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**Tuesday 7 January 2020**

Morning (Time: 1 hour 30 minutes)

Paper Reference **4MB1/01**

**Mathematics B**

**Paper 1**



**You must have:** Ruler graduated in centimetres and millimetres, protractor, compasses, pen, HB pencil, eraser, calculator. Tracing paper may be used.

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*
- **Calculators may be used.**

## Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*

## Advice

- Read each question carefully before you start to answer it.
- Check your answers if you have time at the end.
- Without sufficient working, correct answers may be awarded no marks.

Turn over ►

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Answer ALL TWENTY SEVEN questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

- 1 Write 0.000 315 in standard form.

1 2 3 4

To be in standard form, the number needs to be between 0 and 10 and have a power of 10.

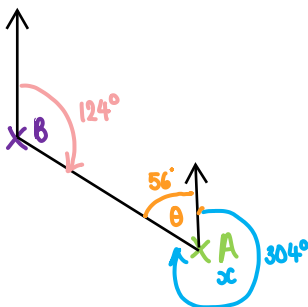
To turn 0.000315 into 3.15, you need to multiply by  $10^{-4}$ .

$$3.15 \times 10^{-4}$$

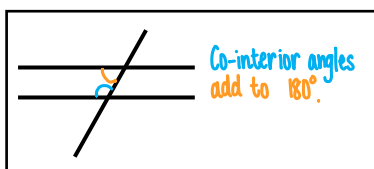
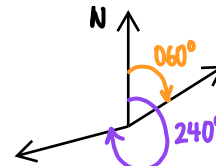
(Total for Question 1 is 1 mark)

- 2 The bearing of village A from village B is  $124^\circ$

Find the bearing of village B from village A.

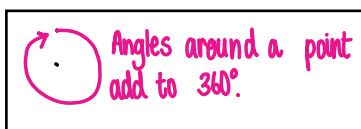


A bearing is an angle measured clockwise from North. It must be written in 3 figures



$$124 + \theta = 180$$

$$\theta = 56^\circ$$



$$56 + x = 360$$

$$x = 304^\circ$$

$$304$$

(Total for Question 2 is 2 marks)

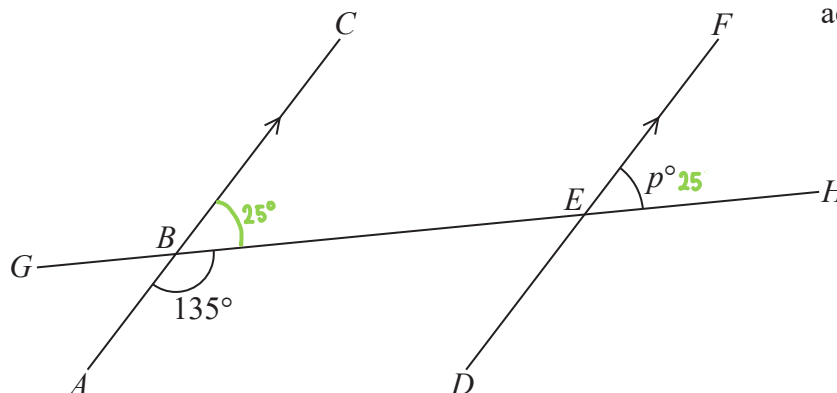
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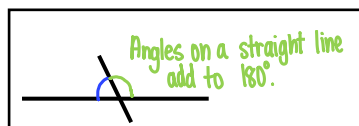
Diagram NOT accurately drawn



$ABC$  and  $DEF$  are parallel straight lines and  $GBEH$  is a straight line.

$\angle ABE = 135^\circ$  and  $\angle FEH = p^\circ$

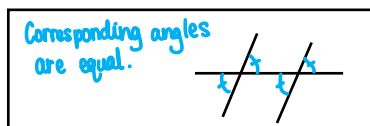
Find the value of  $p$ .



$$\angle ABE + \angle EBC = 180$$

$$135 + \angle EBC = 180$$

$$\angle EBC = 25^\circ$$



$$\angle EBC = p$$

$$p = 25^\circ$$

$$p = 25$$

(Total for Question 3 is 2 marks)

4 Without using a calculator and showing all your working, work out

$$1\frac{7}{8} \times 2\frac{3}{5}$$

Give your answer as a mixed number in its simplest form.

