

- 1 The first five terms of an arithmetic sequence are

$$1 \quad 4 \quad 7 \quad 10 \quad 13$$

*(Handwritten annotations: red numbers 3, 6, 9 above the terms; red arrows from 1 to 4 and 4 to 7 with '+3' below each arrow)*

Write down an expression, in terms of  $n$ , for the  $n$ th term of this sequence.

$$3n - 2$$

(Total for Question 1 is 2 marks)

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2 Show that

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

Tip: Just work out the answer

$$\frac{7}{3} \times \frac{15}{4} = \frac{105}{12} = \frac{35}{4} = 8\frac{3}{4}$$

we know the final denominator needs to be 4, this helps us when simplifying

$$\begin{array}{r} 15 \\ \times 7 \\ \hline 105 \\ \times \end{array}$$

$$\begin{array}{r} 035 \\ 3 \overline{)105} \end{array}$$

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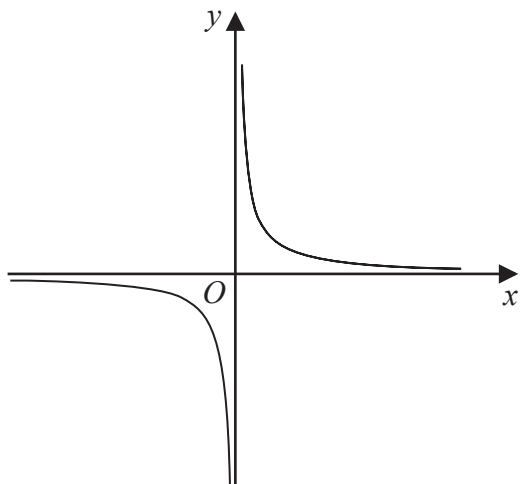
(Total for Question 2 is 3 marks)

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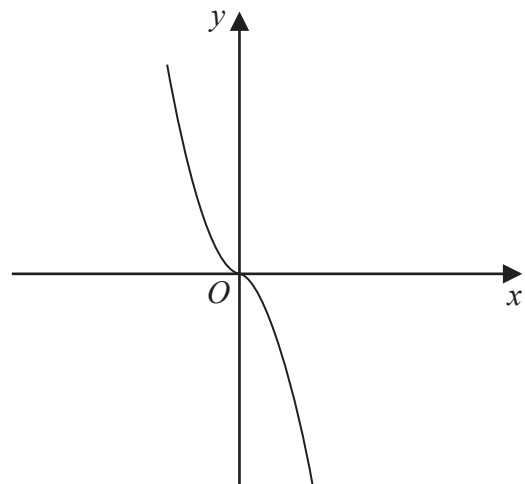
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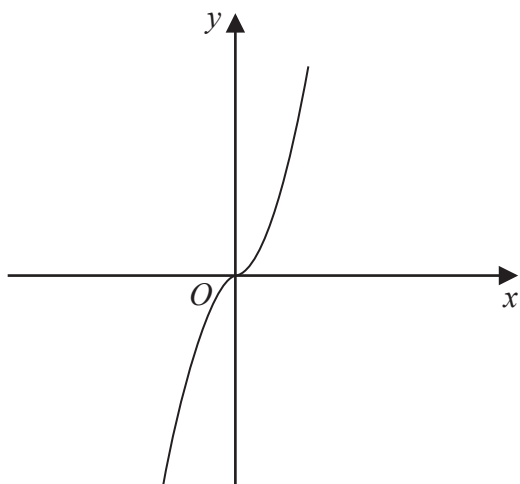
3 The diagram shows four graphs.



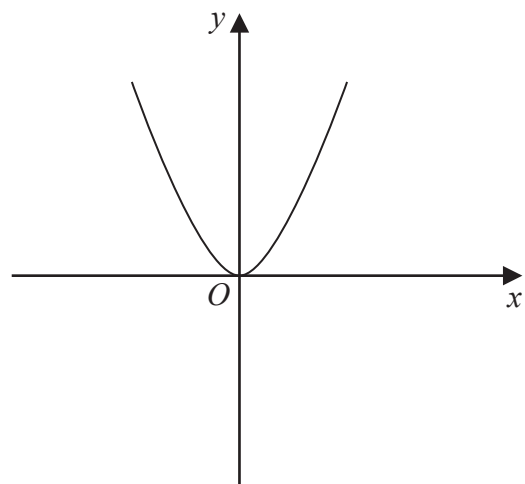
Graph A



Graph B



Graph C



Graph D

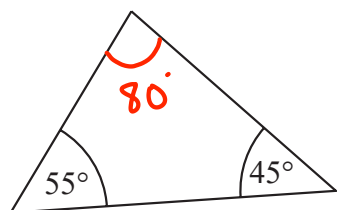
Each of the equations in the table is the equation of one of the graphs.

