Answer ALL TWENTY FOUR questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

1 Here are some integers where $a < b < c < d$

$a \quad b \quad c \quad d \quad d \quad d$

The mode of the integers is 9
The median of the integers is 8
The range of the integers is 4

Work out the value of a, the value of b, the value of c and the value of d (3)

mode is most common value : $d = 9$ *

Median is middle value (and numbers are ordered):

a b c 9 9 9

$Q_2 = \frac{1}{2}(c+9) = 8$ *

$c + 9 = 16$

$c = 7$

Range = largest − smallest

$d - a = 9 - a = 4$ *

$a = 5$

$a < b < c \Rightarrow 5 < b < 7$

$\Rightarrow b = 6$

*: M1 any 1 of these

2nd M1 at least 2 of these (or 2 of a, c, d ✓)

A1: all ✓

$a =$ 5

$b =$ 6

$c =$ 7

$d =$ 9

(Total for Question 1 is 3 marks)

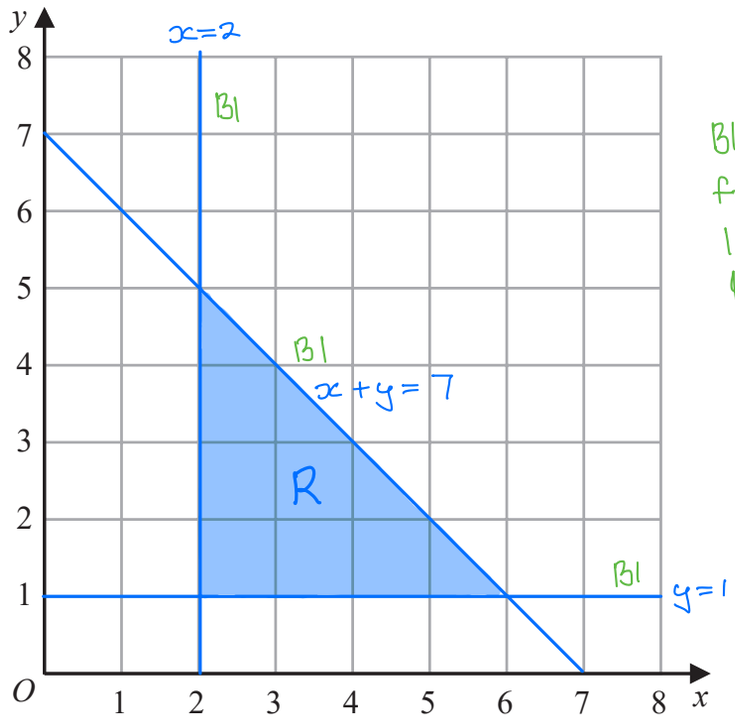
2 (a) On the grid, draw and label with its equation the straight line with equation

(i) $y = 1$ (ii) $x = 2$ (iii) $x + y = 7$

all y coordinates $= 1$

all x coordinates $= 2$

$x + y$ coordinates add to 7
eg (0,7) (2,5) (4,3) (7,0) etc



B1 region
ft only 1 horizontal, 1 vertical & 1 diagonal line with −ve gradient

4

(3)

(b) Show, by shading on the grid, the region that satisfies **all three** of the inequalities

$y \geqslant 1$ $x \geqslant 2$ $x + y \leqslant 7$

above line right of line below line

Label the region **R**.

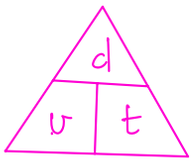
(1)

(Total for Question 2 is 4 marks)

3 An aeroplane travelled from New York City to Los Angeles.

The aeroplane travelled a distance of 3980 kilometres in 5 hours 24 minutes.

Work out the average speed of the aeroplane.
Give your answer in kilometres per hour correct to the nearest whole number.



Average speed = $\frac{\text{total distance}}{\text{total time}}$ (3)

24 minutes = $\frac{24}{60}$ hour

$= \frac{2}{5} = 0.4$ hour

$t = 5.4$ hours B1 (or $5\frac{24}{60}$ or $5\frac{2}{5}$) $\left(\frac{3980}{5.24} : \text{B0 M1}\right)$

$v = \frac{3980}{5.4}$ M1 (or $\frac{3980}{324} \times 60$ MUST be leading to v in km/h)

$\simeq 737$ km/h A1

737 kilometres per hour

(Total for Question 3 is 3 marks)

4 Show that $5\frac{1}{3} - 2\frac{6}{7} = 2\frac{10}{21}$

$5\frac{1}{3} - 2\frac{6}{7}$ Convert to improper fractions (can use calculator)

$= \frac{16}{3} \times \frac{7}{7} - \frac{20}{7} \times \frac{3}{3}$ M1

$= \frac{112}{21} - \frac{60}{21}$ M1 Need common denominator before subtracting

$= \frac{52}{21}$

(3)

