GCSE Higher Tier Paper 2/3 preparation

How to use this booklet:

- Pick a topic (Choose one that you are not 100% confident on)
- Complete the questions
- Scan the QR code to view the worked solutions
- If you still don't feel confident go to one of the useful websites listed below and find some similar questions

Useful websites with exam practice and worked/video solutions:

https://www.1stclassmaths.com/aqarevision

https://www.old.mathsgenie.co.uk/gcse.php

https://corbettmaths.com/2026/05/15/aqa-paper-2-and-3-june-2026/

Contents of this booklet:

Polygons

Q1.

Write down the sum of the **exterior** angles of any polygon.

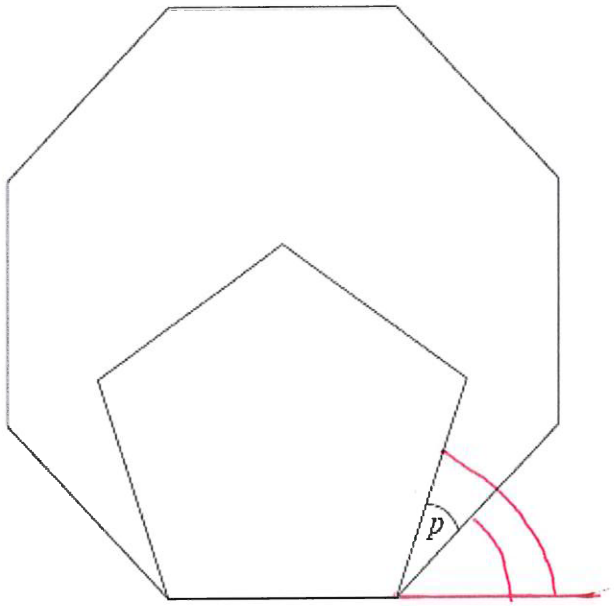
Answer 360

(Total 1 mark)

Q2.

A regular pentagon is drawn inside a regular octagon as shown.

Not drawn accurately



Calculate the size of angle p.
You **must** show your working.

Ext of an Octagon = 360 ÷ 8 = 45

Ext of a Pentagon (regular) = 360 ÷ 5 = 72

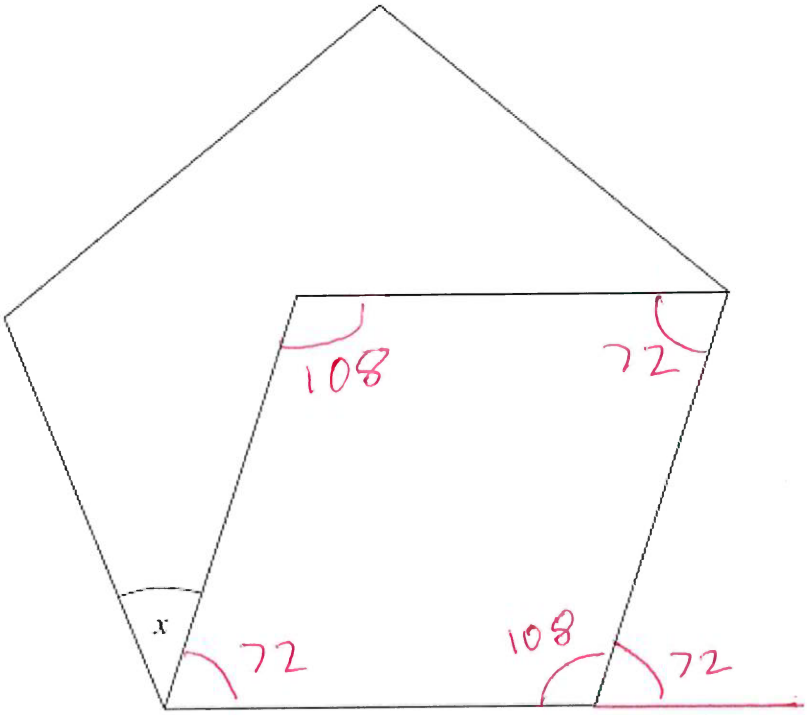
72 − 45 = 27

Answer 27 degrees

(Total 3 marks)

Q3.

The diagram shows a rhombus inside a regular pentagon.



Not drawn accurately

Work out the value of x.

Ext angle of Reg Pentagon = $\frac{360}{5}$ = 72

Int angle of Reg Pentagon = 108 (180 − 72)

x = 108 − 72 = 36°

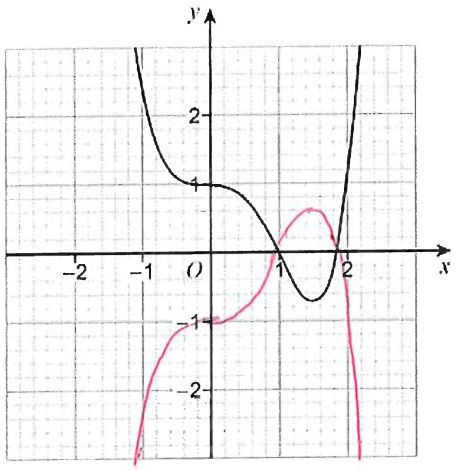
Answer 36° degrees

(Total 4 marks)

Transformation of functions

Q1.

The grid shows the graph of $y = f(x)$



On the grid, draw the graph of $y = -f(x)$

↑ reflection in x axis

(Total 2 marks)

Q2.

(7, 28) is a point on the graph $y = f(x)$

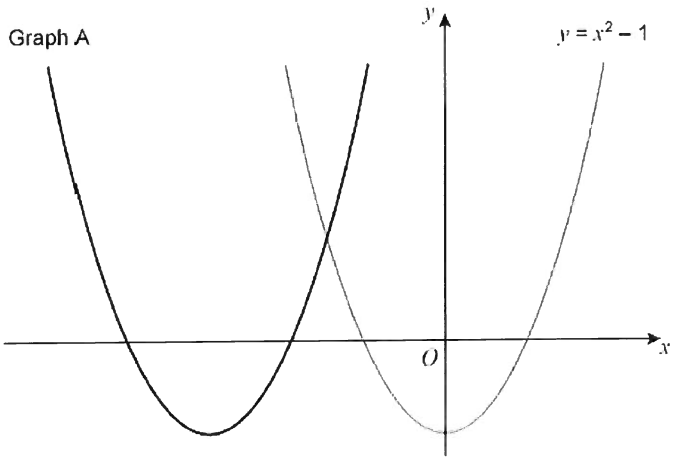
Circle the point which **must** be on the graph $y = f(x) + 2$ → moved up 2 or $\begin{pmatrix} 0 \\ 2 \end{pmatrix}$

(7, 26) (7, 30) (5, 28) (9, 28)

(Total 1 mark)

Q3.

Here are sketches of two graphs.



The graph of $y = x^2 - 1$ is translated 3 units to the left to give graph A.

(a) The equation of graph A can be written in the form $y = x^2 + bx + c$

Work out the values of b and c.

3 units left → replace x with $x+3$

$y = x^2 - 1$ becomes $y = (x+3)^2 - 1$

$= x^2 + 6x + 9 - 1$

$= x^2 + 6x + 8$

$b =$ 6

$c =$ 8

(3)

(b) The graph of $y = x^2 - 1$ is reflected in the x-axis to give graph B.

→ multiply function by -1

Work out the equation of graph B.

$y = -(x^2 - 1)$ or $1 - x^2$

Answer $y = 1 - x^2$

(1)

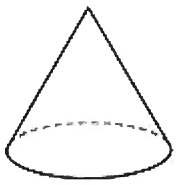
(Total 4 marks)

Similar solids

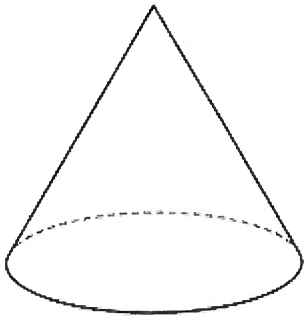
Q1.

Here are two similar cones.

Cone A



Cone B



The surface area of cone A is 2 m²

The surface area of cone B is 4.5 m²

Work out the ratio radius of cone A : radius of cone B

Give your answer in the form 1 : n

(The radius is a length so length Scale factor needed)

Area Scale factor = 4.5 ÷ 2 = 2.25

length Scale factor = $\sqrt{2.25}$ = 1.5

Answer 1 : 1.5

(Total 3 marks)

Q2.

A and B are similar solid cylinders.

base area of A : base area of B = 9 : 25

Area ratio 9 : 25

length ratio = $\sqrt{9}$: $\sqrt{25}$

= 3 : 5

Complete these ratios.

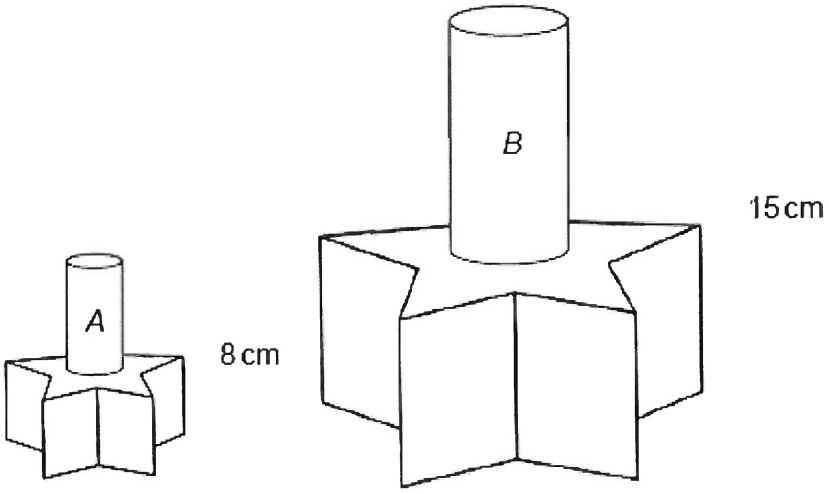
curved surface area of A : curved surface area of B = 9 : 25

height of A : height of B = 3 : 5

(Total 2 marks)

Q3.

Here are two similar solids, *A* and *B*.



Solid *A* is 8 cm tall and solid *B* is 15 cm tall.

The volume of *A* is 250 cm^3

Is the volume of *A* approximately four times of the volume of *B*?

Yes ☐ No ☑

You **must** show your working.

Length Scale factor = $15 \div 8 = 1.875$

Volume Scale factor = $1.875^3 = 6.591796875$

$250 \times 6.59... = 1647.949219$

↓ nowhere near 4 ↓ more than 6 times more

(Total 4 marks)

Random ratio questions

Q1.

A : B = $\frac{1}{5} : \frac{7}{10}$

$A : B = \frac{1}{5} : \frac{7}{10}$ (×10, ×10)

$= 2 : 7$

Write A as a fraction of B.

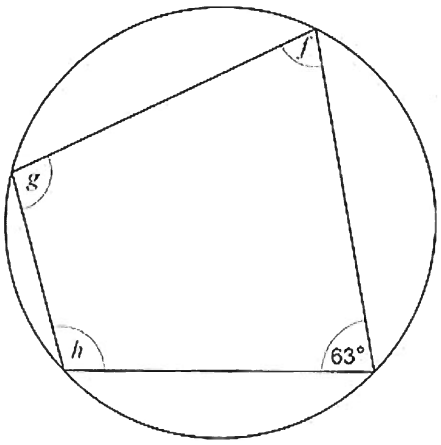
A as a fraction of B = $\frac{2}{7}$

Answer $\frac{2}{7}$

(Total 2 marks)

Q2.

Here is a cyclic quadrilateral.



Not drawn accurately

$f : g = 2 : 3$

Opposite angles in Cyclic Quad add up to 180°

Work out $f : h$

Give your answer in its simplest form.

$180 - 63 = 117 = g$

$f : g$ $\quad 117 \div 3 = 39$

$= 2 : 3$ (×39)

$= f : 117$ (×39)

$f = 78$

$180 - 78 = 102$

$f : h$

$= 78 : 102$

$= 13 : 17$

Answer 13 : 17

(Total 4 marks)

Q3.

Two objects, J and K, are applying pressure to areas of ground.

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

For J, the force is 18.9 newtons and the area is 0.45 m^2

pressure for J : pressure for K = 7 : 8

area for J : area for K = 9 : 5

Work out the force for K.

Pressure for J

$P_J = \frac{18.9}{0.45} = 42$

$P_J : P_K$

$= 42 : 48$ (×6)

$7 : 8$ (×6)

$P_K = 48$

Area : J : K

$9 : 5$ (×0.05)

$0.45 : 0.25$ (×0.05)

$P_K = \frac{\text{Force}_K}{\text{Area}_K}$ ×0.25

$48 = \frac{\text{Force}_K}{0.25}$ ×0.25

$12 = \text{Force}_K$

Answer 12 newtons

(Total 4 marks)

Simultaneous equations

Q1.

Solve these simultaneous equations.

$7x + 2y = 100$

$3x + 2y = 48$ (−)

Subtract

$4x = 52$

$x = 13$

Sub into either equation.

$3 \times 13 + 2y = 48$

$39 + 2y = 48$

$2y = 9$ (−39)

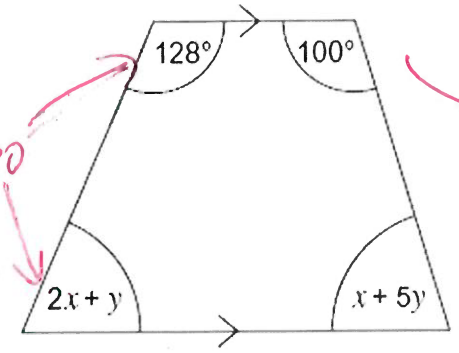
$y = 4.5$ (−39)

$x =$ 13 $y =$ 4.5

(Total 3 marks)

Q2.