Complete the table.

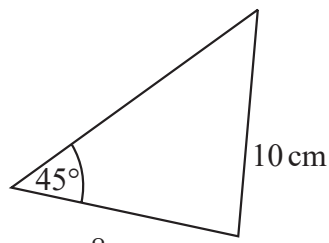
Equation	Letter of graph
$y = -x^3$	B
$y = x^3$	C
$y = x^2$	D
$y = \frac{1}{x}$	A

(Total for Question 3 is 2 marks)

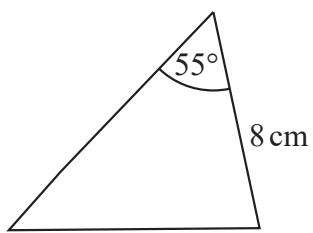
4 The diagram shows four triangles.



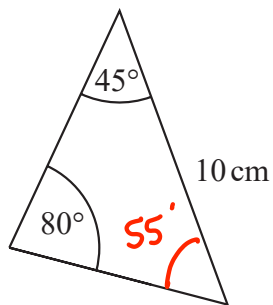
10 cm  
Triangle A



8 cm  
Triangle B



8 cm  
10 cm  
Triangle C



10 cm  
Triangle D

Two of these triangles are congruent.

Write down the letters of these two triangles.

A and D

(Total for Question 4 is 1 mark)

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- 5 Sean pays £10 for 24 chocolate bars.  
He sells all 24 chocolate bars for 50p each.  
Work out Sean's percentage profit.

$$\frac{\text{change}}{\text{original}} \times 100$$

$$24 \times 50\text{p} = \text{£}12$$

$$\frac{12 - 10}{10} \times 100$$

$$= \frac{2}{10} \times \frac{100}{1} = \frac{200}{10} = 20$$

..... 20 %

(Total for Question 5 is 3 marks)

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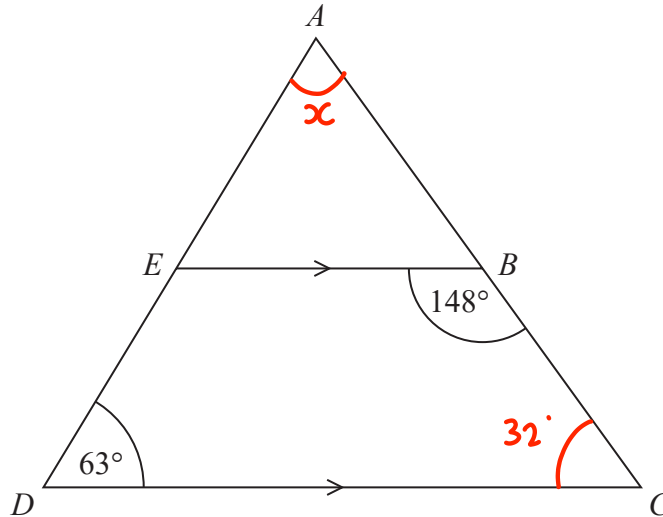
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6  $ADC$  is a triangle.



$AED$  and  $ABC$  are straight lines.  
 $EB$  is parallel to  $DC$ .

Angle  $EBC = 148^\circ$   
 Angle  $ADC = 63^\circ$

Work out the size of angle  $EAB$ .  
 You must give a reason for each stage of your working.

$$\begin{array}{r} 7 \\ 180 \\ - 148 \\ \hline 32 \end{array}$$

$\angle BCD = 32^\circ$  as co-interior angles add to  $180^\circ$   
 $\angle EAB = 85^\circ$  angles in a triangle add to  $180^\circ$

$$\begin{array}{r} 63 \\ + 32 \\ \hline 95 \end{array} \qquad \begin{array}{r} 7 \\ 180 \\ - 95 \\ \hline 85 \end{array}$$

$$\underline{85^\circ}$$

(Total for Question 6 is 5 marks)

7 The table shows information about the heights, in cm, of a group of Year 9 girls.

least height	150 cm
median	165 cm
greatest height	170 cm

$Range = 20$

This stem and leaf diagram shows information about the heights, in cm, of a group of 15 Year 9 boys.