$= 2\frac{10}{21}$ A1 (need $\frac{52}{21}$ as step)

(Total for Question 4 is 3 marks)

5 The diagram shows an 8-sided shape *ABCDEFGH*.

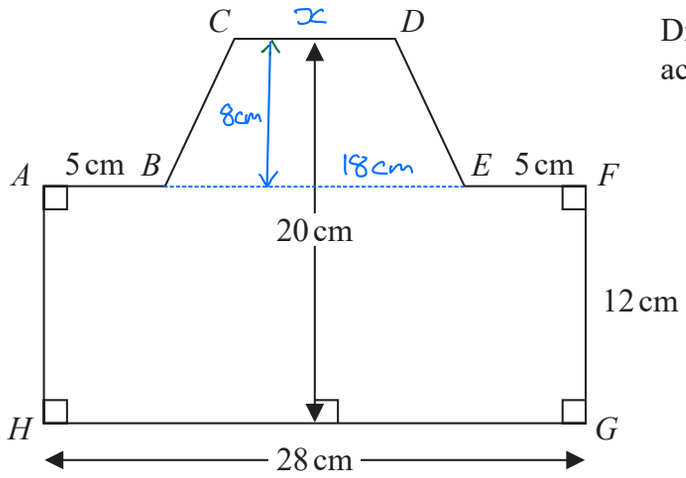


Diagram **NOT** accurately drawn

HG = 28 cm *FG* = 12 cm *AB* = *EF* = 5 cm
The height of the shape is 20 cm
CD is parallel to *HG*

(4)

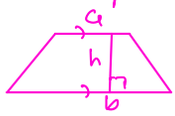
The area of shape *ABCDEFGH* is 434 cm^2

Find the length of *CD*. let CD = x

BE = 28 − 5 − 5 = 18 cm

vertical height trapezium BCDE = 20 − 12 = 8 cm

Area trapezium = $\frac{1}{2}(a+b)h$ on formula sheet



Total Area = Area rectangle AFGH + Area trapezium BCDE

$A = 28 \times 12 + \frac{1}{2}(18+x) \times 8 = 434$ M1: either

M1: correct use of values in equation involving CD (x)

$336 + 4(18+x) = 434$
-336 (expand) -336

$72 + 4x = 98$
-72 -72

M1: correct working to solve correct equation

$4x = 26$
$\div 4$ $\div 4$

$(CD =)\ x = \frac{13}{2} = 6.5$ cm
A1

6.5 cm

(Total for Question 5 is 4 marks)

6 The diagram shows triangle PQR.

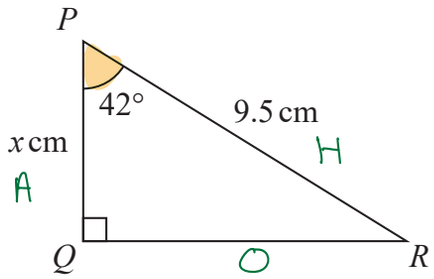


Diagram **NOT** accurately drawn

3

A? H✓ → "CAH"

$\cos\theta = \frac{A}{H}$

Work out the value of x
Give your answer correct to one decimal place.

$\cos 42^\circ = \frac{x}{9.5}$ M1

$\times 9.5 \qquad \times 9.5$

$x = 9.5\cos 42^\circ$ M1

$\simeq 7.1$ A1

$x =$ 7.1

(Total for Question 6 is 3 marks)

7 Change a speed of 81 kilometres per hour to a speed in metres per second.

3

1 km = 1000 m (×1000) 1 hour = 60 minutes = 60 × 60 s (×60×60)

$\frac{81 \text{ km}}{1 \text{ hour}} = \frac{81 \times 1000 \text{ m}}{1 \times 60 \times 60 \text{ s}}$ M1 × 1000 M1 ÷ (60×60) or 60×60 in denominator

$= \frac{45}{2} = 22.5$ m/s A1

22.5 metres per second

(Total for Question 7 is 3 marks)

8 Behnaz makes 300 celebration cards so that

5

number of birthday cards : number of anniversary cards : number of congratulations cards = 7 : 5 : 3

B : A : C

7 + 5 + 3 = 15

$\frac{2}{5}$ of the birthday cards have numbers on them.

→ $\frac{7}{15}$ of cards : B

36% of the anniversary cards have numbers on them.

$\frac{5}{15} = \frac{1}{3}$ of cards : A

None of the congratulations cards have numbers on them.

$\frac{3}{15} = \frac{1}{5}$ of cards : C

Work out what fraction of the 300 cards have numbers on them.
Give your answer in its simplest form.

M1 : 15 used ✓ (eg in fractions)

B : $\frac{7}{15} \times 300 = 140$

with numbers : $\frac{2}{5} \times 140 = 56$ M1

A : $\frac{1}{3} \times 300 = 100$

with numbers : $0.36 \times 100 = 36$ M1

36% = 0.36 (÷ 100)

total with numbers : $56 + 36 = 92$

fraction of cards with numbers : $\frac{92}{300}$ M1 unsimplified fraction

$= \frac{23}{75}$ A1

.....