The diagram shows a trapezium.



Add up to 180

$2x + y + 128 = 180$

add up to 180

$x + 5y + 100 = 180$

Work out the values of x and y.

$2x + y = 52$

$x + 5y = 80$ ×2

$2x + 10y = 160$

Subtract top from bottom → $9y = 108$

$y = 12$

Sub into any equation

$2x + 12 = 52$

-12 / -12

$2x = 40$

$x = 20$

(Total 5 marks)

Q3.

Use algebra to work out the x-coordinates of the points of intersection of

$y = 3x^2$

and $y = 4x + 2$

Give your answers (plural) to 1 decimal place.

$3x^2 = 4x + 2$

$-4x$ / $-4x$

$3x^2 - 4x = 2$

-2 / -2

$3x^2 - 4x - 2 = 0$

Use quadratic formula

$a = 3 \quad b = -4 \quad c = -2$

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

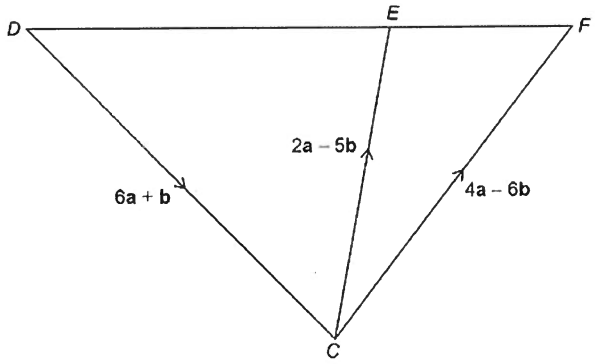
$$= \frac{4 \pm \sqrt{(-4)^2 - 4 \times 3 \times (-2)}}{6} = 1.7, -0.4$$

Answer 1.7, −0.4

(Total 5 marks)

Vector Geometry

Q1.



Not drawn accurately

Prove that *DEF* is a straight line.

→ Plan: • Work out $\overrightarrow{DE}$ and $\overrightarrow{EF}$
• Show they are parallel
• Since they share a point must be a straight line.

$\overrightarrow{DE} = \overrightarrow{DC} + \overrightarrow{CE}$

$= 6a + b + 2a - 5b$

$= 8a - 4b$

$= 4(2a - b)$

$\overrightarrow{EF} = \overrightarrow{EC} + \overrightarrow{CF}$

$= -(2a - 5b) + 4a - 6b$

$= -2a + 5b + 4a - 6b$

$= 2a - b$

$\therefore \overrightarrow{DE} = 4 \times \overrightarrow{EF}$

So $\overrightarrow{DE}$ and $\overrightarrow{EF}$ are parallel
($\overrightarrow{DE}$ is 4 times longer)
Since they also share point E,
They must be a straight line.

(Total 4 marks)

Q2.

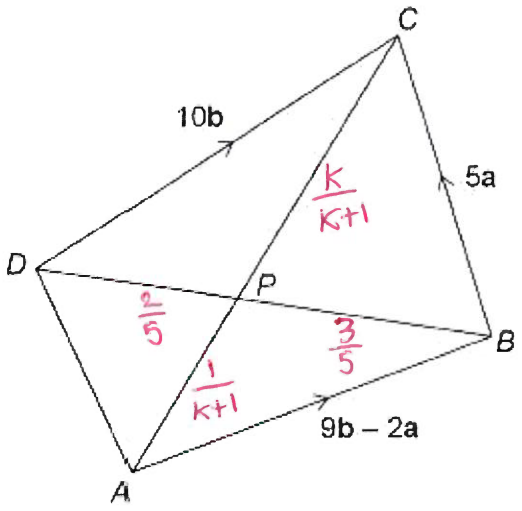
ABCD is a quadrilateral.

AC and *BD* intersect at *P*.

$\overrightarrow{AB} = 9\mathbf{b} - 2\mathbf{a}$

$\overrightarrow{BC} = 5\mathbf{a}$

$\overrightarrow{DC} = 10\mathbf{b}$



Not drawn accurately

$BP : PD = 3 : 2$ Total 5

$AP : PC = 1 : k$ $k+1$

Work out the value of k.

You **must** show your working.

Looks to do.

My Plan: Write 2 ways of getting from A to P

$\rightarrow \overrightarrow{AP} = \overrightarrow{AB} + \overrightarrow{BP}$

and $\overrightarrow{AP}$ = direct route from A to P

Then put them equal to eachother.

$\overrightarrow{BD} = 5a - 10b$

$\overrightarrow{BP} = \frac{3}{5}(5a - 10b) = 3a - 6b$

$\overrightarrow{AP} = \overrightarrow{AB} + \overrightarrow{BP} = 9b - 2a + 3a - 6b$

$= a + 3b$

also

$\overrightarrow{AP} = \frac{1}{k+1}(\overrightarrow{AC})$

$= \frac{1}{k+1}(9b - 2a + 5a)$

$= \frac{1}{k+1}(9b + 3a)$

$= \frac{1}{k+1} \times 3(3b + a)$

So

$a + 3b = \frac{1}{k+1} \times 3(a + 3b)$

$k+1$ must be 3

So $k = 2$

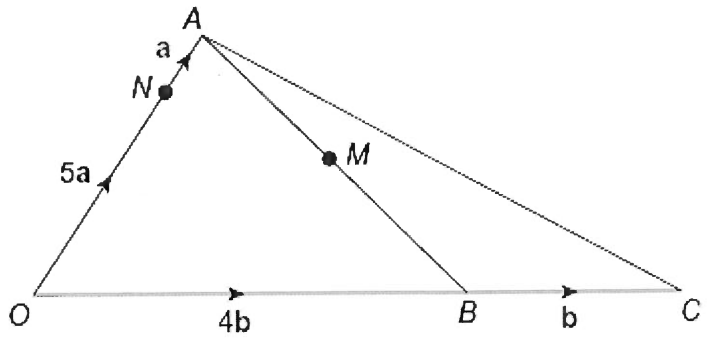
$k =$ 2

(Total 5 marks)

HARD QUESTION!

Q3.

Not drawn accurately



$\overrightarrow{ON} = 5\mathbf{a}$ $\overrightarrow{NA} = \mathbf{a}$

$\overrightarrow{OB} = 4\mathbf{b}$ $\overrightarrow{BC} = \mathbf{b}$

M is the midpoint of AB.

$\overrightarrow{AM} = \frac{1}{2}\overrightarrow{AB}$
$= \frac{1}{2}(-6\mathbf{a} + 4\mathbf{b}) = -3\mathbf{a} + 2\mathbf{b}$

(a) Show that $\overrightarrow{NM} = 2(\mathbf{b} - \mathbf{a})$

$\overrightarrow{NM} = \overrightarrow{NA} + \overrightarrow{AM}$
$= \mathbf{a} + (-3\mathbf{a} + 2\mathbf{b})$
$= -2\mathbf{a} + 2\mathbf{b} = 2(-\mathbf{a} + \mathbf{b}) = 2(\mathbf{b} - \mathbf{a})$

(2)

(b) Work out the ratio $NM : NC$

$\overrightarrow{NC} = -5\mathbf{a} + 5\mathbf{b}$
$= 5(-\mathbf{a} + \mathbf{b}) = 5(\mathbf{b} - \mathbf{a})$

$NM : NC$
$2 : 5$

Answer 2 : 5

(2)

(Total 4 marks)

Algebraic fractions

Q1.

common denominator

Write $\frac{7}{2a^2} - \frac{3}{5a}$ as a single fraction in its simplest form.

$\frac{5}{5} \times \frac{7}{2a^2} - \frac{3}{5a} \times \frac{2a}{2a}$

$\frac{35}{10a^2} - \frac{6a}{10a^2} = \frac{35-6a}{10a^2}$

Answer _____

(Total 2 marks)

Q2.

Always factorise!

Simplify fully $\frac{8x^2+4}{5x} \times \frac{3x}{14x^2+7}$

You **must** show your working.

$\frac{4(2x^2+1)}{5x} \times \frac{3x}{7(2x^2+1)}$

$= \frac{12x(2x^2+1)}{35x(2x^2+1)}$

$= \frac{12}{35}$

Answer $\frac{12}{35}$

(Total 3 marks)

Q3.

Solve $\frac{x}{4} - \frac{2x}{x+2} = 1$

Give your solutions to 2 decimal places.

You **must** show your working.

Common denominator

$\frac{(x+2)}{(x+2)} \times \frac{x}{4} - \frac{2x}{x+2} \times \frac{4}{4} = \frac{x(x+2)}{4(x+2)} - \frac{8x}{4(x+2)}$

$= \frac{x^2+2x-8x}{4(x+2)}$

Always make quadratics $=0$

$\frac{x^2-6x}{4(x+2)} = 1$

$x^2-6x = 4(x+2)$

$x^2-6x = 4x+8$

$x^2-10x-8=0$

Quadratic formula gives

Answer 10.74 ; −0.74

(Total 6 marks)

Averages

Q1.

A school play takes place each day from Monday to Friday.

Here are the attendances on four of the days.

Monday	Tuesday	Wednesday	Thursday
72	+ 83	+ 88	+ 97

Total for 4 days = 340

For all **five** days, the mean attendance is 90

Work out the attendance on Friday.

Total for 5 days = $5 \times 90 = 450$

$450 - 340 = 110$

Answer 110

(Total 3 marks)

Q2.

Rob records the time he takes to drive to work every day for 80 days.

The table shows information about the results.

Time, t (minutes)	Frequency
$20 \leqslant t < 25$	16
$25 \leqslant t < 30$	32
$30 \leqslant t < 40$	24
$40 \leqslant t < 60$	8
	Total = 80

midpoint | mp x f
22.5 | 360
27.5 | 880
35 | 840
50 | 400
2480

2480 ÷ 80 = 31

Last year, the **mean** time Rob took to drive to work was 25 minutes.

Estimate the percentage increase in the **mean** driving time for these 80 days.

Inc from 25 +6→ 31

$\frac{6}{25} \times 100 = 24\%$ ← 2 different methods

OR $31 \div 25 = 1.24$ → % increase of 24%

Answer 24 %

(Total 4 marks)

Q3.

Here is some information about the members of a basketball club.

	Number of members		Mean height of members		Total heights
Junior	30	×	1.6 m	=	48
Senior	20	×	2.05 m	=	41
					89

Work out the mean height of all 50 members of the club.

Give your answer as a decimal.

Total height = 89 Mean = $\frac{89}{50}$ = 1.78

Answer 1.78 m

(Total 3 marks)

Bounds

Q1.

Jack is loading a van.

The van can safely carry 1375 kg of furniture.

Jack has already loaded 1200 kg of furniture to the nearest 50 kg ± 25 to 1200 → LB = 1175, UB = 1225

A table has mass 140 kg to the nearest 10 kg ±5 to 140 → LB = 135, UB = 145

Can the table safely be added to the furniture in the van?

You **must** show your working.

Worst case → furniture already loaded 'weights' 1225 kg

+ Heavy table of 145

1225 + 145 = 1370

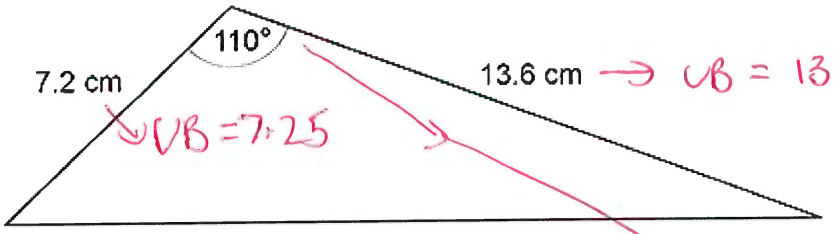
Yes 1370 < 1375

(Total 3 marks)

Q2.

Two sides of a triangle are measured to 1 decimal place.

The angle between the sides is measured to the nearest degree.



7.2 cm → UB = 7.25

13.6 cm → UB = 13.65

Work out the upper bound for the area of the triangle.

You **must** show your working.

Sin 109.5 = 0.94264...

Sin 110.5 = 0.9366...

use this → UB

Area = $\frac{1}{2}$ ab sin C

Area = $\frac{1}{2}$ × 7.25 × 13.65 × sin 109.5

Answer 46.64 (2dp) cm²

(Total 4 marks)

Q3.

A formula connecting speed (s), distance (d) and time (t) is

$$s = \frac{d}{t}$$

$d = 160$ to 2 significant figures → 2nd s.f is 10's ± 5 LB = 155, UB = 165

$t = 7.2$ to 2 significant figures → 2nd sf is 0.1 ± 0.05 LB = 7.15, UB = 7.25

Work out the upper and lower bounds for s.
Give your answers to 3 significant figures.

Upper bound $s = \frac{d \text{ upper}}{t \text{ lower}} = \frac{165}{7.15} = 23.1$

Lower bound $s = \frac{d \text{ lower}}{t \text{ upper}} = \frac{155}{7.25} = 21.4$

Upper bound 21.4

Lower bound 23.1

(Total 4 marks)

Factorising

Q1.

Factorise fully $12t + 4t^3$

$4t(3+t^2)$

Answer _____

(Total 2 marks)

Q2.

Always check to see if 3 is a factor of all terms.

Factorise fully $3x^2 + 23x + 30$

$5 \times 18 = 90$
$5 + 18 = 23$

1 90
2 45
3 30
5 18

	$3x$	$+5$
x	$3x^2$	$5x$
$+6$	$18x$	30

Reverse grid or Trial and Improvement.