15	<del>8</del> <del>9</del> <del>9</del>
16	<del>4</del> <del>5</del> <del>7</del> <del>7</del> 8
17	<del>0</del> <del>3</del> <del>4</del> <del>4</del> <del>7</del>
18	<del>0</del> <del>2</del>

Key: 15 | 8 represents 158 cm

$Range = 182 - 158 = 24$   
 $Median = 168$

Compare the distribution of the heights of the girls with the distribution of the heights of the boys.

The girls have a lower median, suggesting they are shorter.

The boys have a higher range, suggesting their heights vary more.

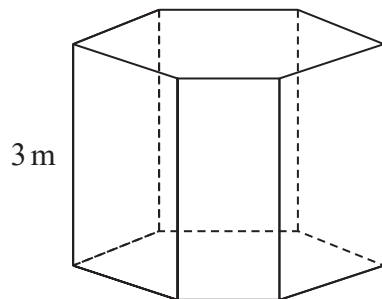
(Total for Question 7 is 3 marks)

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- 8 The diagram shows a prism placed on a horizontal floor.



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

The prism has height 3 m  
The volume of the prism is  $18 \text{ m}^3$

The pressure on the floor due to the prism is  $75 \text{ newtons/m}^2$

Work out the force exerted by the prism on the floor.

$$\text{Area} = 18 \div 3 = 6 \text{ m}^2$$

$$F = p \times A = 75 \times 6 = 450 \text{ N}$$

$$\begin{array}{r} \times 75 \\ 6 \\ \hline 450 \\ 3 \end{array}$$

..... 450 ..... newtons

(Total for Question 8 is 3 marks)



- 9 Write these numbers in order of size.  
Start with the smallest number.

Tip: put them all into standard form or ordinary numbers first

$6.72 \times 10^5$

$67.2 \times 10^{-4}$

$672 \times 10^4$

$0.000672$

$6.72 \times 10^{-3}$

$6.72 \times 10^6$

$6.72 \times 10^{-4}$

.....  
 $0.000672, 67.2 \times 10^{-4}, 6.72 \times 10^5, 672 \times 10^4$

(Total for Question 9 is 2 marks)

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10 Given that  $\frac{a}{b} = \frac{2}{5}$  and  $\frac{b}{c} = \frac{3}{4}$

Tip: Fractions can be expressed as ratios

find  $a:b:c$

$$\begin{array}{ccc} a : b & b : c & \\ \downarrow \times 3 & & \downarrow \times 5 \\ 2 : 5 & 3 : 4 & \\ 6 : 15 & 15 : 20 & \end{array}$$

$$\begin{array}{ccc} a : b : c \\ 6 : 15 : 20 \end{array}$$

$$\underline{\quad\quad\quad} 6 : 15 : 20 \underline{\quad\quad\quad}$$

(Total for Question 10 is 3 marks)

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11 (a) Find the value of  $\sqrt[4]{81 \times 10^8}$

$$\begin{aligned} & 3 \times 10^2 \\ & = 3 \times 100 \\ & = 300 \end{aligned}$$

300

(2)

(b) Find the value of  $64^{-\frac{1}{2}}$

$$\sqrt{64} = 8$$

1/8

(2)

(c) Write  $\frac{3^n}{9^{n-1}}$  as a power of 3

$$\frac{3^n}{(3^2)^{n-1}} = \frac{3^n}{3^{2n-2}}$$

$$3^n \div 3^{2n-2} = 3^{-n+2}$$

$$\begin{aligned} & n - (2n - 2) \\ & = n - 2n + 2 \\ & = -n + 2 \end{aligned}$$

$3^{-n+2}$

(2)

(Total for Question 11 is 6 marks)

12 The table gives information about the weekly wages of 80 people.

Wage (£ $w$ )	Frequency
$200 < w \leq 250$	5
$250 < w \leq 300$	10
$300 < w \leq 350$	20
$350 < w \leq 400$	20
$400 < w \leq 450$	15
$450 < w \leq 500$	10

(a) Complete the cumulative frequency table.