(Total for Question 8 is 5 marks)

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9 Pasha invests 50 000 dollars in a savings account for 4 years.
He gets 1.3% per year compound interest.

3

Work out how much money Pasha will have in his savings account at the end of 4 years.
Give your answer correct to the nearest dollar.

+1.3% each year : 100 + 1.3 = 101.3% = 1.013

4 years : $50\,000 \times 1.013^4 \simeq 52\,651$ dollars (nearest dollar)

M2 A1

(M1 : 50000 x 1.013 or " x 0.013)

52 651 dollars

(Total for Question 9 is 3 marks)

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10 Solve the simultaneous equations

$$7x + 3y = 3 \quad (1)$$
$$3x - y = 7 \quad (2)$$

Show clear algebraic working.

Need coefficient of x or y same in both equations
↑ easier

$(2) \times 3$: $9x - 3y = 21$ (3)

(1) : $7x + 3y = 3$ (1)

opposite signs
⇒ ADD to cancel out

$(1)+(3)$: $16x = 24$

$x = \frac{24}{16} = \frac{3}{2} = 1.5$

in (2) : $3 \times 1.5 - y = 7$

$-y = 7 - 4.5 = 2.5$

$y = -2.5$

$x =$ 1.5

$y =$ −2.5

(Total for Question 10 is 3 marks)

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11 (i) Factorise $x^2 + 5x - 24$ $p+q = 5$ $pq = -24$

"−" $p+q$ have DIFFERENT signs

$24 = 1 \times 24$
$= 2 \times 12$
$= 3 \times 8$ ← difference = 5
$= 4 \times 6$

$p+q = +5$
⇒ $+8, -3$

$= (x+8)(x-3)$

M1 : $(x \pm 8)(x \pm 3)$
or $(x+a)(x+b)$
$ab = -24$ or $a+b = 5$

A1 $(x+8)(x-3)$

(2)

(ii) Hence, solve $x^2 + 5x - 24 = 0$

$x + 8 = 0$ $\quad x - 3 = 0$

$x = -8$ $\quad x = 3$

B1 ft (must follow from answer to i)

$-8, 3$

(1)

(Total for Question 11 is 3 marks)

12 Larry is a delivery man.

He has 7 parcels to deliver.
The mean weight of the 7 parcels is 2.7 kg

Larry delivers 3 of the parcels.
Each of these 3 parcels has a weight of W kg

The mean weight of the other 4 parcels is 3.3 kg

Work out the value of W

mean $= \bar{x} = \frac{\Sigma x}{n}$

$\Rightarrow \Sigma x = n \times \bar{x}$

(3)

7 parcels : $\bar{x} = 2.7$ kg total weight $= 7 \times 2.7$
$= 18.9$ kg

either

3 parcels weight W total weight $= 3W$

other 4 parcels $\bar{x} = 3.3$ kg total weight $= 4 \times 3.3$
$= 13.2$ kg

$\Rightarrow 3W = 18.9 - 13.2$
$= 5.7$

$W = \frac{5.7}{3}$ M1 $\frac{"18.9" - "13.2"}{3}$

$= 1.9$ A1

$W =$ 1.9

(Total for Question 12 is 3 marks)

13 The table gives information about the ages, in years, of 80 people in a train carriage.

Age (a years)	Frequency
$0 < a \leqslant 20$	7
$20 < a \leqslant 30$	25
$30 < a \leqslant 40$	20
$40 < a \leqslant 50$	14
$50 < a \leqslant 60$	8
$60 < a \leqslant 70$	6

7

(a) Complete the cumulative frequency table.

cf = "running total"

Age (a years)	Cumulative frequency
$0 < a \leqslant 20$	7
$0 < a \leqslant 30$	32
$0 < a \leqslant 40$	52
$0 < a \leqslant 50$	66
$0 < a \leqslant 60$	74
$0 < a \leqslant 70$	80

+25 +20 +14 +8 +6

B1

(1)

(b) On the grid opposite, draw a cumulative frequency graph for your table.