First convert into improper fractions.

$$1\frac{7}{8} = \frac{(1 \times 8) + 7}{8}$$

$$= \frac{8+7}{8}$$

$$= \frac{15}{8}$$

$$2\frac{3}{5} = \frac{(2 \times 5) + 3}{5}$$

$$= \frac{10+3}{5}$$

$$= \frac{13}{5}$$

Now multiply

$$\frac{15}{8} \times \frac{13}{5} = \frac{39}{8}$$

$$= 4\frac{7}{8}$$

$$4\frac{7}{8}$$

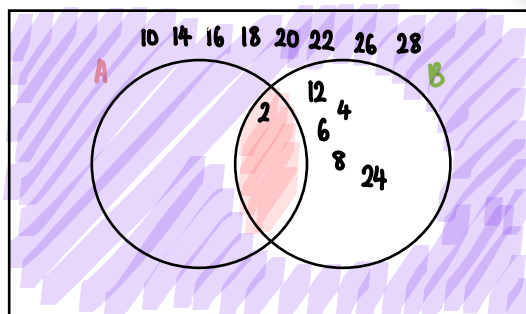
(Total for Question 4 is 2 marks)



- 5  $\mathcal{E} = \{\text{even numbers between 1 and 29}\}$   
 $A = \{\text{prime numbers}\}$   
 $B = \{\text{factors of 24}\}$

List the elements of the set

(a)  $B'$



10, 14, 16, 18, 20, 22, 26, 28  
(1)

(b)  $A \cap B$

2  
(1)

(Total for Question 5 is 2 marks)

- 6 Here are the twelve most recent batting scores of a cricketer.

~~23~~ ~~46~~ ~~7~~ ~~56~~ ~~23~~ ~~18~~ ~~78~~ ~~56~~ ~~6~~ ~~87~~ ~~1~~ ~~26~~

Find the median of these twelve scores.

The median is the middle value.

① Order the numbers from smallest to largest.

3, 6, 11, 18, 23, 23, 26, 45, 56, 56, 78, 87

② Find the middle value.

3, 6, 11, 18, 23, 23, 26, 45, 56, 56, 78, 87

$$23 + \frac{26 - 23}{2} = 24.5$$

24.5

(Total for Question 6 is 2 marks)



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- 7 The  $n$ th term of a sequence is given by  $2 - 5n$

Write down the 3rd, 4th and 5th terms of the sequence.

Substitute each  $n$ th number into the equation.

$$2 - 5(3) = -13$$

$$2 - 5(4) = -18$$

$$2 - 5(5) = -23$$

..... -13 ..... , ..... -18 ..... , ..... -23 .....

(Total for Question 7 is 2 marks)

- 8 Express 42 minutes as a percentage of 5 hours.

① Convert 42 minutes into hours.

$$42 \text{ min} = \frac{42}{60} \text{ hr} = 0.7 \text{ hr}$$

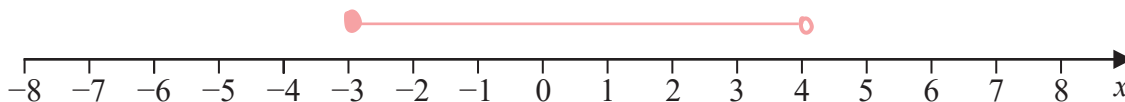
② Find percentage.

$$\frac{0.7}{5} \times 100 = 14\%$$

..... 14 ..... %

(Total for Question 8 is 3 marks)

- 9 Here is a number line.



- (a) Show on the number line the inequality  $-3 \leq x < 4$

(2)

- (b) Write down the integer values of  $x$  for which  $-3 \leq x < 4$

..... -3, -2, -1, 0, 1, 2, 3 .....

(1)

(Total for Question 9 is 3 marks)