Wage (£ $w$ )	Cumulative frequency
$200 < w \leq 250$	5
$200 < w \leq 300$	15
$200 < w \leq 350$	35
$200 < w \leq 400$	55
$200 < w \leq 450$	70
$200 < w \leq 500$	80

(1)

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

(2)

Juan says

“60% of this group of people have a weekly wage of £360 or less.”

(c) Is Juan correct?

You must show how you get your answer.

$$60\% \text{ of } 80 = 48$$

$$10\% = 8$$

NO, 60% have a wage of £380 or less

(3)

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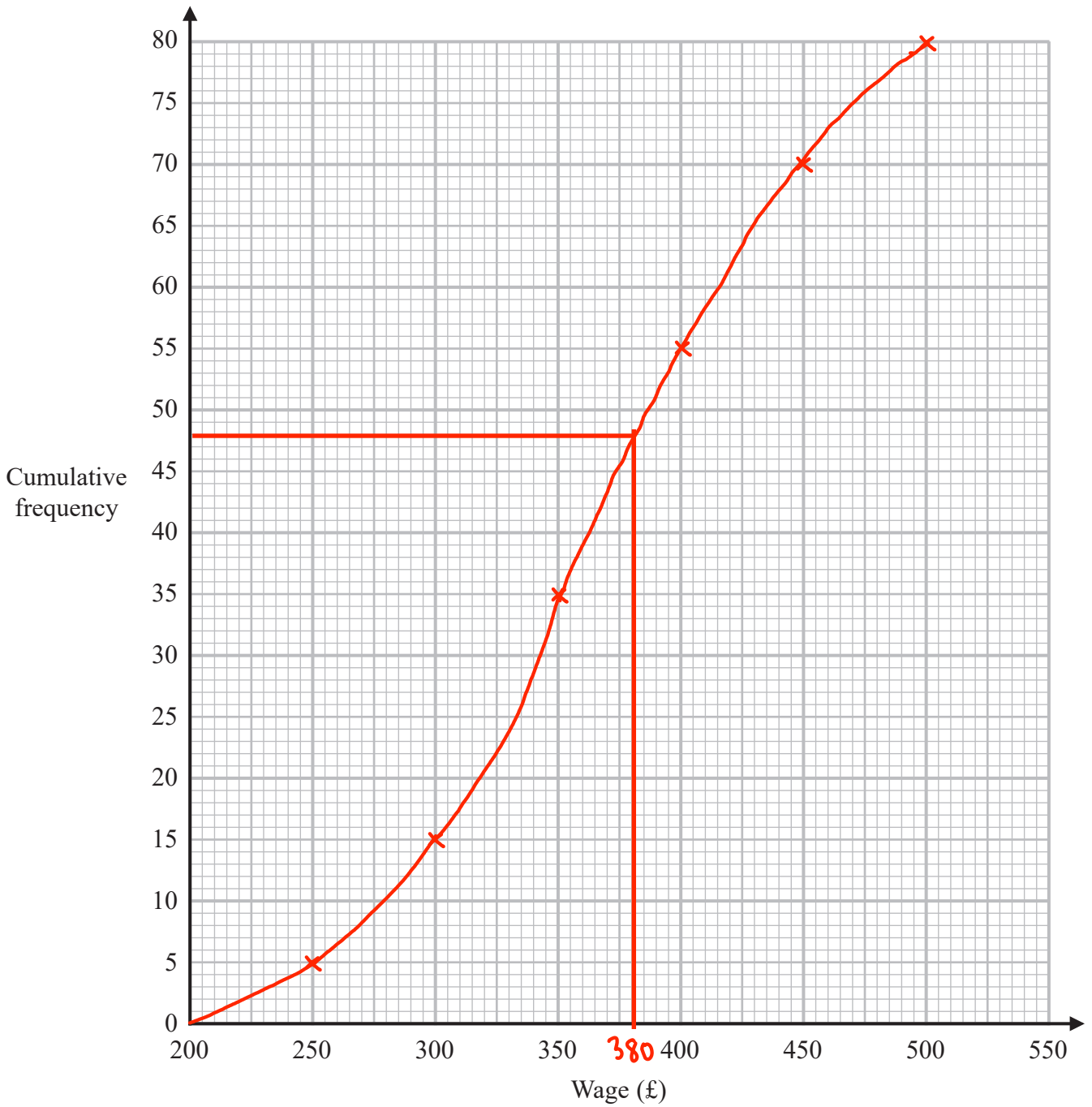
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(Total for Question 12 is 6 marks)

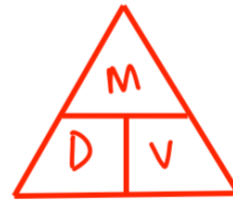
13 Liquid A and liquid B are mixed to make liquid C.