(2)

(c) Use your graph to find an estimate for the median age of the 80 people.

cf = 40 : age = 33

B1 33 ..... years

(1)

(32-34, ft graph)

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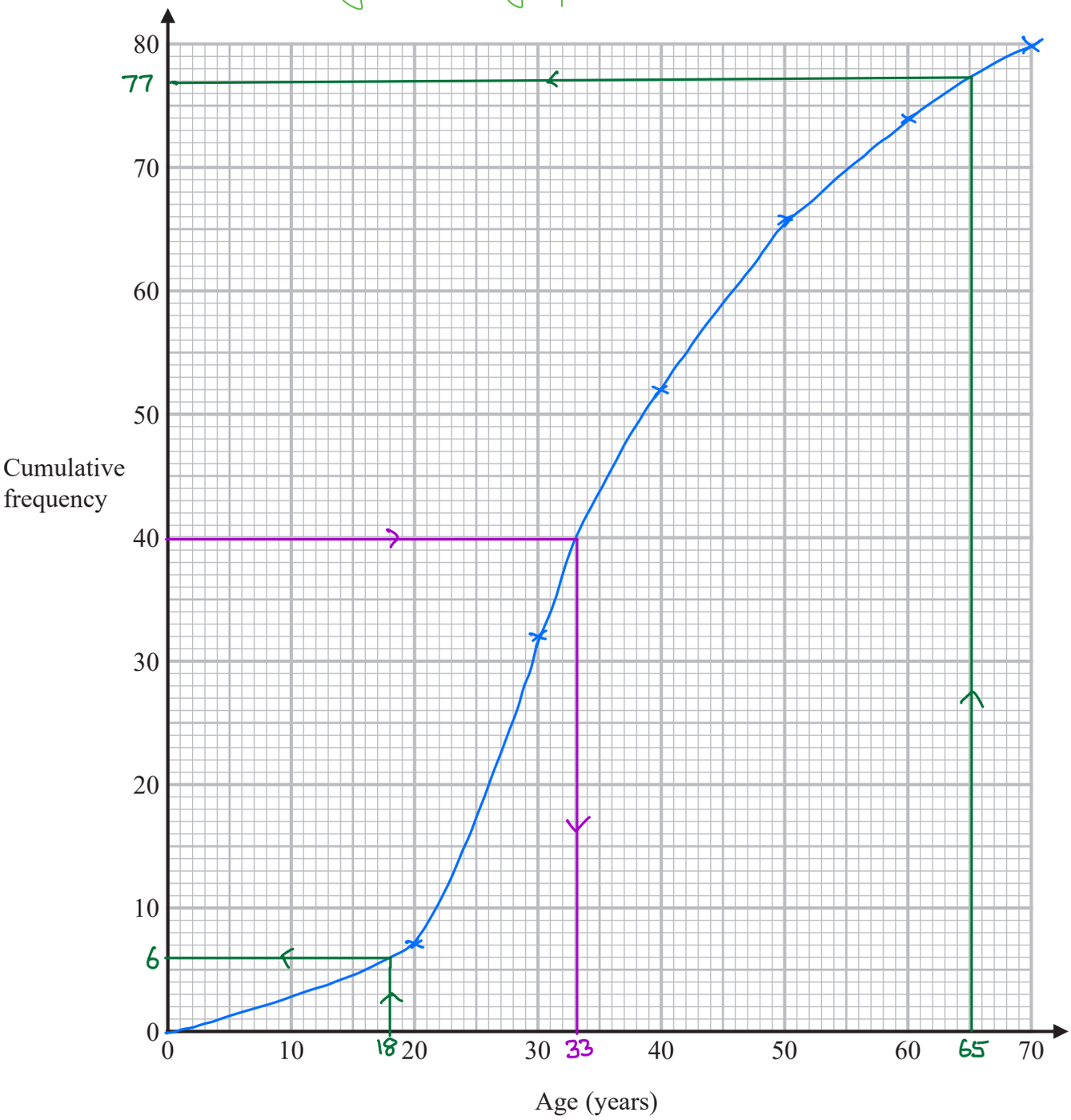
B1 : one error or points ✓ but not joined or points consistent within interval but not at upper boundary

B2 : fully correct graph



Of the people in the train carriage, 60% of those who are aged between 18 and 65 are going to work. None of the other people in the train carriage are going to work.

(d) Use your graph to find an estimate for the number of people in the train carriage who are going to work.

age = 18 : cf = 6
age = 65 : cf = 77
M1 readings at 18 & 65

77 − 6 = 71 people aged 18 - 65

to work : 0·6 × 71 = 42·6 M1 (60% of difference)

≃ 43 people A1 (must be integer, ft graph)

43

(3)

60% = 0·6 (÷ 100)

(Total for Question 13 is 7 marks)

14 (a) Expand and simplify $(5 - x)(2x + 3)(x + 4)$
Show your working clearly.

