	7.5		−7.5	−2.8	−0.5	3.3	8.5

(a) **(i)** Complete the table. [3]

(ii) On the grid, draw the graph of $y = x^2 - \frac{3}{2x}$ for $-3 \leqslant x \leqslant -0.2$ and $0.2 \leqslant x \leqslant 3$.



[5]

(b) By drawing a suitable straight line on the grid, solve the equation $x^2 - \frac{3}{2x} = \frac{24}{5} - 2x$ for $-3 \leqslant x \leqslant -0.2$ and $0.2 \leqslant x \leqslant 3$.

Draw $y = \frac{24}{5} - 2x$

$x =$ ......-0.35...... or $x =$ ......1.6...... [4]

(c) The solutions to the equation $x^2 - \frac{3}{2x} = \frac{24}{5} - 2x$ are also the solutions to an equation of the form $ax^3 + bx^2 + cx - 15 = 0$ where a, b and c are integers.

Find the values of a, b and c.

$$\frac{x^2 \times 2x - 3}{2x} = \frac{24 - 2x \times 5}{5}$$

$$(2x^3 - 3)5 = 2x(24 - 10x)$$

$$10x^3 - 15 = 48x - 20x^2$$

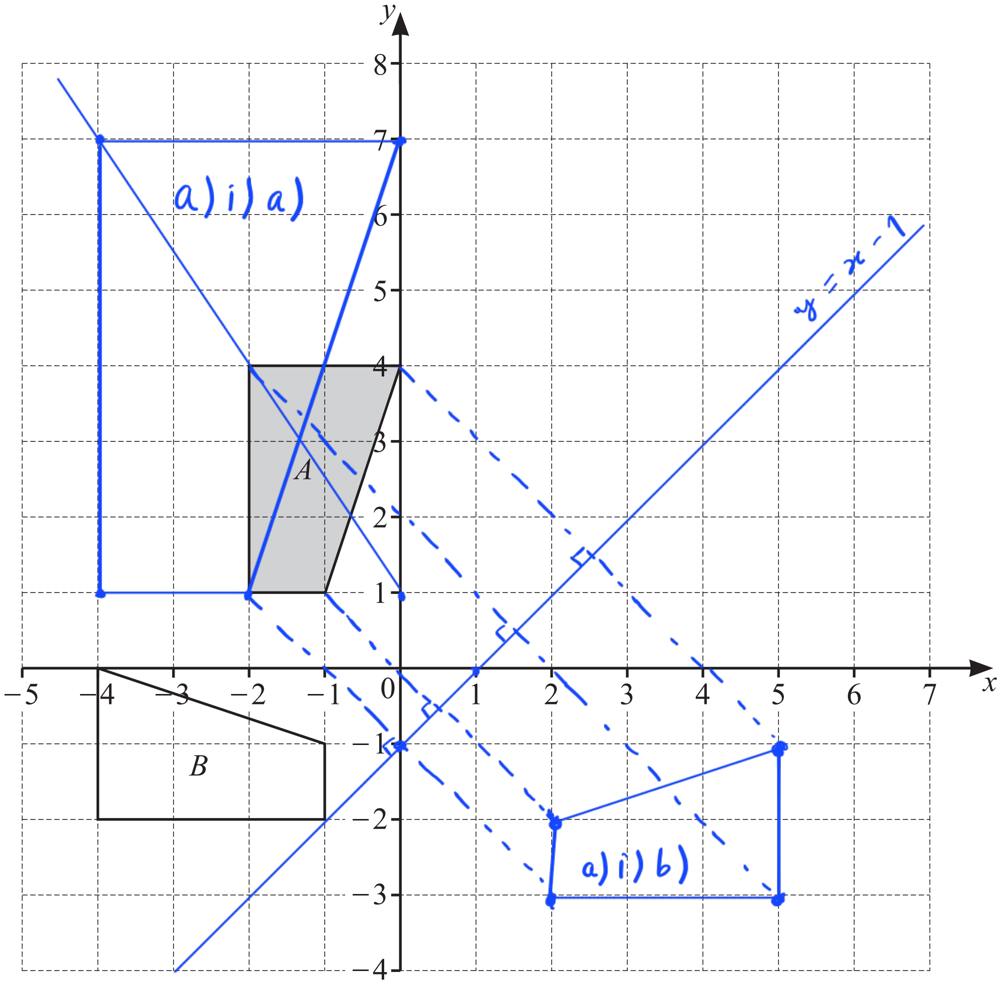
$$10x^3 + 20x^2 - 48x - 15 = 0$$

$a =$ ......10......