10

$$\mathbf{A} = \begin{pmatrix} 2 & -3 \\ 4 & 1 \end{pmatrix}$$

$$\mathbf{B} = \begin{pmatrix} 5 & 0 \\ 4 & -2 \end{pmatrix}$$

Calculate

(a)  $\mathbf{A} + \mathbf{B}$

To add a  $2 \times 2$  matrix to a  $2 \times 2$  matrix:

$$\begin{pmatrix} a_1 & b_1 \\ c_1 & d_1 \end{pmatrix} + \begin{pmatrix} a_2 & b_2 \\ c_2 & d_2 \end{pmatrix} = \begin{pmatrix} a_1 + a_2 & b_1 + b_2 \\ c_1 + c_2 & d_1 + d_2 \end{pmatrix}$$

$$\begin{pmatrix} 2 & -3 \\ 4 & 1 \end{pmatrix} + \begin{pmatrix} 5 & 0 \\ 4 & -2 \end{pmatrix} = \begin{pmatrix} 2+5 & -3+0 \\ 4+4 & 1+(-2) \end{pmatrix} \\ = \begin{pmatrix} 7 & -3 \\ 8 & -1 \end{pmatrix}$$

$$\begin{pmatrix} 7 & -3 \\ 8 & -1 \end{pmatrix} \\ (1)$$

(b)  $2\mathbf{A} - 4\mathbf{B}$

To multiply a  $2 \times 2$  matrix by a factor  $x$ .

$$x \begin{pmatrix} a_1 & b_1 \\ c_1 & d_1 \end{pmatrix} = \begin{pmatrix} xa_1 & xb_1 \\ xc_1 & xd_1 \end{pmatrix}$$

$$2\mathbf{A} = 2 \begin{pmatrix} 2 & -3 \\ 4 & 1 \end{pmatrix} = \begin{pmatrix} 4 & -6 \\ 8 & 2 \end{pmatrix} \quad 4\mathbf{B} = 4 \begin{pmatrix} 5 & 0 \\ 4 & -2 \end{pmatrix} = \begin{pmatrix} 20 & 0 \\ 16 & -8 \end{pmatrix}$$

To subtract a  $2 \times 2$  matrix from a  $2 \times 2$  matrix:

$$\begin{pmatrix} a_1 & b_1 \\ c_1 & d_1 \end{pmatrix} - \begin{pmatrix} a_2 & b_2 \\ c_2 & d_2 \end{pmatrix} = \begin{pmatrix} a_1 - a_2 & b_1 - b_2 \\ c_1 - c_2 & d_1 - d_2 \end{pmatrix}$$

$$\begin{pmatrix} 4 & -6 \\ 8 & 2 \end{pmatrix} - \begin{pmatrix} 20 & 0 \\ 16 & -8 \end{pmatrix} = \begin{pmatrix} 4-20 & -6-0 \\ 8-16 & 2-(-8) \end{pmatrix} \\ = \begin{pmatrix} -16 & -6 \\ -8 & 10 \end{pmatrix}$$

$$\begin{pmatrix} -16 & -6 \\ -8 & 10 \end{pmatrix} \\ (2)$$

(Total for Question 10 is 3 marks)

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11 Express as a single fraction in its simplest form

$$\frac{5}{3-2x} - \frac{2}{2+5x}$$

$$\begin{aligned} \frac{5}{3-2x} - \frac{2}{2+5x} &= \frac{5(2+5x) - 2(3-2x)}{(3-2x)(2+5x)} \\ &= \frac{10 + 25x - 6 + 4x}{6 + 15x - 4x - 10x^2} \\ &= \frac{4 + 29x}{6 + 11x - 10x^2} \end{aligned}$$

$$\frac{4 + 29x}{6 + 11x - 10x^2}$$

(Total for Question 11 is 3 marks)



12 Given that, for all values of  $x$ ,

$$4x^3 - 8x^2 - 12x + 11 = (2x + k)Q(x) + 11$$

where  $Q(x)$  is a quadratic expression in  $x$ ,

find the positive value of  $k$ .

$$4x^3 - 8x^2 - 12x + \cancel{11} = (2x + k)Q(x) + \cancel{11}$$

$$4x^3 - 8x^2 - 12x = (2x + k)Q(x)$$

$$4x(x^2 - 2x - 3) = (2x + k)Q(x)$$

$$4x(x - 3)(x + 1) = (2x + k)Q(x)$$

$$x(2x - 6)(2x + 2) = (2x + k)Q(x)$$

$$2x - 6 = 2x + k \quad \text{or} \quad 2x + 2 = 2x + k$$

$$-6 = k$$

$$2 = k$$

↳ You only want the positive value.

$$k = \underline{2}$$

(Total for Question 12 is 3 marks)

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13 Simplify  $\frac{(3x^2y^3)^3}{9xy^2}$