7

Expand first 2 brackets using FOIL

$(10x + 15 - 2x^2 - 3x)(x + 4)$ M1 (3✓) Collect x terms (& order)

$= (-2x^2 + 7x + 15)(x + 4)$ Multiply every term in 1st (...) by x, then by 4

$= -2x^3 + 7x^2 + 15x - 8x^2 + 28x + 60$ M1 (allow one error)

$= -2x^3 - x^2 + 43x + 60$ Collect terms in x and in x^2
A1 (dM1)

$-2x^3 - x^2 + 43x + 60$

(3)

(b) Make c the subject of $g = \dfrac{c + 3}{4 + c} - 7$

$g = \dfrac{c+3}{4+c} - 7$ M1 +7 both sides

$g + 7 = \dfrac{c+3}{4+c}$ $\times(4+c)$ both sides

Brackets essential: whole expression "g+7" multiplied by whole expression "4+c"

$(g+7)(4+c) = c+3$

$4g + cg + 28 + 7c = c + 3$ M1 Multiply out (...)(...) : "FOIL"

$cg + 7c - c = 3 - 4g - 28$ M1 Collect all "c" terms on one side & all other terms on other side

$cg + 6c = -4g - 25$ simplify

$c(g + 6) = -4g - 25$ take c out as factor on LHS

$c = \dfrac{-4g - 25}{g + 6}$ A1 (oe) $\div(g+6)$ both sides

$c = \dfrac{-4g - 25}{g + 6}$

(4)

(Total for Question 14 is 7 marks)

15 (a) Solve $\frac{4x+5}{3} - \frac{3-2x}{2} = 13$

Show clear algebraic working.

(4)

Multiply x 6 on both sides:

$-\frac{{}^{3}\cancel{6}(3-2x)}{\cancel{2}} = -3(3-2x)$

$\frac{{}^{2}\cancel{6}(4x+5)}{\cancel{3}} = 2(4x+5)$

$2(4x+5) - 3(3-2x) = 6 \times 13$ M1

$8x + 10 - 9 + 6x = 78$ M1 ft (dM1) Multiply out brackets

$14x + 1 = 78$

$14x = 77$ M1 ft (d previous M1)

$x = \frac{11}{2}$ $(= 5{\cdot}5)$ A1

$x = \frac{11}{2}$

(4)

(Total for Question 15 is 4 marks)

16 100 farmers are asked if they have goats (G), sheep (S) or chickens (C) on their farms.

(8)

Of these farmers

31 have sheep — S only : 31 − 5 − 6 − 11 = 9 } ③

53 have chickens — C only : 53 − 12 − 6 − 11 = 24 }

6 have goats, sheep and chickens ← in centre : all 3 ①

11 have sheep and goats 11 − 6 = 5 (no chickens) } ②

17 have sheep and chickens 17 − 6 = 11 (no goats) }

18 have goats and chickens 18 − 6 = 12 (no sheep) }

20 do not have any goats, sheep or chickens outside all circles ④

(a) Using this information, complete the Venn diagram to show the number of farmers in each appropriate subset.

Start from centre and work outwards

G only : 100 − 5 − 9 − 12 − 6 − 11 − 24 − 20 = 13

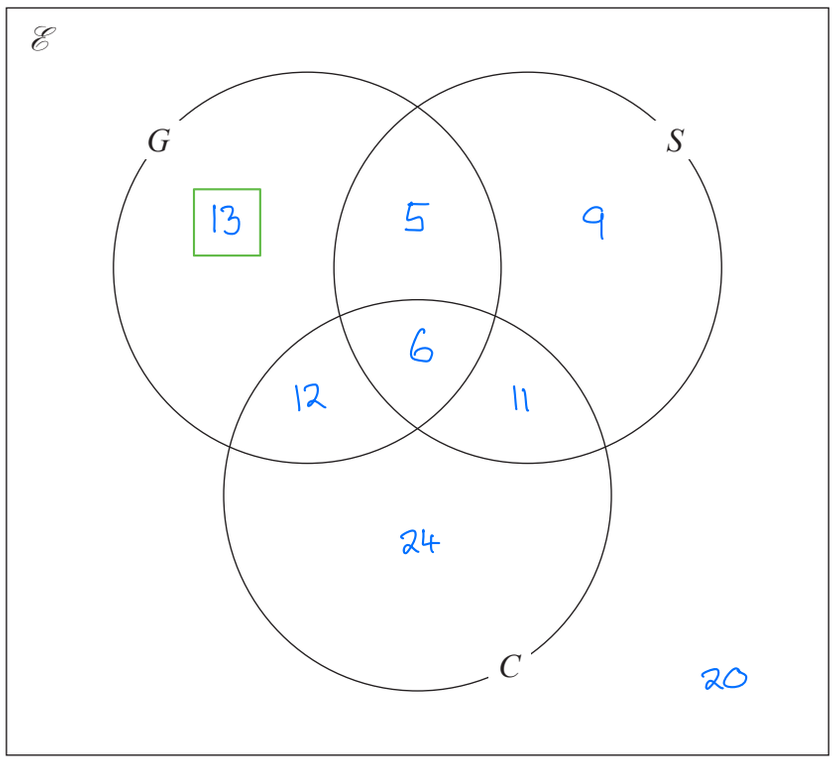
(total; subtract numbers in all other regions)

(B3 in total)

B1 : 13 in G only

B2 : all 7 others ✓

(B1 : 4–6 others ✓)



(3)

(b) Find

(i) n(G) $13 + 5 + 12 + 6 = 36$

(ii) n($[G \cup S]'$) not in (G or S)

ie not in either

$24 + 20 = 44$

(iii) n($G' \cap C$) chickens and not goats

$24 + 11 = 35$

ft diagram if values present in required regions

36 B1 (1)

44 B1 (1)

35 B1 (1)

One of the farmers who has chickens is chosen at random.