$b =$ ......20......

$c =$ ......-48...... [4]

7 **(a)**



(i) On the grid, draw the image of

(a) shape A after an enlargement, scale factor 2, centre (0, 1), [2]

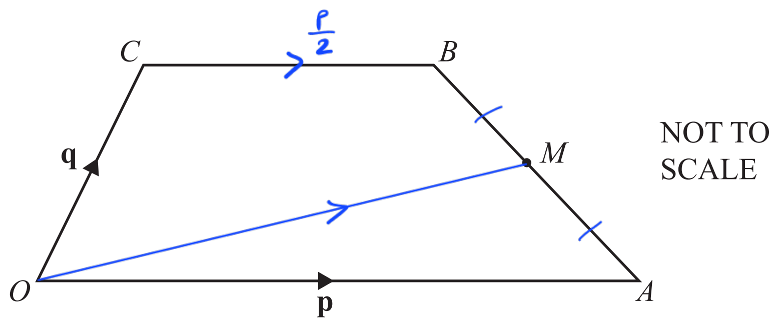
(b) shape A after a reflection in the line $y = x - 1$. [3]

(ii) Describe fully the **single** transformation that maps shape A onto shape B.

Rotation, center (0,0), anticlockwise 90°

.... [3]

(b)



$OABC$ is a trapezium and O is the origin.
M is the midpoint of AB.
$\overrightarrow{OA} = \mathbf{p}$, $\overrightarrow{OC} = \mathbf{q}$ and $OA = 2CB$.

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

$\overrightarrow{BA} = \overrightarrow{BC} + \overrightarrow{CO} + \overrightarrow{OA}$

$\overrightarrow{BA} = -\frac{p}{2} - q + p = \frac{p}{2} - q$

$\overrightarrow{BM} = \frac{1}{2}\overrightarrow{BA} = \frac{1}{2}\left(\frac{p}{2} - q\right) = \frac{p}{4} - \frac{q}{2}$

$\overrightarrow{OM} = \overrightarrow{OC} + \overrightarrow{CB} + \overrightarrow{BM}$

$\overrightarrow{OM} = q + \frac{p}{2} + \left(\frac{p}{4} - \frac{q}{2}\right)$

$\overrightarrow{OM} = \frac{3}{4}p + \frac{1}{2}q$

$\frac{3}{4}p + \frac{1}{2}q$ [3]

8 **(a)** $f(x) = 3 - 5x$

(i) Find x when $f(x) = -5$.

$3 - 5x = -5$

$3 + 5 = 5x$

$8 = 5x$

$x =$ $\frac{8}{5}$ [2]

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

$f: \; x(-5) \longrightarrow +3$

$: (-5) \longleftarrow -3 \quad f^{-1}$

$f^{-1}(x) =$ $\frac{x-3}{-5}$ [2]

(b) $g(x) = 18 - 3x - x^2$

(i) Write $g(x)$ in the form $b - (a + x)^2$.

$g(x) = -x^2 - 3x + 18$

$= -(x^2 + 3x) + 18$

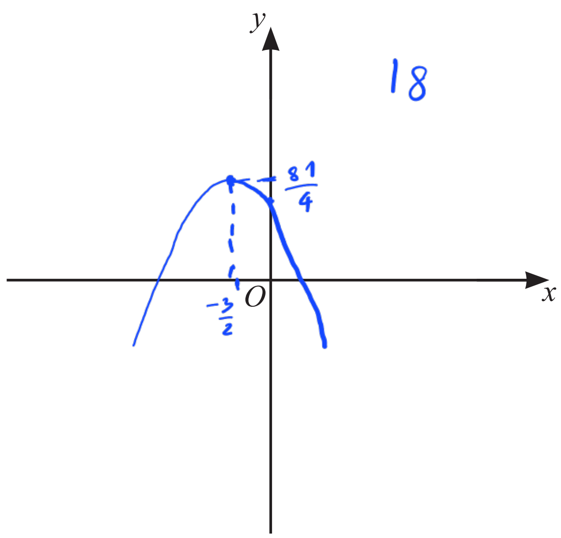
$= -\left[x^2 + 2x\frac{3}{2} + \left(\frac{3}{2}\right)^2 - \left(\frac{3}{2}\right)^2\right] + 18$

$= -\left[\left(x + \frac{3}{2}\right)^2 - \frac{9}{4}\right] + 18$

$= -\left(x + \frac{3}{2}\right)^2 + \frac{81}{4}$

$\frac{81}{4} - \left(x + \frac{3}{2}\right)^2$ [3]

(ii) Sketch the graph of $y = g(x)$.
On your sketch, show the coordinates of the turning point.