Answer $(3x+5)(x+6)$

(Total 2 marks)

Difference of 2 squares.

Q3.

Factorise $25a^2 - b^2$

$(5a - b)(5a + b)$

Answer _____

(Total 1 mark)

Form & solve equations

Q1.

A biased spinner can land on A, B or C.

The table shows the probabilities, in terms of k, of A, B and C.

	A	B	C
Probability	$0.5k$	$7k - 0.15$	$2.5k$

Total 1

Work out the probability of B.

$0.5k + 7k - 0.15 + 2.5k = 1$

$10k - 0.15 = 1$ (+0.15)

$10k = 1.15$ (÷10)

$k = 0.115$

So

$P(B) = 7 \times 0.115 - 0.15$

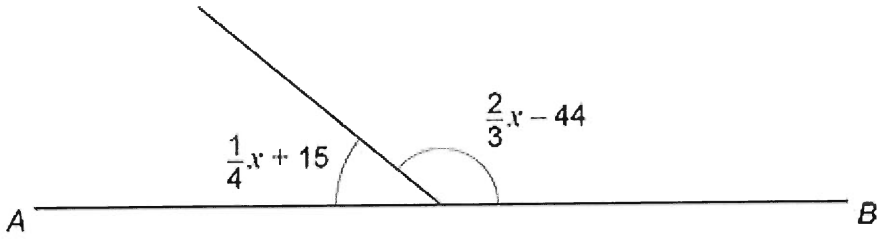
Answer 0.655

(Total 3 marks)

Q2.

AB is a straight line.

Both angles are given in degrees.



Not drawn accurately

By working out the value of x,

work out the ratio smaller angle : larger angle

$\frac{1}{4} + \frac{2}{3}$

$= \frac{3}{12} + \frac{8}{12} = \frac{11}{12}$

$\frac{1}{4}x + 15 + \frac{2}{3}x - 44 = 180$

$\frac{11x}{12} - 24 = 180$ +24

$\frac{11x}{12} = 204$ ×12

$11x = 2508$ ÷11

$x = 228$

small angle → $\frac{1}{4} \times 228 = 72$

large = 108

72 : 108 ÷36

2 : 3 ÷36

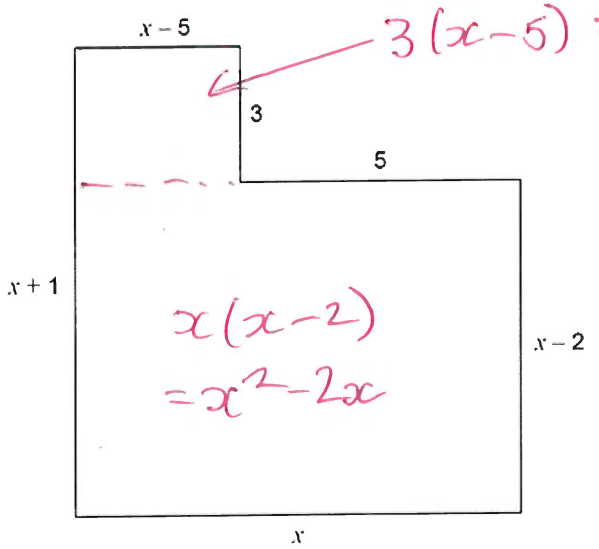
Answer 2 : 3

(Total 4 marks)

Q3.

Here is the plan of the floor of an L-shaped room.

All lengths are in metres.



$3(x-5) = 3x - 15$

$x(x-2)$

$= x^2 - 2x$

Not drawn accurately

(a) The area of the floor is 75 m²

Show that $x^2 + x - 90 = 0$

$3x - 15 + x^2 - 2x = 75$

$x^2 + x - 15 = 75$

$-75 \quad x^2 + x - 90 = 0 \quad -75$

(3)

(b) By factorising $x^2 + x - 90$ work out the value of x.

You **must** show your working

$(x+10)(x-9)$

$x = -10$ ← Doesn't make sense.

$x = 9$

$x =$ 9

(2)

(Total 5 marks)

Functions

Q1.

$f(x) = 3^x$ and $g(x) = 3x + 7$

(a) Work out the value of f(2) + g(5)

$3^2 + 3 \times 5 + 7$

$= 9 + 15 + 7$

Answer 31

(2)

(b) Work out the value of gf (2)

$f(2) = 9$

$g(9) = 34$

Answer 34

(1)

(c) Determine the value of x for which

$$g(x) = g^{-1}(x)$$

$y = 3x + 7$

$y - 7 = 3x$

$\frac{y-7}{3} = x$

So $g^{-1}(x) = \frac{x-7}{3}$

$\frac{x-7}{3} = 3x + 7$ $\times 3$

$x - 7 = 9x + 21$

$-7 = 8x + 21$ $-x$

$-28 = 8x$

$-3.5 = x$

Answer -3.5

(3)

Q2.

$f(x) = 2x + 5$

Show that $3f(x) - 12f^{-1}(x)$ simplifies to an integer.

$f^{-1}(x) \Rightarrow y = 2x + 5$

$y - 5 = 2x$

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

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

$3(2x+5) - 12\left(\frac{x-5}{2}\right)$

$= 6x + 15 - 6(x - 5)$

$= 6x + 15 - 6x + 30$

$= 45$

(Total 4 marks)

Q3.

$f(x) = \frac{1}{2}x$ $\quad g(x) = x - x^2$

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

Solve $f^{-1}(x) = gf(x)$

$2x = \left(\frac{1}{2}x\right) - \left(\frac{1}{2}x\right)^2$

$2x = \frac{1}{2}x - \frac{1}{4}x^2$

$-\frac{1}{2}x$ $\quad 1.5x = -\frac{1}{4}x^2$

$1.5x = -\frac{1}{4}x^2$

$\frac{1}{4}x^2 + 1.5x = 0 \rightarrow 0.25x^2 + 1.5x = 0$

$0.25x(x + 6) = 0$

$\frac{1}{4}x(x + 6) = 0$

Answer $x = 0 \quad x = -6$

(Total 4 marks)

Histograms

Q1.

The police want to know how many cars exceed the speed limit.
An officer stands with a speed gun and records the speeds of 1000 consecutive cars.

(a) Identify **one** possible source of bias for this experiment.

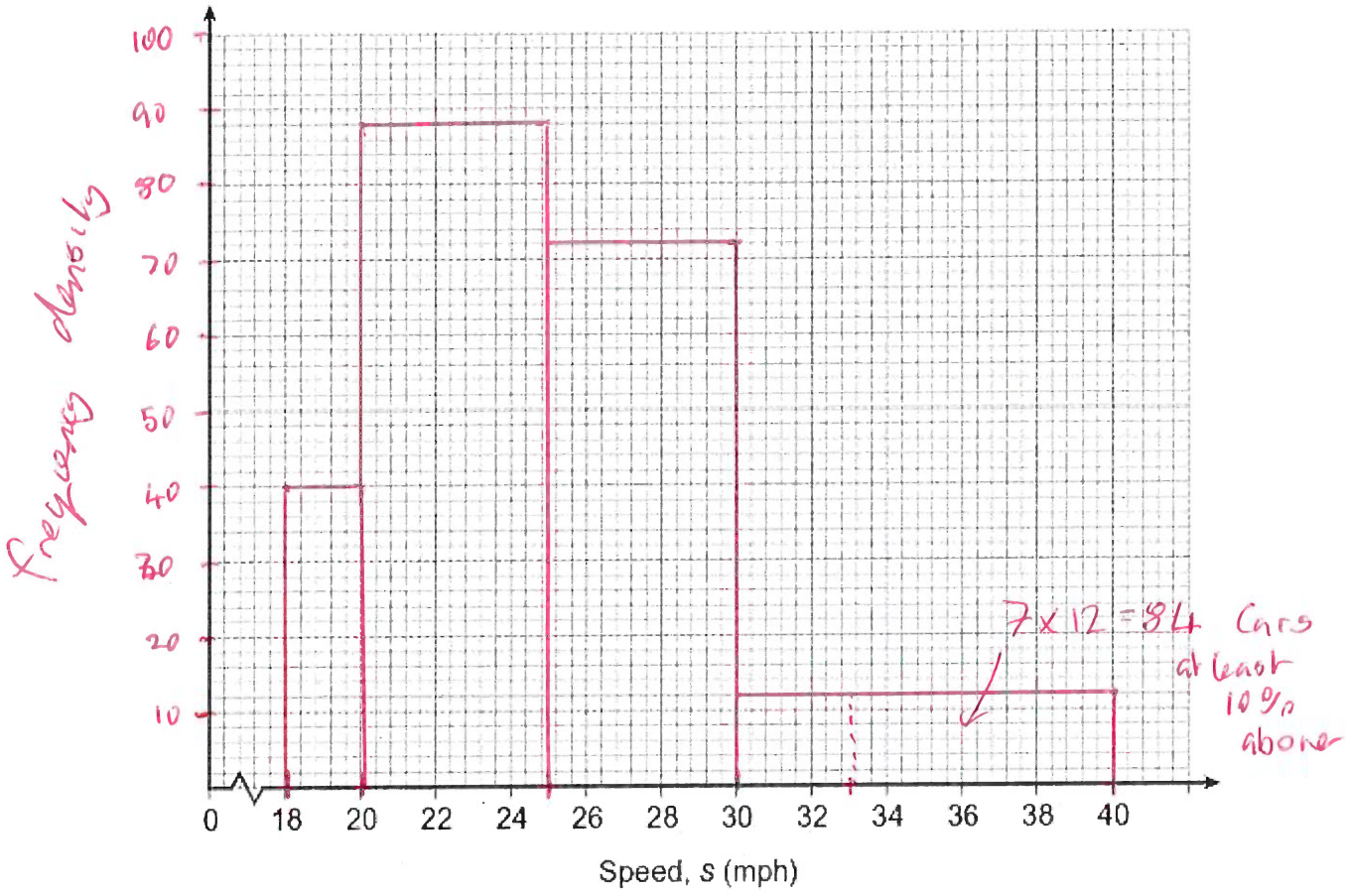
Cars will slow down if they see a police officer with a speed gun so results will be biased.

(1)

(b) The grouped frequency table represents the speeds of the 1000 cars.

Speed, s (mph)	Frequency	class width	frequency density
$18 \leq s < 20$	80	2	40
$20 \leq s < 25$	440	5	88
$25 \leq s < 30$	360	5	72
$30 \leq s < 40$	120	10	12

On the grid below, show the data on a histogram.



(4)

(c) The speed limit for the road is 30 miles per hour.
Two cars are chosen at random from the 1000 cars.

33

Estimate the probability that **both** cars are at least 10% above the speed limit.

$\frac{84}{1000} \times \frac{83}{999}$

Answer 0.006978

(3)

(Total 8 marks)

Q2.

The table and histogram give some information about the heights of 120 children.

Height, h (cm)	Frequency
$40 < h \leq 60$	30
$60 < h \leq 70$	20
$70 < h \leq 75$	15
$75 < h \leq 95$	50
$95 < h \leq 105$	5
	Total = 120

CW FD

20 1.5

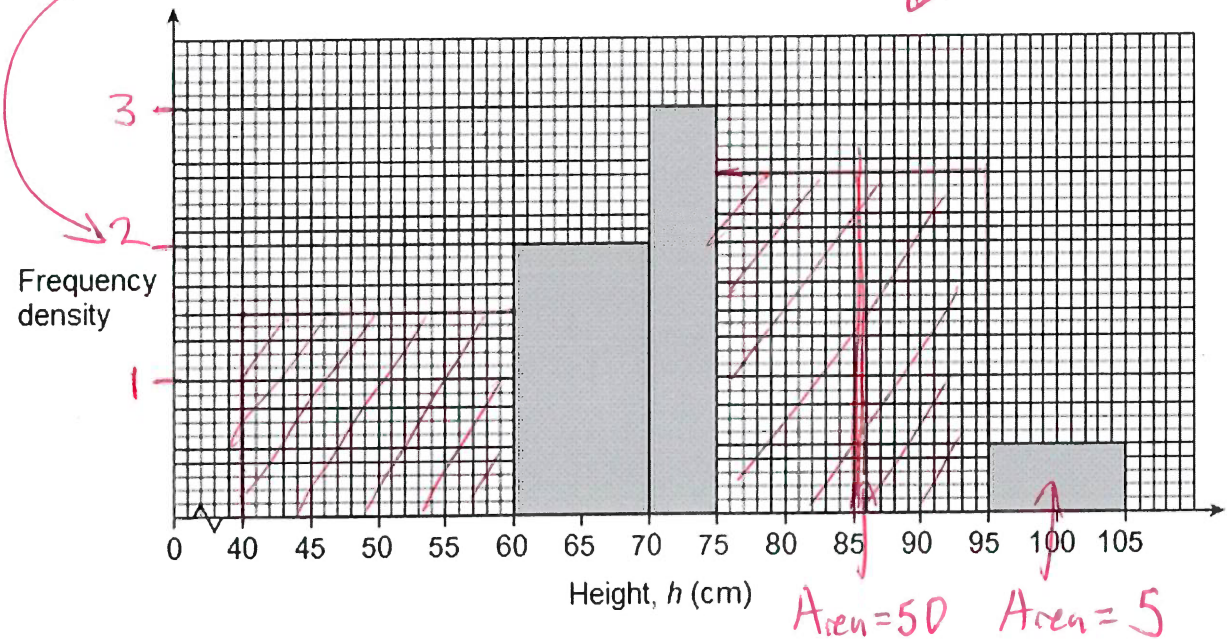
10 2

5 3

20 2.5

10 0.5

Area = frequency



(a) Complete the table and the histogram.