(c) Find the probability that this farmer also has goats.

$p = \frac{\text{no with goats and chickens}}{\text{no with chickens}} = \frac{18}{53}$

(B1 : $\frac{18}{m}$ $m > 18$ or $\frac{n}{53}$ $n < 53$)

$\frac{18}{53}$ B2 (2)

(Total for Question 16 is 8 marks)

17 M varies directly as the cube of h

$M = 4$ when $h = 0.5$

$M \propto h^3 \Rightarrow M = kh^3$ (4)

Find the value of h when $M = 500$

$4 = k \times 0.5^3$ M1 (or $M = kh^3$)

$k = \frac{4}{0.5^3}$ | M1 (either)

$= 32$

$\rightarrow M = 32h^3$

$M = 500$: $500 = 32h^3$

$h^3 = \frac{500}{32} = \frac{125}{8}$

$h = \sqrt[3]{\frac{125}{8}}$ M1

$= \frac{5}{2} = 2.5$ A1

2.5

(Total for Question 17 is 4 marks)

(3)

18 $X = \dfrac{2a - b}{f}$

$a = 7.5$ correct to 1 decimal place. 7.45 – 7.55
$b = 3.42$ correct to 2 decimal places. 3.415 – 3.425
$f = 2$ correct to the nearest whole number. 1.5 – 2.5

B1 : 1✓ UB or LB

Work out the upper bound of the value of X
Show your working clearly.

$UB(x) = \dfrac{2 \times UB(a) - LB(b)}{LB(f)}$ need largest answer for UB

$UB(x) = \dfrac{2 \times 7.55 - 3.415}{1.5}$ M1 : $\dfrac{2 \times \text{"}UB_a\text{"} - \text{"}LB_b\text{"}}{\text{"}LB_f\text{"}}$

where :
$7.5 < UB_a \leq 7.55$
$3.415 \leq LB_b < 3.42$
$1.5 \leq LB_f < 2$

$= 7.79$ A1 (from correct working)

7.79

(Total for Question 18 is 3 marks)

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19 $a = \dfrac{14}{3x - 7}$ $\quad x = \dfrac{7}{4y - 3}$

(3)

Express a in the form $\dfrac{py + q}{ry + s}$ where p, q, r and s are integers.

Give your answer in its simplest form.

Need to eliminate x : substitute $\frac{7}{4y-3}$ for x in 1st equation

$$a = \frac{14}{3\left(\frac{7}{4y-3}\right) - 7}$$ M1 $\times (4y-3)$ $\times (4y-3)$

$$= \frac{14(4y-3)}{21 - 7(4y-3)}$$ M1 Expand brackets & simplify

$$= \frac{56y - 42}{21 - 28y + 21}$$

$$= \frac{56y - 42}{42 - 28y}$$ Take out common factor & cancel

$$= \frac{14(4y-3)}{14(3-2y)}$$

$$= \frac{4y-3}{3-2y}$$ A1

$a = \dfrac{4y-3}{3-2y}$

(Total for Question 19 is 3 marks)

20 The diagram shows four identical circles drawn inside a square.

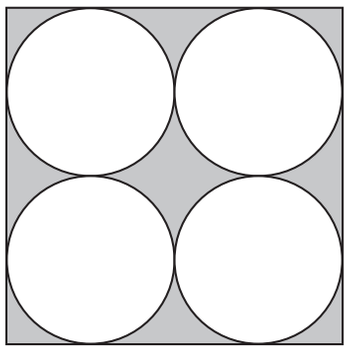


Diagram **NOT** accurately drawn

4

Each circle touches two other circles and two sides of the square.

The region inside the square that is outside the circles, shown shaded in the diagram, has a total area of 40 cm^2

Work out the perimeter of the square.
Give your answer correct to 3 significant figures.

let r = radius of the (identical circles)

→ side length of square = $4r$

Shaded area = Area of square − 4 × (Area of 1 circle)

$(4r)^2 - 4 \times (\pi r^2) = 40$ M1 : LHS

$16r^2 - 4\pi r^2 = 40$

$4r^2 - \pi r^2 = 10$

$r^2(4 - \pi) = 10$

$r = \sqrt{\frac{10}{4-\pi}}$ M1 ($r > 0$ as radius of circles)

↖ or any correct expression for d or 4r or 2d

$= 3.413...$

Perimeter = $16r$

$= 16 \times 3.413...$ M1 ft "r" but d 1st M1

$\simeq 54.6$ cm (3sf) A1

54.6 cm

(Total for Question 20 is 4 marks)