Liquid A has a density of  $70 \text{ kg/m}^3$   
 Liquid A has a mass of  $1400 \text{ kg}$

Liquid B has a density of  $280 \text{ kg/m}^3$   
 Liquid B has a volume of  $30 \text{ m}^3$

Work out the density of liquid C.

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



$$M = D \times V$$

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

A

$$D = 70$$

$$M = 1400$$

$$V = 20$$

$$\frac{1400}{70} = \frac{140}{7} = 20$$

B

$$D = 280$$

$$M = 8400$$

$$V = 30$$

$$\begin{array}{r} \times 280 \\ 30 \\ \hline 000 \\ 8400 \\ \hline 8400 \end{array}$$

C

$$D =$$

$$M = 9800$$

$$V = 50$$

$$\frac{9800}{50} = \frac{980}{5}$$

$$\begin{array}{r} 196 \\ 5 \overline{) 980} \\ \underline{95} \phantom{0} \\ 30 \\ \underline{28} \phantom{0} \\ 20 \\ \underline{20} \\ 0 \end{array}$$

..... 196 .....  $\text{kg/m}^3$

(Total for Question 13 is 3 marks)

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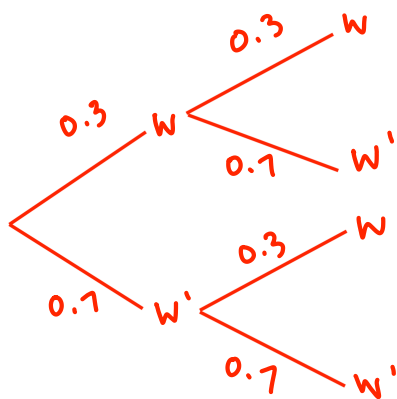
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- 14 Sally plays two games against Martin.  
In each game, Sally could win, draw or lose.

In each game they play,  
the probability that Sally will win against Martin is 0.3  
the probability that Sally will draw against Martin is 0.1

Work out the probability that Sally will win **exactly** one of the two games against Martin.



$$P(W, W') = 0.3 \times 0.7 = 0.21$$

$$P(W', W) = 0.1 \times 0.3 = 0.21 \quad +$$

$$\underline{0.42}$$

$$0.42$$

(Total for Question 14 is 3 marks)

15 The straight line  $L_1$  has equation  $y = 3x - 4$

The straight line  $L_2$  is perpendicular to  $L_1$  and passes through the point  $(9, 5)$  x, y

Find an equation of line  $L_2$

Tip: When you know the gradient of a line, the gradient of a perpendicular line is the negative reciprocal.

$$\text{Gradient } L_2 = -\frac{1}{3}$$

$$y = -\frac{1}{3}x + c$$

$$5 = -\frac{1}{3}(9) + c$$

$$\begin{array}{r|l} 5 & = & -3 + c \\ +3 & & +3 \\ \hline 8 & = & c \end{array}$$

$$y = -\frac{1}{3}x + 8$$

$$y = -\frac{1}{3}x + 8$$

(Total for Question 15 is 3 marks)



16 Shirley wants to find an estimate for the number of bees in her hive.

On Monday she catches 90 of the bees.  
She puts a mark on each bee and returns them to her hive.

On Tuesday she catches 120 of the bees.  
She finds that 20 of these bees have been marked.

(a) Work out an estimate for the total number of bees in her hive.

$$\begin{array}{r}
 120 \\
 \times 45 \\
 \hline
 600 \\
 4800 \\
 \hline
 5400
 \end{array}$$

$$\frac{90}{x} = \frac{20}{120} \quad \xrightarrow{\times 4.5}$$

$$120 \times 4.5 = 540$$

$$\begin{array}{r}
 540 \\
 \hline
 \end{array}$$

(3)

Shirley assumes that none of the marks had rubbed off between Monday and Tuesday.

(b) If Shirley's assumption is wrong, explain what effect this would have on your answer to part (a).