(3)

(b) Calculate an estimate of the upper quartile of the heights of the 120 children.

120 ÷ 4 = 30

Approx 30 children is area to right of 85

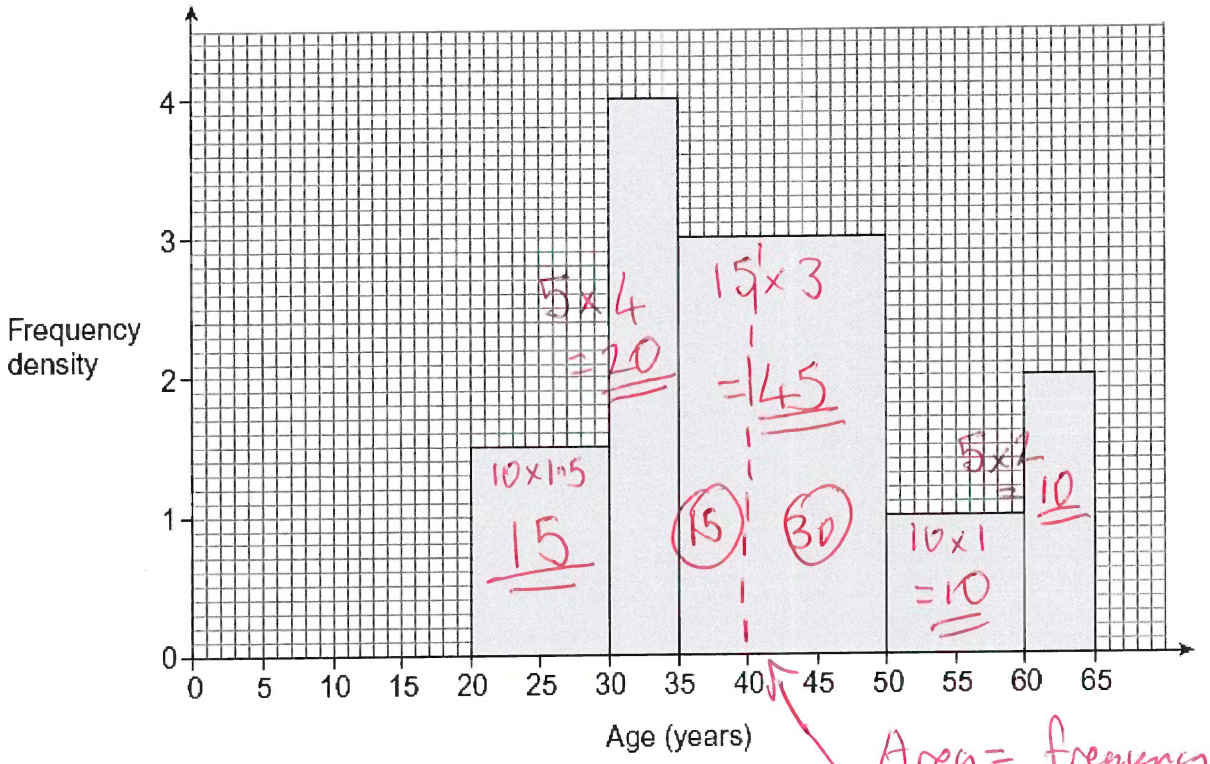
Answer 85 cm

(2)

(Total 5 marks)

Q3.

The histogram shows information about the ages of 100 employees.



Area = frequency

Work out an estimate of the median age of the employees.

100 ÷ 2 = 50 need to draw a vertical line with area to left = 50 and area to right = 50.

Area to left of 40 = 15 + 20 + 15 = 50

So median = 40

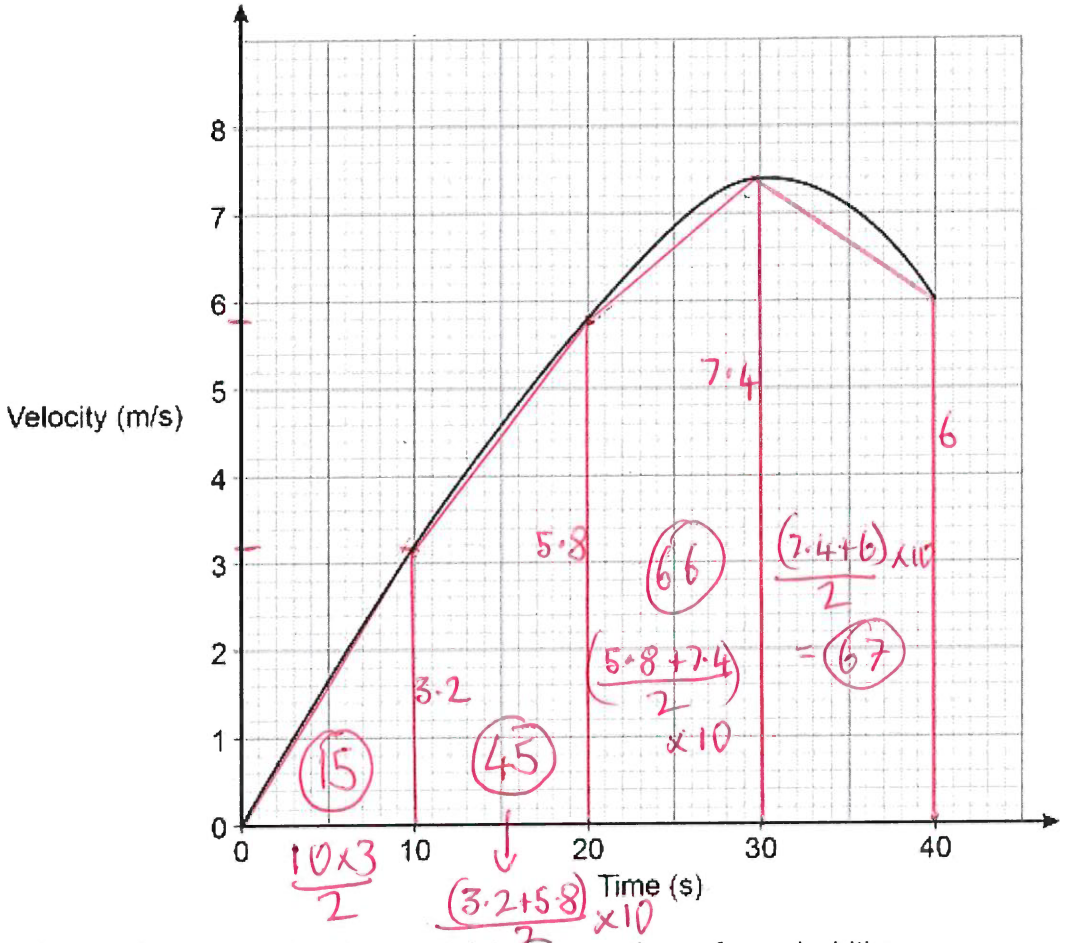
Answer _____ years

(Total 4 marks)

Instantaneous rates of change

Q1.

Here is the velocity-time graph of a cyclist for 40 seconds.



(a) By dividing the area under the graph into four sections of equal widths, estimate the distance travelled during the 40 seconds.

15 + 45 + 66 + 67 = 193 metres

Answer _____ m

(3)

(b) Work out the average acceleration of the cyclist during the 40 seconds.
State the units of your answer.

6 ÷ 40 =

Answer 0·15 m/s²

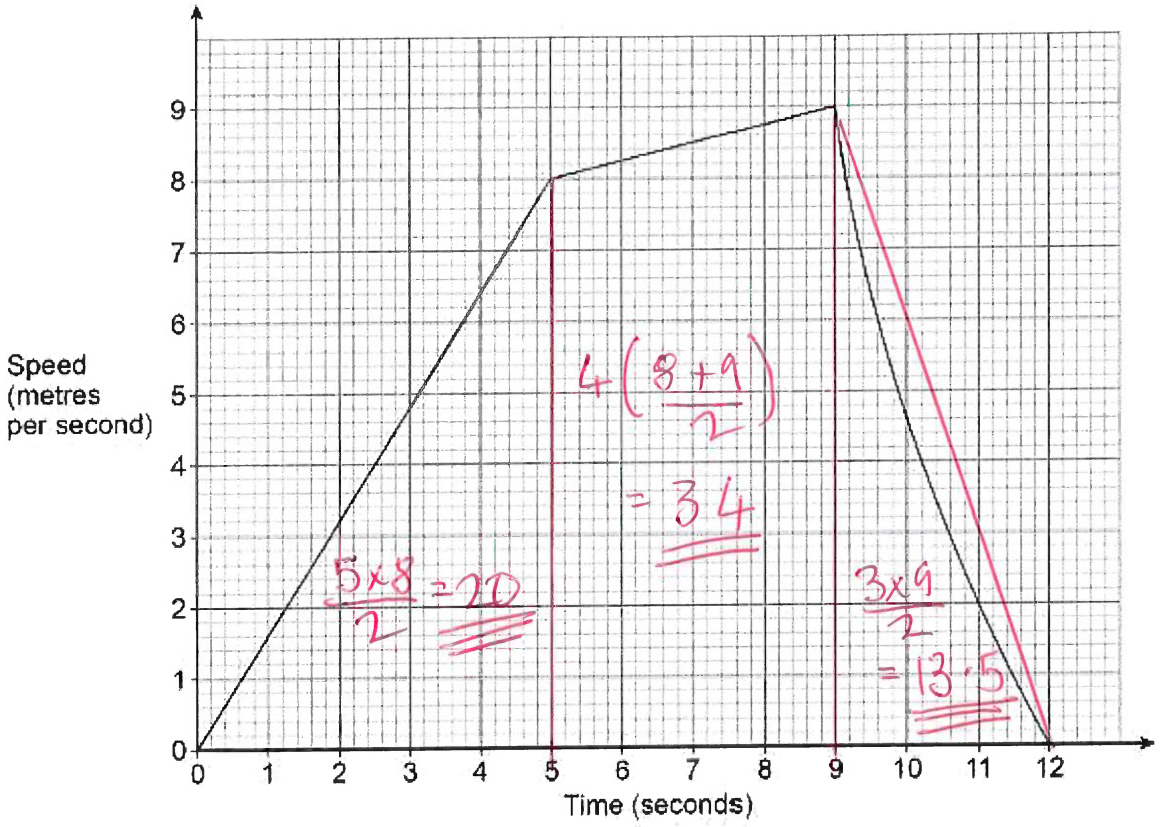
(2)

(Total 5 marks)

Q2.

Leo runs for 12 seconds.

The graph shows his speed.



(a) Show that the distance he runs is less than 67.5 metres.

Area under < 67.5
as the triangle area
is an overestimate of the
actual area.

(4)

(b) Work out his average acceleration for the first 9 seconds.

State the units of your answer.

9 ÷ 9

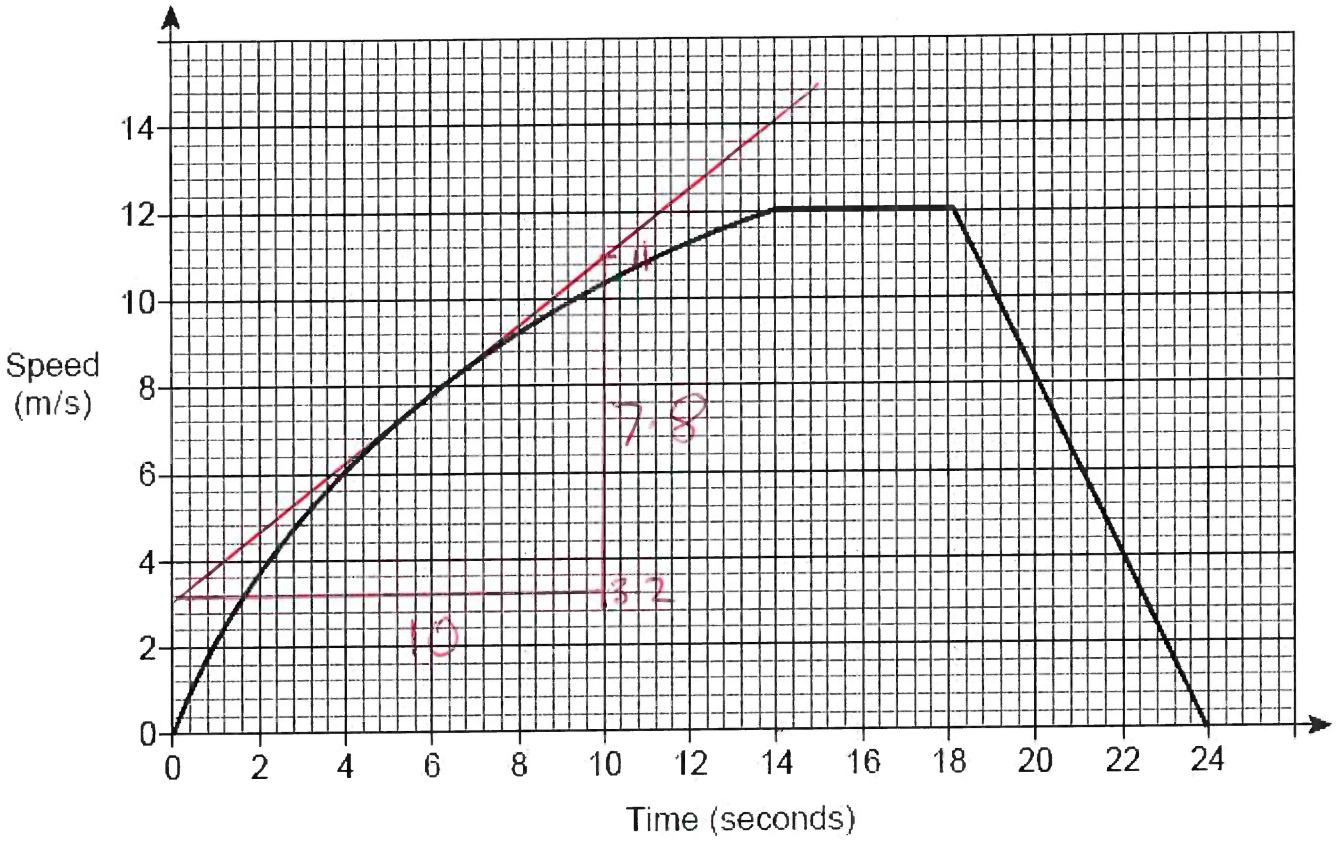
Answer 1 ms^{-2}

(2)

(Total 6 marks)

Q3.