21

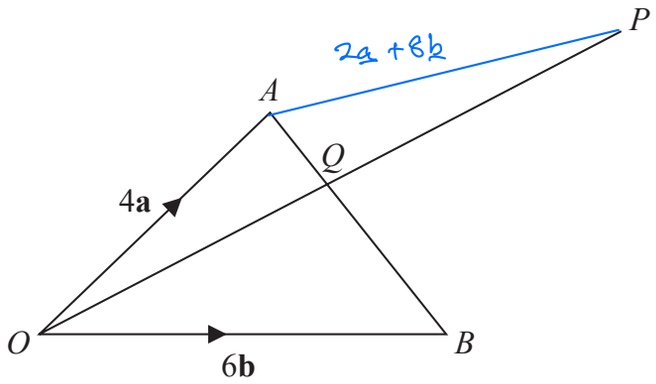


Diagram **NOT** accurately drawn

OAB is a triangle.
Q is the point on AB such that OQP is a straight line.

$\overrightarrow{OA} = \mathbf{4a}$ $\overrightarrow{OB} = \mathbf{6b}$ $\overrightarrow{AP} = \mathbf{2a + 8b}$ add to diagram

Using a vector method, find the ratio $AQ : QB$

Need to use the fact that Q is the point of intersection of OP and AB
→ find 2 different expressions for $\overrightarrow{OQ}$
(one using fact that Q lies on OP, other using fact that Q lies on AB)

$\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AB}$
$= 4\underline{a} + 2\underline{a} + 8\underline{b}$
$= 6\underline{a} + 8\underline{b}$

$\overrightarrow{AB} = \overrightarrow{AO} + \overrightarrow{OB}$ $\overrightarrow{AO} = -\overrightarrow{OA}$
$= -4\underline{a} + 6\underline{b}$

M1 (either)

Q lies on OP $\Rightarrow \overrightarrow{OQ} = \lambda \overrightarrow{OP}$
$\overrightarrow{OQ} = \lambda(6\underline{a} + 8\underline{b})$ M1
$= 6\lambda\underline{a} + 8\lambda\underline{b}$

Q lies on AB $= \overrightarrow{AQ} = \mu \overrightarrow{AB}$
2nd expression for $\overrightarrow{OQ}$:
$\overrightarrow{OQ} = \overrightarrow{OA} + \overrightarrow{AQ}$
$\overrightarrow{OQ} = 4\underline{a} + \mu(-4\underline{a} + 6\underline{b})$ M1
$= (4 - 4\mu)\underline{a} + 6\mu\underline{b}$

these 2 vectors are equal (both $\overrightarrow{OQ}$)
$\Rightarrow$ $\underline{a}$ components are equal, $\underline{b}$ components are equal

$\underline{a}$: $6\lambda = 4 - 4\mu \Rightarrow 3\lambda = 2 - 2\mu$ ①

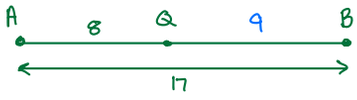
$\underline{b}$: $8\lambda = 6\mu \Rightarrow 4\lambda = 3\mu$ ②

Want AQ : QB so really need μ $\left(\mu = \frac{AQ}{AB}\right)$

5

② : $\lambda = \frac{3\mu}{4}$

in ① : $3 \times \frac{3\mu}{4} = 2 - 2\mu$
$2\mu + \frac{9}{4}\mu = 2$
$\frac{17}{4}\mu = 2$
$\Rightarrow \mu = \frac{2 \times 4}{17} = \frac{8}{17}$ A1



$AQ = \frac{8}{17} AB \Rightarrow BQ = \frac{9}{17} AB$

$AQ : BQ = 8 : 9$ A1

$AQ : QB =$ 8 : 9

(Total for Question 21 is 5 marks)

22 *ABCD* is a kite, with diagonals *AC* and *BD*, drawn on a centimetre square grid, with a scale of 1 cm for 1 unit on each axis.

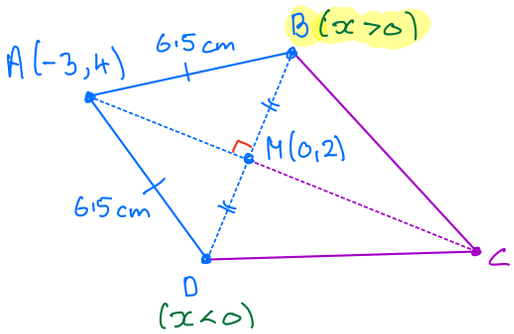
7

A is the point with coordinates (−3, 4)

The diagonals of the kite intersect at the point *M* with coordinates (0, 2)

Given that $AB = AD = 6.5$ cm and the *x* coordinate of *B* is positive,

find the coordinates of the points *B* and *D*.