If some of the marks had rubbed off she would have overestimated the number of bees

(1)

(Total for Question 16 is 4 marks)

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17 Make  $f$  the subject of the formula  $d = \frac{3(1-f)}{f-4}$

$$\begin{array}{l}
 \times f-4 \quad \times f-4 \\
 d(f-4) = 3(1-f) \\
 df - 4d = 3 - 3f \\
 +3f \qquad \qquad +3f \\
 df + 3f - 4d = 3 \\
 +4d \qquad \qquad +4d \\
 df + 3f = 3 + 4d \\
 \frac{f(d+3)}{d+3} = \frac{3+4d}{d+3} \\
 f = \frac{3+4d}{d+3}
 \end{array}$$

(Total for Question 17 is 4 marks)

18  $x$  is proportional to  $\sqrt{y}$  where  $y > 0$

$y$  is increased by 44%  $\rightarrow 1.44y$

Work out the percentage increase in  $x$ .

$$x \propto \sqrt{y}$$

$$x = k\sqrt{y}$$

$$x = k\sqrt{1.44y}$$

$$x = 1.2k\sqrt{y}$$

20% increase

$$\sqrt{144} = 12$$

$$\sqrt{1.44} = 1.2$$

..... 20 %

(Total for Question 18 is 3 marks)

19 f and g are functions such that

$$f(x) = \frac{12}{\sqrt{x}} \quad \text{and} \quad g(x) = 3(2x + 1) = 6x + 3$$

(a) Find  $g(5)$

$$\begin{aligned} g(x) &= 6x + 3 \\ g(5) &= 6(5) + 3 \\ &= 30 + 3 \\ &= 33 \end{aligned}$$

33

(1)

(b) Find  $gf(9)$

$$\begin{aligned} f(9) &= \frac{12}{\sqrt{9}} = \frac{12}{3} = 4 \\ g(4) &= 6 \times 4 + 3 \\ &= 24 + 3 \\ &= 27 \end{aligned}$$

27

(2)

(c) Find  $g^{-1}(6)$

$$\begin{array}{r|l} 6x + 3 & = & 6 \\ -3 & & -3 \\ \hline 6x & = & 3 \\ \div 6 & & \div 6 \\ \hline x & = & \frac{3}{6} \quad \text{or} \quad \frac{1}{2} \end{array}$$

$\frac{1}{2}$

(2)

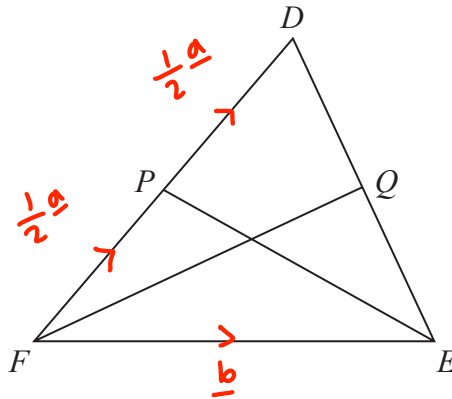
(Total for Question 19 is 5 marks)

20 Show that  $\frac{\sqrt{180} - 2\sqrt{5}}{5\sqrt{5} - 5}$  can be written in the form  $a + \frac{\sqrt{5}}{b}$  where  $a$  and  $b$  are integers.

$$\sqrt{180} = \sqrt{36} \times \sqrt{5} = 6\sqrt{5}$$

$$\begin{aligned} \frac{6\sqrt{5} - 2\sqrt{5}}{5\sqrt{5} - 5} &= \frac{4\sqrt{5}}{5\sqrt{5} - 5} \times \frac{5\sqrt{5} + 5}{5\sqrt{5} + 5} \\ &= \frac{20(5) + 20\sqrt{5}}{25(5) + 25\sqrt{5} - 25\sqrt{5} - 25} \\ &= \frac{100 + 20\sqrt{5}}{100} = 1 + \frac{\sqrt{5}}{5} \end{aligned}$$

(Total for Question 20 is 4 marks)

21  $DEF$  is a triangle.