The speed-time graph for a car's journey is shown.



(a) Estimate the acceleration at 6 seconds.
You **must** show your working.

Draw a tangent a t=6

7·8 ÷ 10 =

Answer 0·78 m/s²

(3)

(b) Estimate the average speed of the car for the journey.
You **must** show your working.

Distance travelled ÷ time.

Triangle between 0 - 14 seconds
= 14×12 / 2 = 84m

Rectangle between 14→18 second
= 2×12 = 24m

Triangle between 18→24 seconds.
6×12 / 2 = 36m

Answer 144 / 24 = 6 m/s

(4)

(c) Evaluate your answer to part (b).

Tick a box.

☑ underestimate ☐ exact ☐ overestimate

Comment The area for the first 14 seconds was under the curve

(1)

(Total 8 marks)

Iterative processes

Q1.

Here is a formula for an iterative process.

$$u_{n+1} = \frac{24}{u_n} + 4$$

$u_2 = 8$

Work out the values of u_1 and u_3

$u_3 = \frac{24}{u_2} + 4$

$= \frac{24}{8} + 4$

$= 3 + 4$

$= 7$

$u_2 = \frac{24}{u_1} + 4$

$8 = \frac{24}{u_1} + 4$

$-4 \qquad -4$

$4 = \frac{24}{u_1}$

$4u_1 = 24$

$u_1 = 6$

$u_1 =$ 6 $u_3 =$ 7

(Total 3 marks)

Q2.

Rick borrows £1500 from a bank.

He pays back £100 each month.

This iterative formula works out the amount he still owes at the end of each month.

$$A_{n+1} = 1.02 \times A_n - 100$$

$A_0 = 1500$

Work out the amount he still owes at the end of the 2nd month.

$A_1 = 1.02 \times A_0 - 100$

$= 1.02 \times 1500 - 100 = 1430$

$A_2 = 1.02 \times 1430 - 100 = 1358.6$

Answer £ 1358.60

(Total 3 marks)

Q3.

An approximate value of a root of an equation, x, can be found using the iterative formula

$$x_{n+1} = \sqrt[3]{5(x_n)^2 - 2x_n - 3}$$

The starting value is $x_1 = 4$

(a) Work out the values of x_2 and x_3

$x_2 = \sqrt[3]{5(4)^2 - 2 \times 4 - 3}$

$= 4.10156593$

$x_2 =$ 4.10156593

$x_3 =$ 4.17764148

Use the 'ANS' button

(2)

(b) By continuing the iteration, show that the value of x is more than 4.25

repeated iterations show that to 2dp the solution is 4.39 (> 4.25)

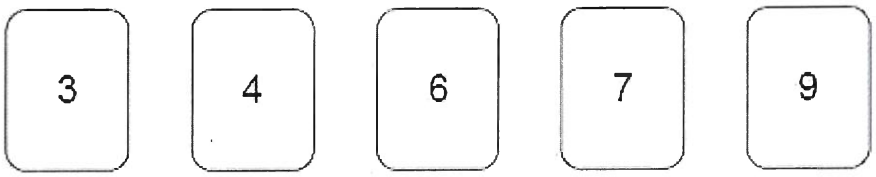
(1)

(Total 3 marks)

Product rule for counting

Q1.

Sofia makes 5-digit numbers using all of these cards.



How many different **even** numbers can she make?

Last digit → 2 options (4 or 6)
1st digit → 4 options
2nd digit → 3 options
3rd digit → 2 options
4th digit → 1 option

2 × 4 × 3 × 2 × 1
= 48

Answer 48

(Total 3 marks)

Q2.

Fatima is choosing a 4-digit code.

Each digit is a whole number from 0 to 9

She decides

all her digits will be odd numbers

no digits will be repeated.

How many different codes can she make?

_ _ _ _
5 × 4 × 3 × 2
5 options
(1, 3, 5, 7, 9

5 × 4 × 3 × 2 = 120

Answer 120

(Total 2 marks)

Q3.

A vending machine has a different item in each section.

It sells

7 drinks, 3 of which are juice

5 snacks, 2 of which are fruit bars

11 meals, 4 of which are salad.

One drink, one snack and one meal are chosen at random.

Show that the probability of getting a juice, a fruit bar and a salad is **more** than 5%

$\frac{3}{7} \times \frac{2}{5} \times \frac{4}{11} = \frac{24}{385} = 0.0623376\ldots$

$\times 100$

$= 6.2\%$

$> 5\%$

(Total 3 marks)

Proportion questions

Q1.

H is inversely proportional to the cube root of L.

$H = 7$ when $L = 64$

(a) Work out an equation connecting H and L.

$H = \frac{K}{\sqrt[3]{L}}$

$7 = \frac{K}{\sqrt[3]{64}}$

$7 = \frac{K}{4} \rightarrow K = 28$

$H = \frac{28}{\sqrt[3]{L}}$

Answer _____

(3)

(b) Work out the value of H when $L = 2744$

$H = \frac{28}{\sqrt[3]{2744}} = 2$

$H =$ 2

(2)

(Total 5 marks)

Q2.

A stone falls vertically from 300 metres above ground.

- The stone falls d metres in t seconds.
- d is directly proportional to the square of t.
- The stone falls 20 metres in the first 2 seconds.

Work out the **total** time taken for the stone to reach the ground.

$d = k \times t^2$

$20 = k \times 2^2$

$20 = k \times 4$

$k = 5$

$300 = 5 \times t^2$

$60 = t^2$

$t = \sqrt{60}$

$= 7.7$ seconds

Answer 7.7 seconds

(Total 4 marks)

Q3.

P, Q, and R have positive values.

P is directly proportional to Q

When $P = 8$, $Q = 2$

R is inversely proportional to Q^2

When $R = 10$, $Q = 3$

Work out the value of R when $P = 0.5$

$P = kQ$

$8 = k \times 2$

$k = 4$

$P = 4Q$

$P = 0.5$

$0.5 = 4Q$

$0.125 = Q$

$R = \frac{k}{Q^2}$

$10 = \frac{k}{3^2}$

$10 = \frac{k}{9}$

$k = 90$

$R = \frac{90}{Q^2}$

$R = \frac{90}{0.125^2}$

$= 5760$

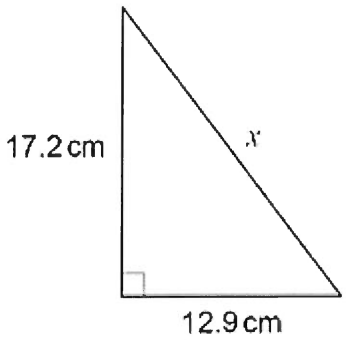
$R =$ 5760

(Total 5 marks)

Pythagoras

Q1.

Use Pythagoras' theorem to work out the value of x.



add

Not drawn accurately

$17.2^2 + 12.9^2 = 462.25$

$\sqrt{462.25} = 21.5$

$x =$ 21.5 cm

(Total 3 marks)

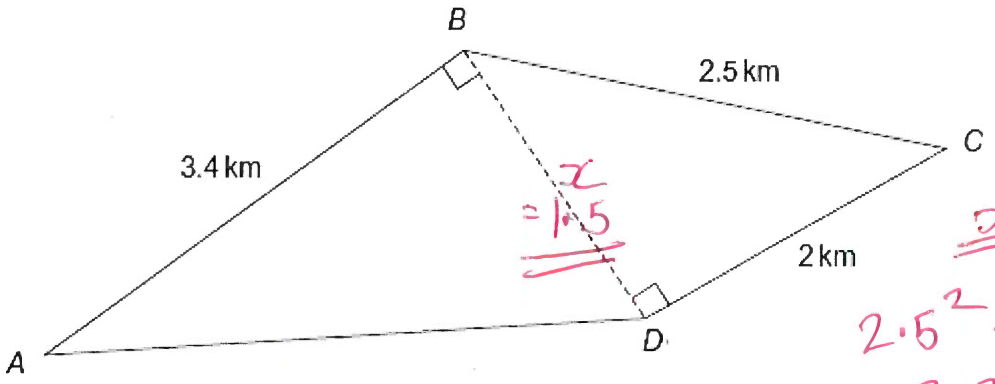
Q2.

A runner starts at *A*.
She follows this route.

$A \rightarrow B \rightarrow C \rightarrow D \rightarrow A$

Three of the distances are shown on the diagram.

Not drawn accurately



Work out the distance, in kilometres, from *D* to *A*.

x

$2.5^2 - 2^2$

$= 2.25$

$\sqrt{2.25} = 1.5$

$1.5^2 + 3.4^2 = 13.81$

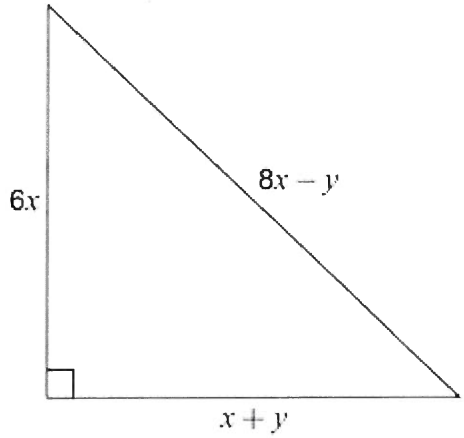
$\sqrt{13.81} = 3.716188...$

Answer 3.7 km

(Total 5 marks)

Q3.

The diagram shows a right-angled triangle.



Not drawn accurately

	x	y
x	x^2	xy
y	xy	y^2

$x^2 + 2xy + y^2$

	$8x$	$-y$
$8x$	$64x^2$	$-8xy$
$-y$	$-8xy$	$+y^2$

$64x^2 - 16xy + y^2$

Prove algebraically that $x : y = 2 : 3$

$(6x)^2 + (x+y)^2 = (8x-y)^2$

$36x^2 + x^2 + 2xy + y^2 = 64x^2 - 16xy + y^2$

$37x^2 + 2xy + y^2 = 64x^2 - 16xy + y^2$

$0 = 27x^2 - 18xy$

$0 = 9x(3x - 2y)$

So

$9x = 0$ → not possible (x can't be 0)

$3x - 2y = 0 \Rightarrow 3x = 2y$

$\therefore x : y = 2 : 3$

(Total 6 marks)

NOT $x : y = 3 : 2$ ✗

Quadratic formula

Q1.

Solve $3x^2 + 5x - 9 = 0$

Give your solutions as decimals.

Quadratic formula (given on sheet in exam)

$a=3 \quad b=5 \quad c=-9$

$$x = \frac{-5 \pm \sqrt{5^2 - 4 \times 3 \times (-9)}}{2 \times 3}$$

1 decimal place is fine

Answer 1.1 and −2.8

(Total 2 marks)

Q2.

$(x-9) = \dfrac{2(6-x^2)}{x+3}$ and $x = \dfrac{d \pm \sqrt{e}}{f}$

	x	$+3$
x	x^2	$3x$
-9	$-9x$	-27

$x^2 - 6x - 27$

Work out one set of possible values for d, e and f

$(x+3)(x-9) = 2(6-x^2)$

$x^2 - 6x - 27 = 12 - 2x^2$ $\quad +2x^2$

$3x^2 - 6x - 27 = 12$ $\quad -12$

$3x^2 - 6x - 39 = 0$ $\quad \div 3$

$x^2 - 2x - 13 = 0$

$a=1$

$b=-2$

$c=-13$

Quad formula gives:

$1 + \sqrt{14}$

or $1 - \sqrt{14}$

$d =$ 1

$e =$ 14

$f =$ 1

(Total 4 marks)

Q3.

Solve $4x^2 + 7x - 3 = 0$

Give your answers to 2 decimal places.

$x =$ 0.36, −2.11

(Total 3 marks)

Random number questions

Q1.

Write a number in each box to make the calculations correct.

left to right

10	÷	−2	×	−1	=	5
$\frac{1}{3}$	×	4π	×	6	=	8π

−5

$\frac{1}{3} \times 6 = 2$ $\quad 2 \times 4\pi = 8\pi$

(Total 2 marks)

Q2.

a and b are different prime numbers.

$a^3 \times b^2 = 200$

Work out the value of $a^4 \times b$

$200 = 2^3 \times 5^2$

100 × 2

2 × 50

2 × 25

5 × 5

$a = 2$ $b = 5$

$a^4 \times b$

$= 2^4 \times 5$

$= 16 \times 5$

$= 80$

Answer 80

(Total 3 marks)

Q3.

The first two cube numbers are 1 and 8

Show that

the 3rd cube number can be written as the sum of three different prime numbers.

2 factors

2 13
3 17
5 19
7 23
11 29

$3^3 = 27$

27 = 3 + 5 + 19

There may be more possibilities e.g. (17+7+3)

(Total 3 marks)

Q4.

k is a whole number between 40 and 50

The cube root of k is 3, to the nearest whole number.

Work out the **largest** possible value of k.