[3]

(iii) Find the equation of the tangent to the graph of $y = 18 - 3x - x^2$ at $x = 4$.
Give your answer in the form $y = mx + c$.

$$\frac{dy}{dx} = -3 - 2x$$

When $x = 4$: $\frac{dy}{dx} = -3 - 2(4) = -11$

$\Rightarrow m_{tangent} = -11$

When $x = 4$, $y = 18 - 3 \times 4 - 4^2 = -10$

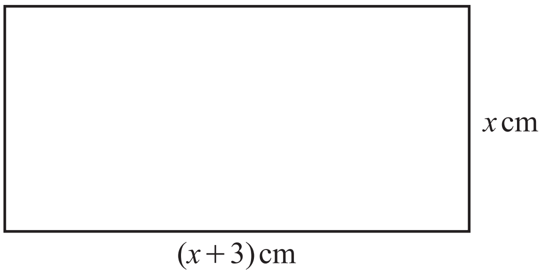
$\Rightarrow$ Equation of tangent : $y - (-10) = -11(x - 4)$

$y + 10 = -11x + 44$

$y = -11x + 34$

$y =$ ....$-11x + 34$.... [6]

9 **(a)**



NOT TO SCALE

This rectangle has perimeter 20 cm.

Find the value of x.

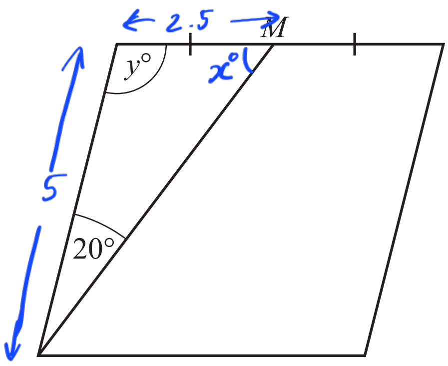
$2(x + x + 3) = 20$

$2x + 3 = 10$

$2x = 7$

$x =$ ....$\frac{7}{2}$.... [3]

(b)



NOT TO SCALE

This rhombus has perimeter 20 cm and angle y is obtuse.
M is the midpoint of one of the sides.

Find the value of y.

$\text{side} = \frac{20}{4} = 5$

$\frac{2.5}{\sin 20°} = \frac{5}{\sin x}$

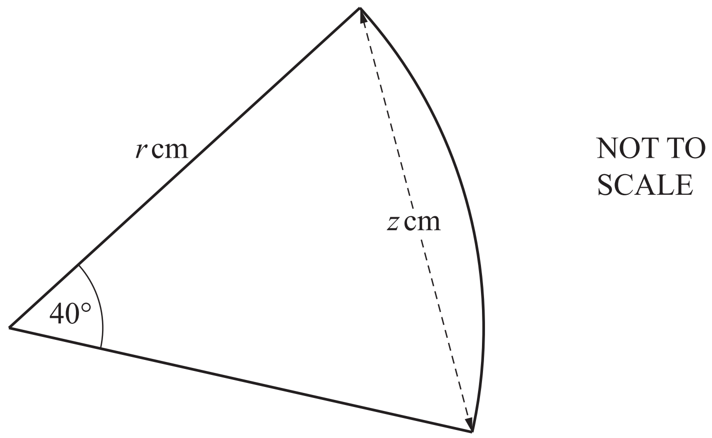
$\Rightarrow \sin x = \frac{5 \sin 20°}{2.5} \approx 0.68404$

$x = 43.16°$

$y = 180° - 43.16° - 20° = 116.84°$

$y =$ ....116.8°.... [5]

(c)



This sector of a circle has radius r and perimeter 20 cm.

Find the value of z.

$$40^\circ = \frac{40\pi}{180} \text{ radian}$$

$$\text{arc length} = r \times \frac{40\pi}{180} = \frac{2\pi r}{9}$$

$$\text{perimeter} = 20$$

$$\Rightarrow \quad 2r + \frac{2\pi r}{9} = 20$$

$$\Rightarrow \quad r\left(2 + \frac{2\pi}{9}\right) = 20$$

$$\Rightarrow \quad r \approx 7.4125$$

cosine rule: $z^2 = r^2 + r^2 - 2r \times r \times \cos 40^\circ$

$$z^2 = 2 \times 7.4125^2 - 2 \times 7.4125 \times 7.4125 \cos 40^\circ$$

$$z^2 = 25.709$$

$$z \approx 5.07$$

$z =$ ......5.07...................................... [6]