Laws of indices:

$$x^a \times x^b = x^{a+b}$$

$$x^a \div x^b = x^{a-b}$$

$$(x^a)^b = x^{ab}$$

$$\begin{aligned} \frac{(3x^2y^3)^3}{9xy^2} &= \frac{(3)^3 \times (x^2)^3 \times (y^3)^3}{9xy^2} \\ &= \frac{27 \times x^{2 \times 3} \times y^{3 \times 3}}{9xy^2} \\ &= \frac{27x^6y^9}{9xy^2} \\ &= \frac{27}{9} \times \frac{x^6}{x} \times \frac{y^9}{y^2} \\ &= 3 \times x^{6-1} \times y^{9-2} \\ &= 3x^5y^7 \end{aligned}$$

$$3x^5y^7$$

(Total for Question 13 is 3 marks)

14 Solve the simultaneous equations

$$3x + 2y = 8$$

$$-4x + 9y = 22$$

Show clear algebraic working.

Method 1: Elimination

① Make the value in front of  $x$  equal, regardless of sign.

$$\begin{array}{r} \times 4 \rightarrow 3x + 2y = 8 \\ \phantom{\times 4 \rightarrow} 12x + 8y = 32 \end{array}$$

$$\begin{array}{r} \times 3 \rightarrow -4x + 9y = 22 \\ \phantom{\times 3 \rightarrow} -12x + 27y = 66 \end{array}$$

② Since the signs in front of  $x$  are different, add

$$\begin{array}{r} 12x + 8y = 32 \\ + \quad -12x + 27y = 66 \\ \hline 35y = 98 \\ y = \frac{14}{5} \end{array}$$

③ Substitute your value of  $y$  to find  $x$ .

$$\begin{aligned} 3x + 2\left(\frac{14}{5}\right) &= 8 \\ 3x + \frac{28}{5} &= 8 \\ 3x &= \frac{12}{5} \\ x &= \frac{4}{5} \end{aligned}$$

Method 2: Substitution

① Make  $x$  the subject of the formula.

$$\begin{aligned} 3x + 2y &= 8 \\ 3x &= 8 - 2y \\ x &= \frac{8 - 2y}{3} \end{aligned}$$

② Substitute into the other equation.

$$\begin{aligned} -4\left(\frac{8 - 2y}{3}\right) + 9y &= 22 \\ \frac{-32 + 8y}{3} + \frac{27y}{3} &= 22 \\ \frac{-32 + 35y}{3} &= 22 \\ -32 + 35y &= 66 \\ 35y &= 98 \\ y &= \frac{14}{5} \end{aligned}$$

③ Substitute your value of  $y$  to find  $x$ .

$$\begin{aligned} 3x + 2\left(\frac{14}{5}\right) &= 8 \\ 3x + \frac{28}{5} &= 8 \\ 3x &= \frac{12}{5} \\ x &= \frac{4}{5} \end{aligned}$$