$k =$

$\sqrt[3]{27} = 3$

$\sqrt[3]{64} = 4$

$\sqrt[3]{40} = 3.41$ $\sqrt[3]{43} = 3.50$ ✗

$\sqrt[3]{41} = 3.44$

$\sqrt[3]{42} = 3.47$ ✓

Answer 42

(Total 2 marks)

Q5.

Work out $\dfrac{4^6 - 11}{\sqrt{625} - 225}$

Type as it appears into calc - start with fraction button

Circle your answer.

−61.6 −20.425 204.25 3870.56

(Total 1 mark)

Q6.

Circle the reciprocal of 8^5

$\frac{1}{8^5} = 8^{-5}$

8^{-5} 5^{-8} -8^5 5^8

(Total 1 mark)

Q7.

Circle the largest number.

$0.\dot{5}$ 0.55 0.545 $0.5\dot{4}\dot{5}$

0.5555 0.55 0.545 0.54545

(Total 1 mark)

Q8.

$a^b = 3$ where a is an integer and b is a proper fraction.

Work out **one** possible pair of values of a and b.

$9^{\frac{1}{2}} = 3 \quad (\sqrt{9} = 3)$

OR

$27^{\frac{1}{3}} = 3 \quad (\sqrt[3]{27} = 3)$

OR

$81^{\frac{1}{4}} = 3$ etc...

$a =$ 9 $b =$ $\frac{1}{2}$

(Total 1 mark)

Q9.

Work out

cube root of 512 : reciprocal of 0.4

$\sqrt[3]{512} = 8$

$\frac{1}{0.4} = 2.5$

Give your answer in the form n : 1

8 : 2.5

÷2.5 3.2 : 1 ÷2.5

Answer 3.2 : 1

(Total 3 marks)

Repeated percentage change

Q1.

£1800 is invested at 4% compound interest per year.

How many years will it take for the investment to be worth £2000?

$1800 \times 1.04^2 = 1946.88$

$1800 \times 1.04^3 = 2024.7552$

Answer 3 years

(Total 4 marks)

Q2.

The population of a country is now 67 200 000

The population is predicted to

increase by 1% per year for 6 years

and then

decrease by 1.2% per year for 2 years.

100 + 1 = 101
÷100 = 1.01

100 − 1.2 = 98.8
÷100
= 0.988

Work out the predicted population of the country 8 years from now.

Give your answer to 3 significant figures.

$67200000 \times 1.01^6 \times 0.988^2$

$= 69632406.54$

Answer 69600 000

(Total 4 marks)

Q3.

The value of a new car is £18 000

The value of the car decreases by

25% in the first year 0.75

12% in each of the next 4 years. 0.88

Work out the value of the car after 5 years.

$18000 \times 0.75 \times 0.88^4$

$= 8095.89$

Answer £ 8095.89

(Total 3 marks)

Reverse percentages

Q1.

Greg and Hanna want to know if students at their school think lunchtime clubs are important.

Here are Hanna's results.

- 62% answered Important.
- 24% answered Not Important.
- The rest answered Don't Know.

62 + 24 = 86
100 − 86 = 14%

93 students answered Important.

How many students answered Don't Know?

62% → 93 students
÷62
1% → 1·5 students.
×14
14% → 21 students.

Answer _____

(Total 3 marks)

Q2.

I increase a number by 24%
The answer is 6014.

What number did I start with?

$x \times 1{\cdot}24 = 6014$
$x = 6014 \div 1{\cdot}24$
$= 4850$

OR 124% → 6014
÷124 1% → 48·5 ÷124
×100 100% → 4850 ×100

Answer 4850

(Total 3 marks)

Q3.

It is estimated that there are 7 500 000 000 000 000 000 grains of sand on the world's beaches.

(Source University of Hawaii)

(a) Write this number in standard form.

Answer 7.5×10^{18}

(1)

(b) This number is 10% higher than the previous estimate.

Calculate the previous estimate.
Give your answer in standard form to two significant figures.

110% → 7.5×10^{18}

÷110 1% ÷110

×100 $6.818181\ldots \times 10^{18}$ ×100

Answer 6.8×10^{18}

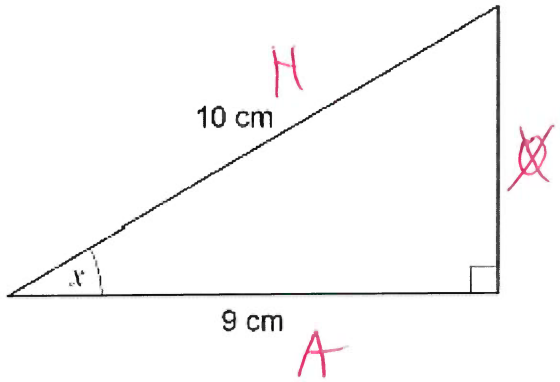
(3)

(Total 4 marks)

Right angle triangle trigonometry

Q1.

Use trigonometry to work out the size of angle x.



Not drawn accurately

$\cos x = \frac{9}{10}$

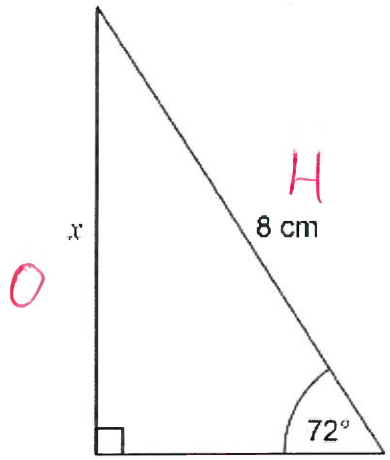
$x = \cos^{-1}\left(\frac{9}{10}\right)$

Answer 25.8° degrees

(Total 2 marks)

Q2.

Use trigonometry to work out the length x.



Not drawn accurately

H

O

$\sin 72 = \frac{x}{8}$

$8 \times \sin 72 = x$

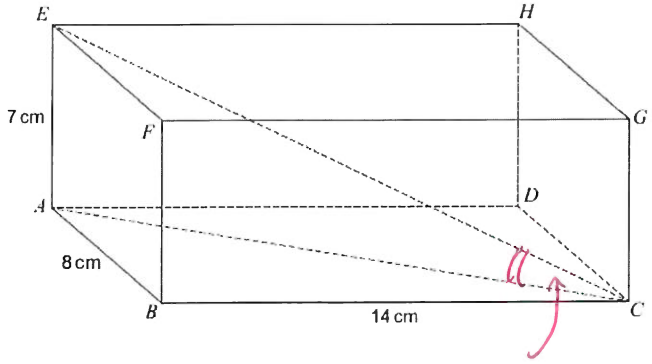
$x = 7.6$

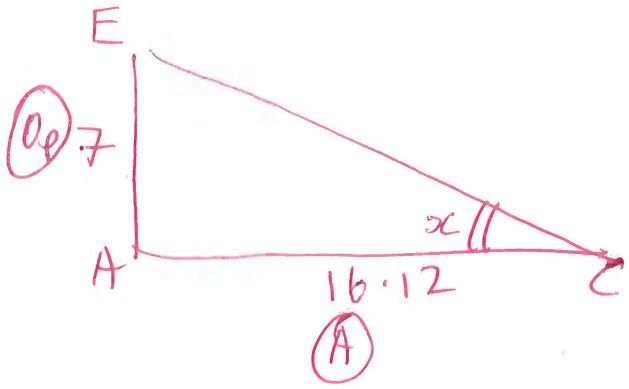
Answer 7.6 cm

(Total 2 marks)

Q3.

ABCDEFGH is a cuboid.





Work out the angle between EC and $ABCD$.

$AC \rightarrow 8^2 + 14^2 = 260$

$\sqrt{260} = 16{\cdot}12$

$\text{Tan}\, x^\circ = \frac{7}{16{\cdot}12}$

$x^\circ = \text{Tan}^{-1}\left(\frac{7}{16{\cdot}12}\right)$

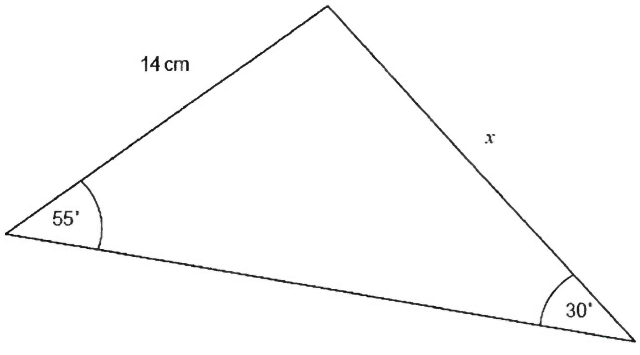
$= 23{\cdot}5$

Answer 23·5° degrees

(Total 3 marks)

Sine & Cosine rules

Q1.



Not drawn accurately

Work out the value of x

Sine rule

$\frac{x}{\sin 55} = \frac{14}{\sin 30}$ × sin 55

$x = \frac{14 \sin 55}{\sin 30}$

$= 22{\cdot}9$

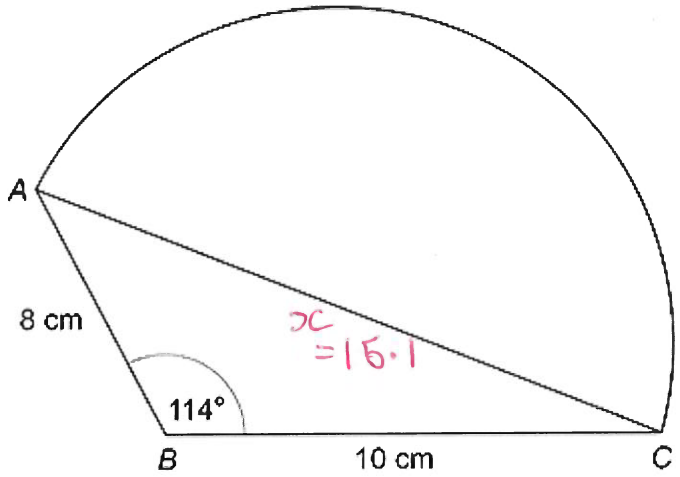
Answer 22.9 cm

(Total 2 marks)

Q2.

A shape is made by joining triangle *ABC* to a semicircle with diameter *AC*.

Not drawn accurately



Work out the **total** area of the shape.

AC → Cosine rule

$x^2 = 8^2 + 10^2 - 2 \times 8 \times 10 \times \cos 114$

$= 229.07...$

$\sqrt{229.07} = 15.1$ → Diameter

Area of Semicircle $= \pi \times \left(\frac{15.1}{2}\right)^2 = 179.9173328$

Area of triangle $= \frac{1}{2} \times 8 \times 10 \times \sin 114 = 36.54181831$

Total =

Answer 216.459 cm²

(Total 5 marks)

Q3.

The area of this triangle is 18cm²

6

12

Work out y.

Area $= \frac{1}{2} \times w \times 2w \times \sin 30$

$18 = \frac{1}{2} \times w \times 2w \times \frac{1}{2}$

$18 = \frac{w^2}{2}$

$36 = w^2$ $w = 6$ (or -6)

Cosine rule

$y^2 = 6^2 + 12^2 - 2 \times 6 \times 12 \times \cos 30$

$= 55.29...$

$\sqrt{55.29} = 7.435...$

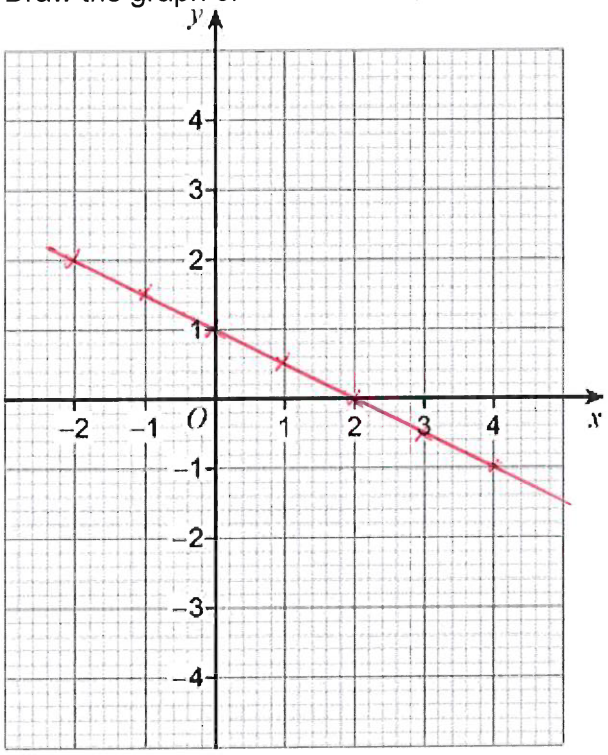
$y =$ 7.4 cm

(Total 5 marks)

Straight line graphs

Q1.

Draw the graph of $y = 1 - \frac{1}{2}x$ for values of x from –2 to 4



x	–2	–1	0	1	2	3	4
y	2	1·5	1	0·5	0	–0·5	–1

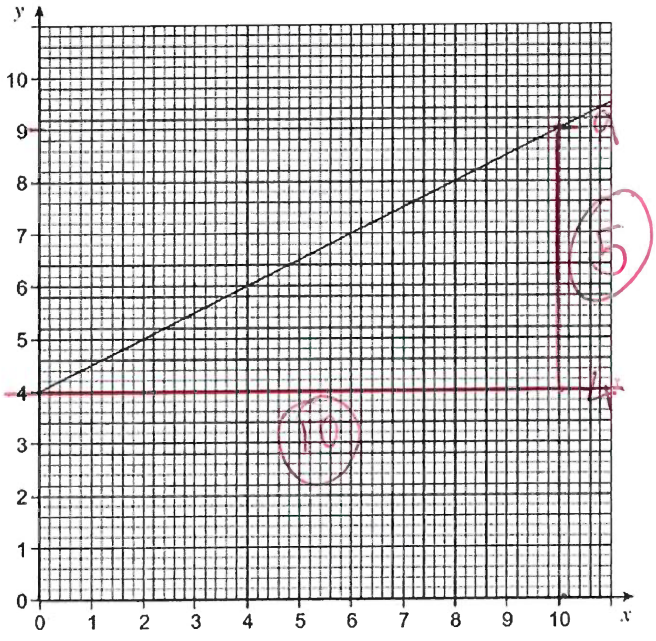
or gradient $= -\frac{1}{2}$

y intercept $= 1$

(Total 3 marks)

Q2.