Diagonals of a kite intersect at right angles

$\Rightarrow AC \perp BD$

As $AB = AD$, AC is line of symmetry of kite $\Rightarrow MB = MD$

$AM: m = \frac{-2}{3}$ M1

$\Rightarrow m_{BD} = \frac{3}{2}$

line DMB has equation $y = \frac{3}{2}x + c$ as $m = 3/2$

through M(0,2): $2 = \frac{3}{2} \times 0 + c$

$\Rightarrow c = 2$

$y = \frac{3}{2}x + 2$ M1 B and D both lie on this line

$\Rightarrow$ have coordinates $(x, \frac{3x}{2} + 2)$

$AB = AD = 6.5$ $\quad d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$

use $(x_1, y_1) = (x, \frac{3x}{2} + 2)$ B or D

$(x_2, y_2) = (-3, 4)$ A

$\Rightarrow \sqrt{(x - (-3))^2 + (\frac{3x}{2} + 2 - 4)^2} = 6.5$ M1 square both sides

(equn could include y at this point)

$(x+3)^2 + (\frac{3x}{2} - 2)^2 = 6.5^2$ Expand brackets

$x^2 + 6x + 9 + \frac{9x^2}{4} - 6x + 4 = \frac{169}{4}$ M1 : brackets expanded

M1 : substitute to get equation in x or y only

$\frac{13x^2}{4} + 13 = \frac{169}{4}$ $\times \frac{4}{13}$ both sides

$x^2 + 4 = 13$

$x^2 = 9$ M1 : correct simplified equation in x or y only

$x = \pm 3$

$x > 0$ at B $\Rightarrow$ at B : $x = 3$ $\quad y = \frac{3}{2} \times 3 + 2 = \frac{13}{2} = 6.5$

at D : $x = -3$, $y = \frac{3}{2} \times (-3) + 2 = -\frac{5}{2} = -2.5$

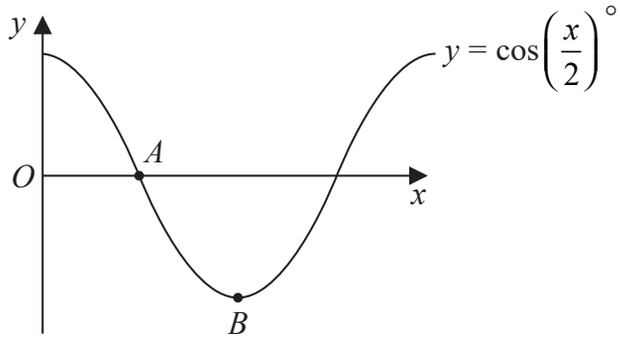
B(3, 6.5) , D(−3, −2.5) A1

(3 , 6.5)

(−3 , −2.5)

(Total for Question 22 is 7 marks)

23 The diagram shows a sketch of the graph of $y = \cos\left(\frac{x}{2}\right)^\circ$



2

(i) Find the coordinates of the point A

$f(\frac{x}{2})$: $(x, y) \rightarrow (2x, y)$

$y = \cos x$, 1st 0 (x-intercept at (90, 0)

(90, 0) → (180, 0)

B1

(180 , 0)

(1)

(ii) Find the coordinates of the point B

$y = \cos x$, minimum at (180, −1)

(180, 0) → (360, −1)

B1

(360 , −1)

(1)

(Total for Question 23 is 2 marks)

24

$$\frac{18 \times \left(\sqrt{27}\right)^{4n+6}}{6 \times 9^{2n+8}} = 3^x$$

Express x in terms of n

Show your working clearly and simplify your expression.

Express everything as powers of 2 and/or 3

$18 = 2 \times 3 \times 3 = 2 \times 3^2$

$27 = 3^3 \therefore \sqrt{27} = \sqrt{3^3} = (3^3)^{1/2} = 3^{3/2}$ $\quad \sqrt{a} = a^{1/2}$

$\Rightarrow \left(\sqrt{27}\right)^{4n+6} = 3^{\frac{3}{2}(4n+6)} = 3^{6n+9}$ $\quad (a^m)^n = a^{m \times n}$

$6 = 2 \times 3$

$9 = 3^2 \Rightarrow 9^{2n+8} = 3^{2(2n+8)} = 3^{4n+16}$

$$\frac{2 \times 3^2 \times 3^{6n+9}}{2 \times 3 \times 3^{4n+16}} = 3^x$$

Simplify using index laws:

$a^m \times a^n = a^{m+n}$ $\quad \frac{a^m}{a^n} = a^{m-n}$

$$\frac{3^{6n+9+2}}{3^{4n+16+1}} = 3^x$$

$$3^x = \frac{3^{6n+11}}{3^{4n+17}} = 3^{6n+11-4n-17}$$

$$3^x = 3^{2n-6}$$

$$\Rightarrow x = 2n - 6$$

$x =$ $2n - 6$

(Total for Question 24 is 3 marks)

TOTAL FOR PAPER IS 100 MARKS