$P$  is the midpoint of  $FD$ .  
 $Q$  is the midpoint of  $DE$ .

$$\vec{FD} = \mathbf{a} \quad \text{and} \quad \vec{FE} = \mathbf{b}$$

Use a vector method to prove that  $PQ$  is parallel to  $FE$ .

$$\vec{FE} = \mathbf{b}$$

$$\vec{DE} = -\mathbf{a} + \mathbf{b}$$

$$\vec{DQ} = -\frac{1}{2}\mathbf{a} + \frac{1}{2}\mathbf{b}$$

$$\vec{PQ} = \vec{PD} + \vec{DQ} = \frac{1}{2}\mathbf{a} - \frac{1}{2}\mathbf{a} + \frac{1}{2}\mathbf{b} = \frac{1}{2}\mathbf{b}$$

$$\vec{FE} = \mathbf{b}$$

$$\vec{PQ} = \frac{1}{2}\mathbf{b}$$

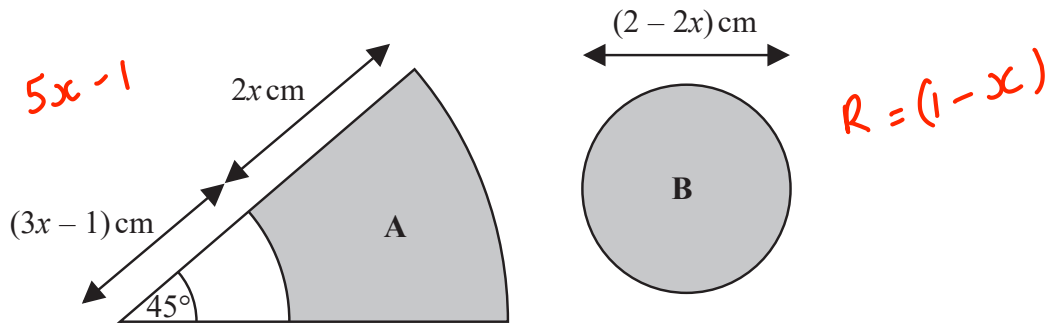
$$\therefore \text{parallel as } \vec{PQ} = \frac{1}{2}\vec{FE}$$

(Total for Question 21 is 4 marks)

22 The diagram shows two shaded shapes, A and B.

Shape A is formed by removing a sector of a circle with radius  $(3x - 1)$  cm from a sector of the circle with radius  $(5x - 1)$  cm.

Shape B is a circle of diameter  $(2 - 2x)$  cm.



The area of shape A is equal to the area of shape B.

Find the value of  $x$ .

You must show all your working.

Area A :

$$\left[ \frac{45}{360} \times \pi \times (5x-1)^2 \right] - \left[ \frac{45}{360} \times \pi \times (3x-1)^2 \right]$$

$$= \frac{45}{360} \pi (5x-1)(5x-1) - \frac{45}{360} \pi (3x-1)(3x-1)$$

$$= \frac{45}{360} \pi (25x^2 - 10x + 1) - \frac{45}{360} \pi (9x^2 - 6x + 1)$$

$$= \frac{45}{360} \pi (16x^2 - 4x) = \frac{1}{8} \pi (16x^2 - 4x)$$

$$\text{Area B: } \pi \times (1-x)(1-x) = \pi (1 - 2x + x^2)$$

$$\frac{1}{8} \pi (16x^2 - 4x) = \pi (1 - 2x + x^2)$$

$$2x^2 - 0.5x = 1 - 2x + x^2$$

$$x^2 + 1.5x - 1 = 0$$

$$(x+2)(x-0.5) = 0$$

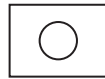
$$x = 0.5$$

$$x = -2 \text{ or } x = 0.5$$

(Total for Question 22 is 5 marks)

23 There are four types of cards in a game.

Each card has a black circle or a white circle or a black triangle or a white triangle.



number of cards with a black shape : number of cards with a white shape = 3:5 (8 parts)

number of cards with a circle : number of cards with a triangle = 2:7 (9 parts)

Need same amount of parts

Express the total number of cards with a black shape as a fraction of the total number of cards with a triangle.

$$8 \times 9 = 72$$

$$\begin{array}{r}
 \text{BS : WS} \\
 3 : 5 \\
 \times 9 \quad \downarrow \quad \times 9 \\
 27 : 45
 \end{array}
 \qquad
 \begin{array}{r}
 \text{C : T} \\
 2 : 7 \\
 \times 8 \quad \downarrow \quad \times 8 \\
 16 : 56
 \end{array}$$

$$\frac{27}{56}$$

(Total for Question 23 is 3 marks)

TOTAL FOR PAPER IS 80 MARKS