Work out the equation of the line shown.



$y = mx + c$

gradient $= \frac{5}{10} = 0.5$

y intercept $= 4$

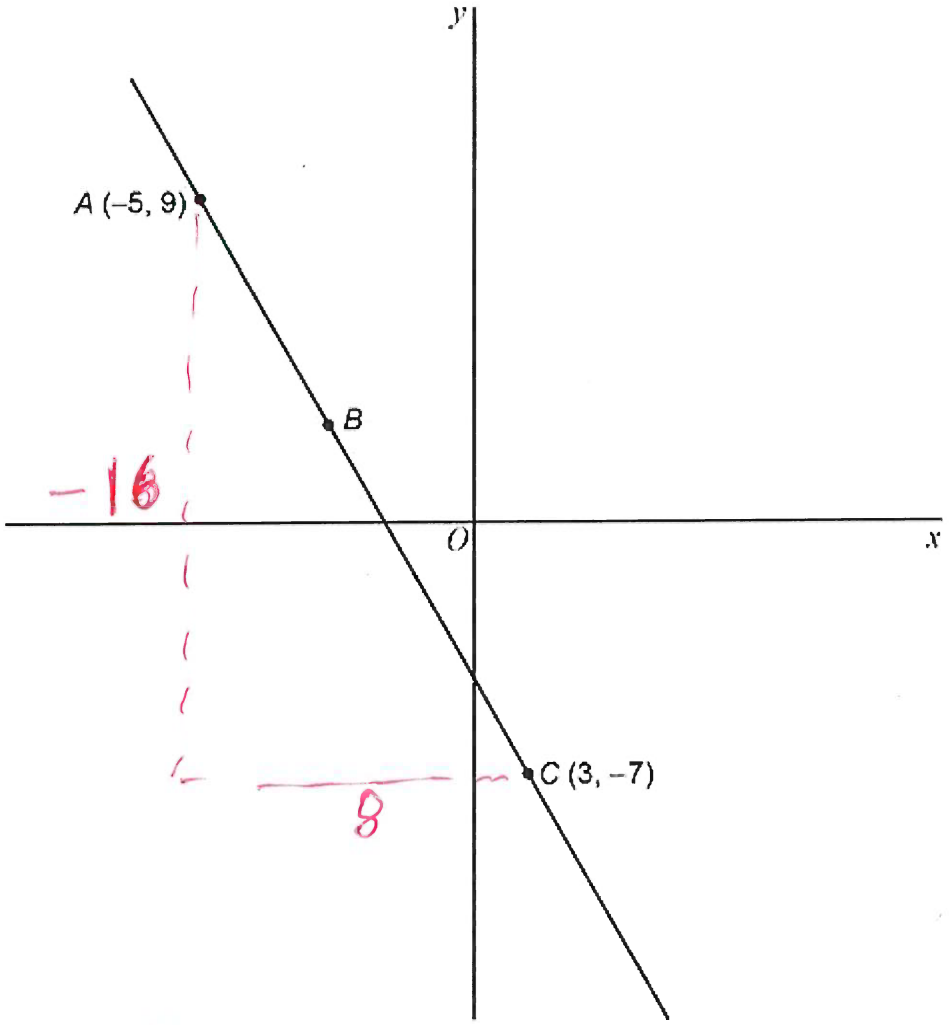
(c)

Answer $y = 0.5x + 4$

(Total 3 marks)

Q3.

A straight line passes through points A (–5, 9), B and C (3, –7).



Not drawn accurately

(a) $AB : BC = 1 : 3$

Work out the coordinates of point B.

1 : 3

x: –5 → 3 Distance = 8 → 2 : 6

–5 + 2 = –3

y: 9 → –7 Distance = 16 → 4 : 12

4 down from 1 = 5

Answer (–3 , 5)

(3)

(b) Work out the equation of the line perpendicular to AC that passes through C.

Gradient AC → –16 ÷ 8 = –2 (rise ÷ run)

Perpendicular gradient = $\frac{1}{2}$ (negative reciprocal)

$y = \frac{1}{2}x + c$ Sub in $x = 3$, $y = -7$

$-7 = \frac{1}{2} \times 3 + c$

$-7 = 1.5 + c$

$-1.5 \quad -8.5 = c \quad -1.5$

Answer $y = \frac{1}{2}x - 8.5$

(4)

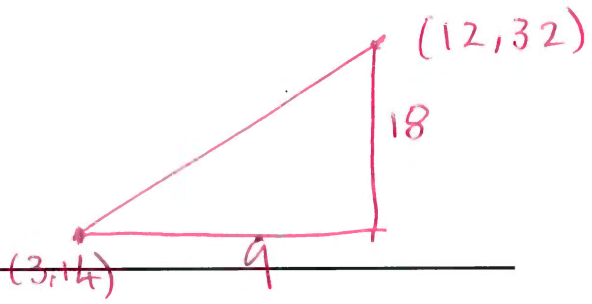
(Total 7 marks)

Q4.

A straight line passes through (3, 14) and (12, 32)

Work out the equation of the line.

Give your answer in the form $y = mx + c$



Gradient $= \frac{18}{9} = 2$

$y = 2x + c$ → Sub in either coordinate

$14 = 2 \times 3 + c$

$14 = 6 + c$

$c = 8$

Answer $y = 2x + 8$

(Total 3 marks)

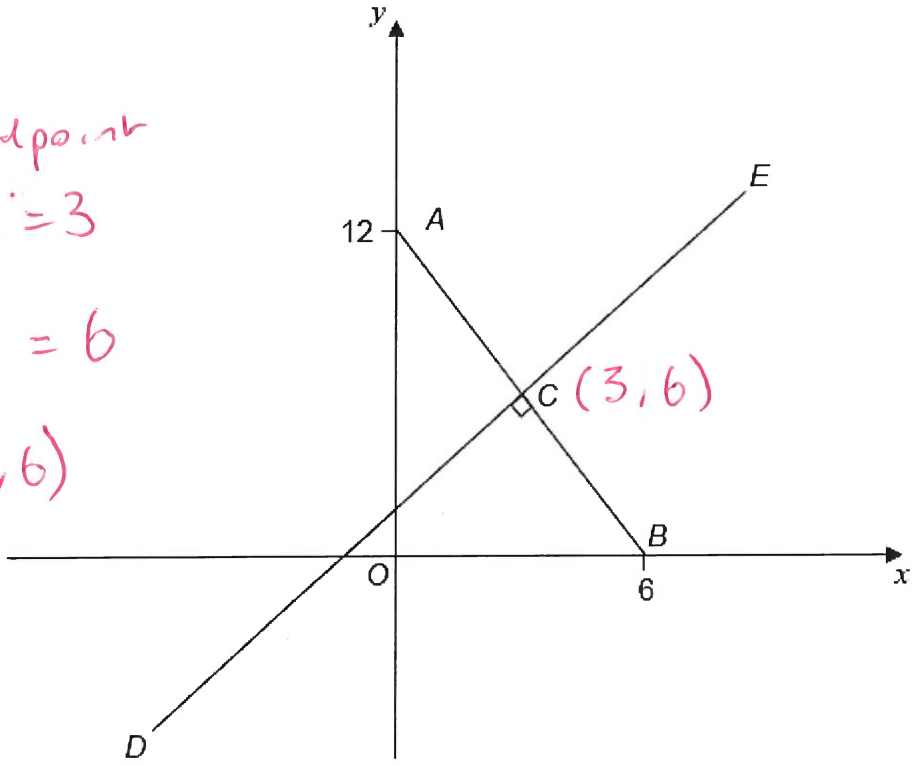
Q5.

ACB is a straight line.

A is the point (0, 12), and *B* is the point (6, 0)

C is the midpoint of *AB*.

Line *DCE* is perpendicular to line *ACB*.



Not drawn accurately

C is midpoint

$\frac{0+6}{2} = 3$

$\frac{12+0}{2} = 6$

C (3, 6)

Work out the equation of line *DCE*.

Gradient of AB $= -12 \div 6 = -2$

~~$y = 2x$~~ Gradient of DCE $= \frac{1}{2}$ (negative reciprocal)

$y = \frac{1}{2}x + c$ sub in (3, 6)

$6 = \frac{1}{2} \times 3 + c$

$6 = 1.5 + c$

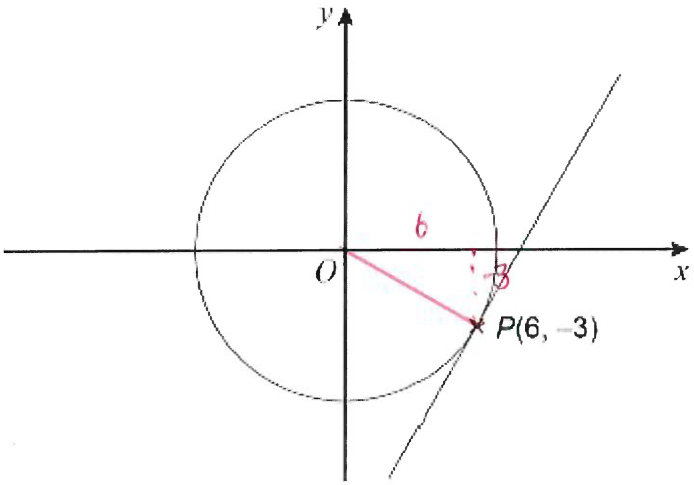
$c = 4.5$

Answer $y = \frac{1}{2}x + 4.5$

(Total 5 marks)

Q6.

A circle with centre O and radius $\sqrt{45}$ has a tangent drawn at point $P(6, -3)$



Not drawn accurately

Work out the equation of the **tangent**.

Give your answer in the form $y = mx + c$

Gradient of radius $= \frac{-3}{6} = -\frac{1}{2}$

Gradient of tangent $= 2$

$y = 2x + c$

Sub in $(6, -3)$

$-3 = 2 \times 6 + c$

$-3 = 12 + c$

$-15 = c$

$y = 2x - 15$

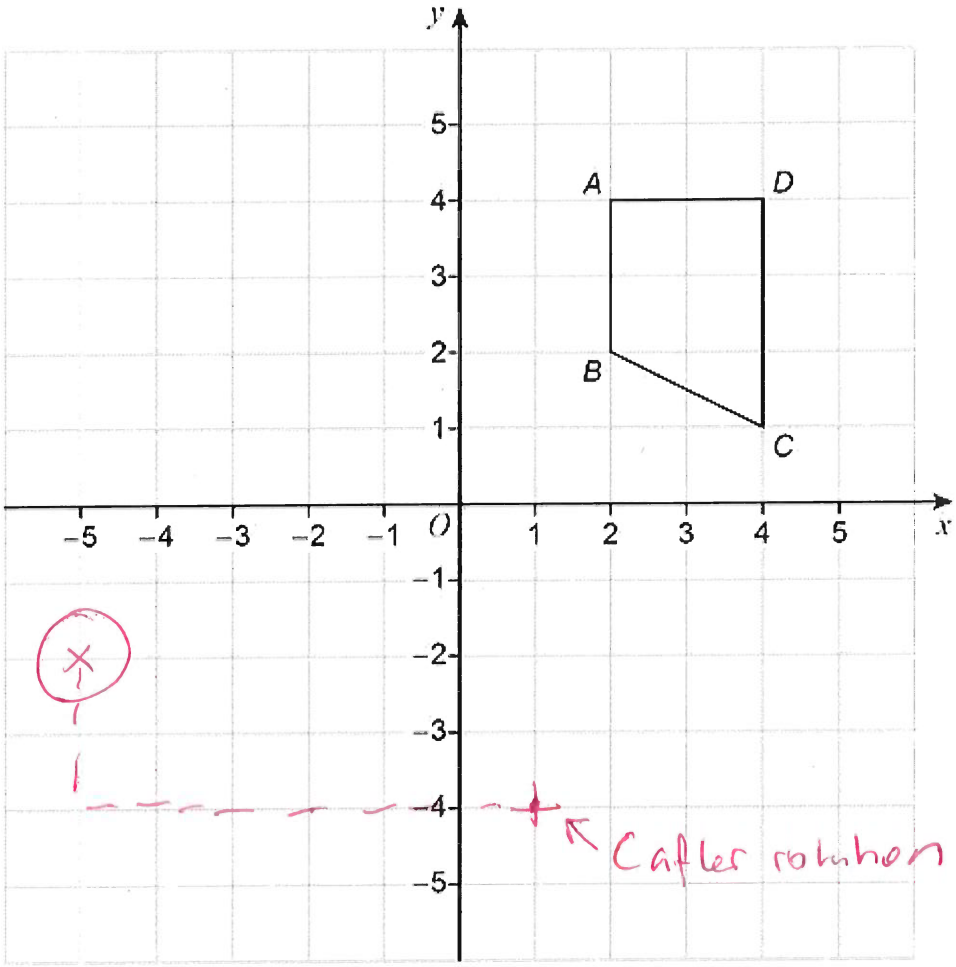
Answer _____

(Total 4 marks)

Transformations

Q1.

Quadrilateral *ABCD* is shown.



Work out the coordinates of *C* when *ABCD* is

rotated 90° clockwise about *O*

then

translated by $\begin{pmatrix} -6 \\ 2 \end{pmatrix}$

Use tracing paper if you like.

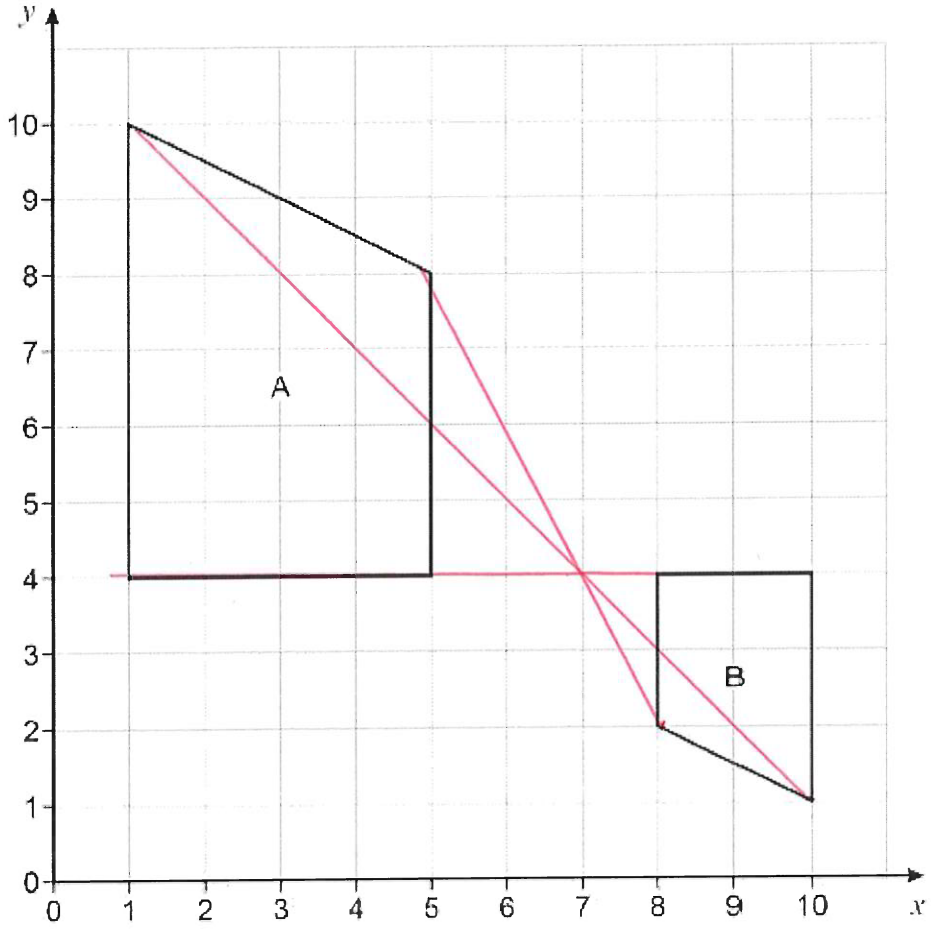
After rotation

Answer (-5 , -2)

(Total 2 marks)

Q2.

Shape A and shape B are shown on the grid.



Describe the **single** transformation that maps shape A to shape B.

Enlargement

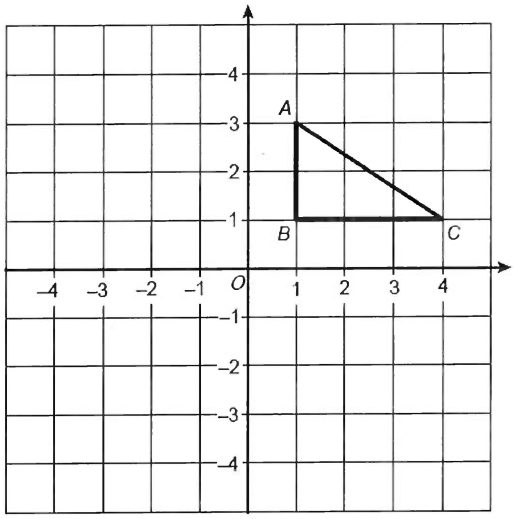
Scale factor $-\frac{1}{2}$

Centre (7, 4)

(Total 3 marks)

Q3.

(a) Here is triangle *ABC*.



Describe fully a **single** transformation of the triangle for which

all points on *AB* are invariant

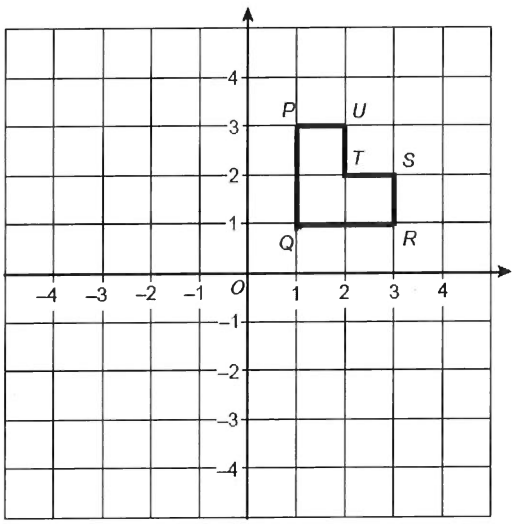
there are no other invariant points.

Invariant means they don't change.

reflection in line $x = 1$

(1)

(b) Here is an L-shape *PQRSTU*.



Describe fully a **single** transformation of the L-shape for which

Q is invariant

the line joining *P* and *Q* becomes horizontal

the area of the L-shape does not change.

Rotation centre (1, 1) 90° clockwise (or anticlockwise

OR reflection in line $x + y = 2$

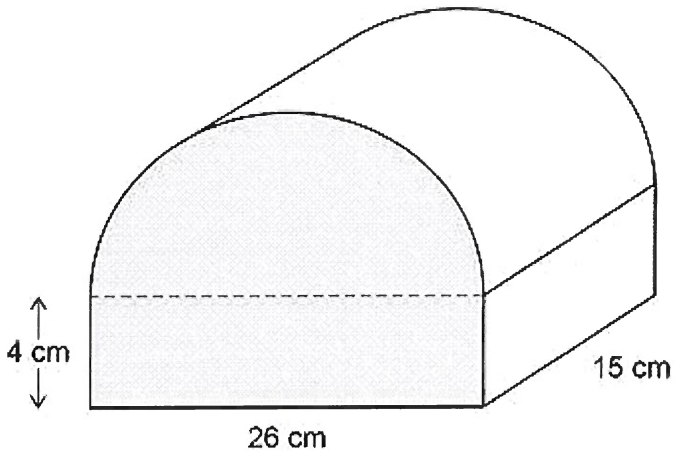
(2)

(Total 3 marks)

Volume of 3D shapes

Q1.

A box is the shape of half a cylinder on top of a cuboid.



Work out the volume of the box.

Area of cross section $= 26 \times 4 + \frac{\pi \times 13^2}{2}$

$= 369$

$\times 15$

$=$

Answer 5541.968688 cm³

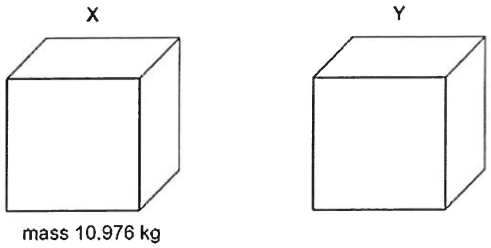
(Total 4 marks)

Q2.

Here are two solid cubes, X and Y.

The mass of X is 10.976 kg → = 10976 g

The area of **each face** of X is 784 cm²



(a) Zayan wants to know the density of Y.

He assumes that Y is identical to X.

$D = \frac{m}{V}$

What density should he get for Y?

Give your answer in **grams per cubic centimetre**.

Area of Square = 784

length of side = 28

Vol of cube = 21952

= ~~10.976 kg~~

= 10976 / 21952

= $\frac{1}{2}$

Answer 0.5 g/cm³

(4)

(b) In fact,

the mass of Y is less than the mass of X → ~~bigger mass~~

the area of each face of Y is greater than the area of each face of X.

What does this mean about the actual density of Y?

Tick **one** box.

Smaller mass for Y
bigger volume
So less dense

- [x] It is less than the answer to part (a)
- [ ] It is equal to the answer to part (a)
- [ ] It is greater than the answer to part (a)
- [ ] It is not possible to tell

(1)

(Total 5 marks)

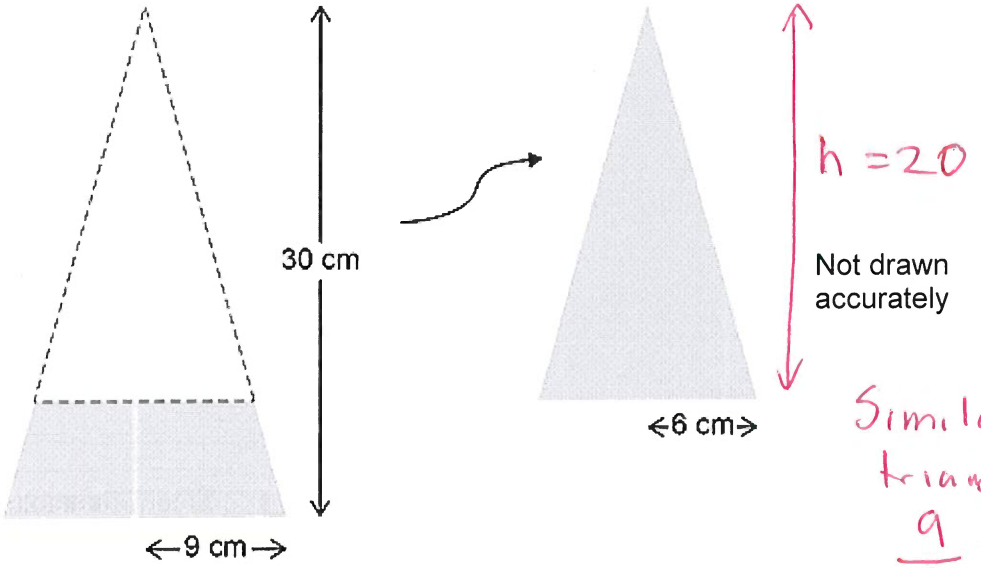
Q3.

Alec makes a bowl for dog food from a solid wooden cone.

The sketches show how the bowl is made.

The cone has radius 9 cm and perpendicular height 30 cm

A smaller cone, with radius 6 cm, is removed.



Similar triangles.

$\frac{9}{6} = \frac{30}{h}$

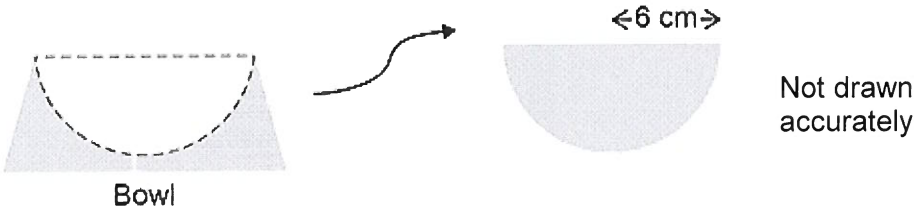
$1.5 = \frac{30}{h}$

$h = \frac{30}{1.5}$

$= 20$

Volume of a cone = $\frac{1}{3}\pi r^2 h$
where r is the radius and h is the perpendicular height

A hemisphere with radius 6 cm is then removed.



Volume of a hemisphere = $\frac{2}{3}\pi r^3$ where r is the radius

Work out the volume of the remaining wood that forms the bowl.

[0]

$Vol = \frac{1}{3}\pi \times 9^2 \times 30 - \frac{1}{3} \times \pi \times 6^2 \times 20$

$= 1790.7 \quad (570\pi)$

$\frac{2}{3} \times \pi \times 6^3 = 144\pi$

$570\pi - 144\pi$

$= 426\pi$

$= 1338.3 \text{ cm}^3$

Answer _____ cm^3

(Total 5 marks)

Q4.

Curved surface area of a cone = πrl where r is the radius and l is the slant height.

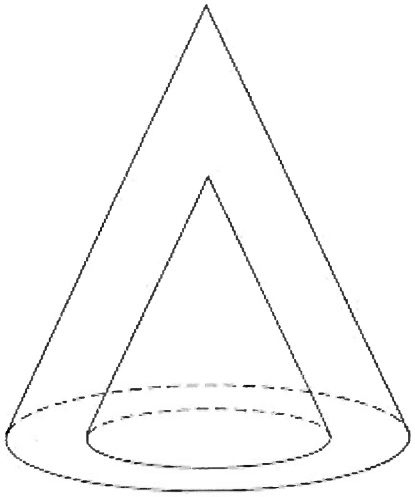
The diagram shows a hollow cone made from thick glass.

The radius of the **outer** cone is 10 cm

The slant height of the **outer** cone is 25 cm

The radius of the **inner** cone is 5 cm

The slant height of the **inner** cone is 12.5 cm



Curved SA = $\pi \times r \times L$

Work out the **total** surface area of the glass.

Big cone = $\pi \times 10 \times 25 = 250\pi$

Small cone = $\pi \times 5 \times 12.5 = 62.5\pi$

Hoop on base = $\pi \times 10^2 - \pi \times 5^2$

$= 75\pi$

$250\pi + 62.5\pi + 75\pi$

$= 387.5\pi$

Answer _____ cm^2

(Total 5 marks)