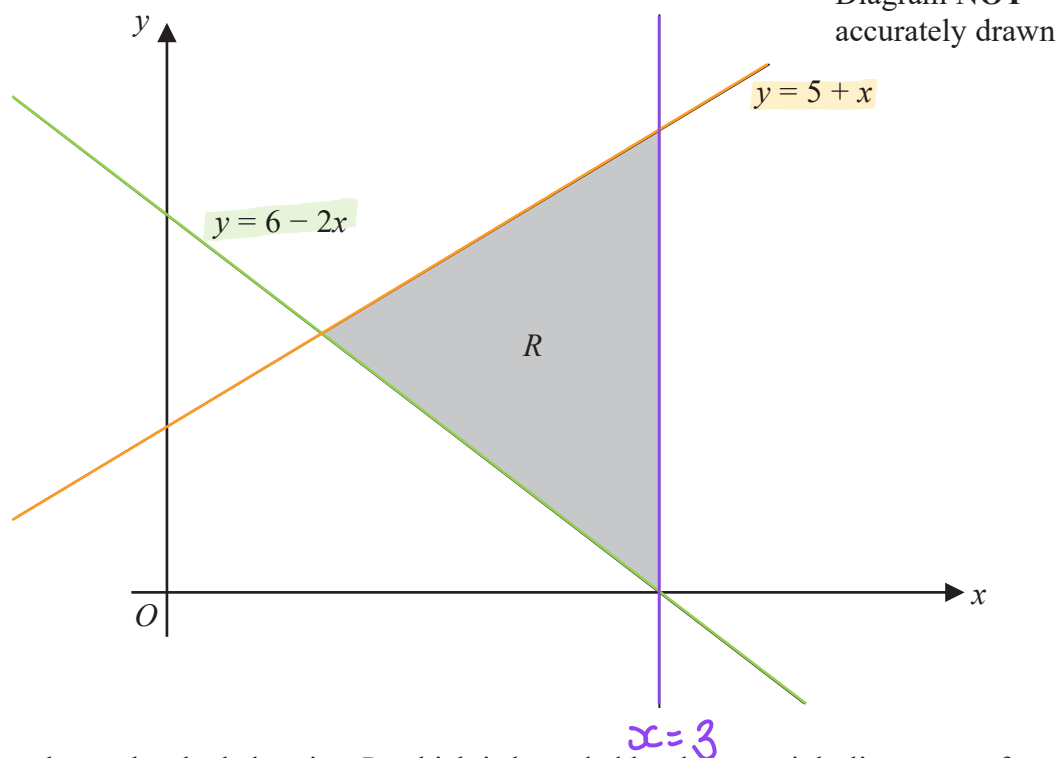
$$x = \frac{4}{5}$$

$$y = \frac{14}{5}$$

(Total for Question 14 is 4 marks)



15



The diagram shows the shaded region  $R$ , which is bounded by three straight lines, one of which is parallel to the  $y$ -axis.  
One vertex of  $R$  lies on the  $x$ -axis.

Find three inequalities that define  $R$ .

Since you do not have the equation for the straight line, the first step is to find this. You can do this by finding the point of intersection of  $y = 6 - 2x$  with the  $x$ -axis.

$$0 = 6 - 2x$$

$$-6 = -2x$$

$$3 = x$$

$\therefore$  The line  $y = 6 - 2x$  meets the  $x$ -axis at  $(3, 0)$  so the straight line must be  $x = 3$

The shaded region is above  $y = 6 - 2x$  and the line is solid so  $y \geq 6 - 2x$

The shaded region is below  $y = 5 + x$  and is a solid line so  $y \leq 5 + x$

The shaded region is to the left of the solid line  $x = 3$  so  $x \leq 3$

$$y \geq 6 - 2x$$

$$y \leq 5 + x$$

$$x \leq 3$$

(Total for Question 15 is 4 marks)

16 A model of a ship is made to a scale of 3:400

The surface area of the model is 7200 cm<sup>2</sup>

Calculate, in m<sup>2</sup>, the surface area of the ship.

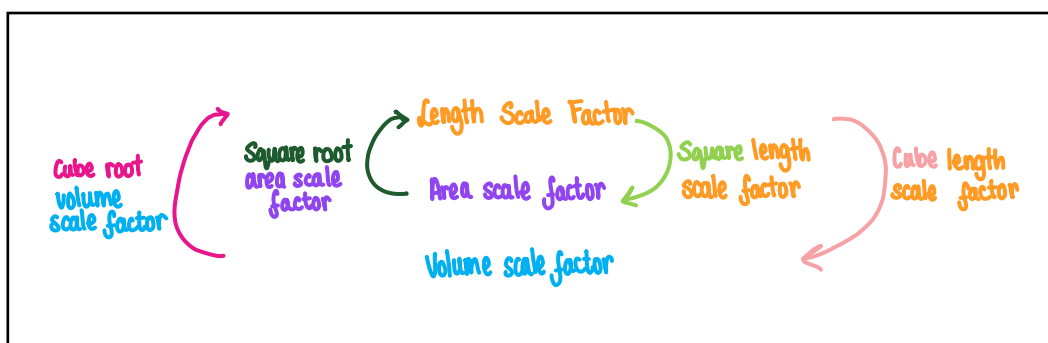
First convert 7200 cm<sup>2</sup> into m<sup>2</sup>.

$$\text{cm} : \text{m} \\ \curvearrowright \div 100$$

$$\text{cm}^2 : \text{m}^2 \\ \curvearrowright \div (100)^2$$

$$7200 \text{ cm}^2 \div (100)^2 = 0.72 \text{ m}^2$$

Now find the Surface Area scale factor from the length scale factor.



$$3 : 400 \\ \curvearrowright \times \frac{400}{3}$$

$$0.72 : 12800 \text{ m}^2 \\ \curvearrowright \times \left(\frac{400}{3}\right)^2$$

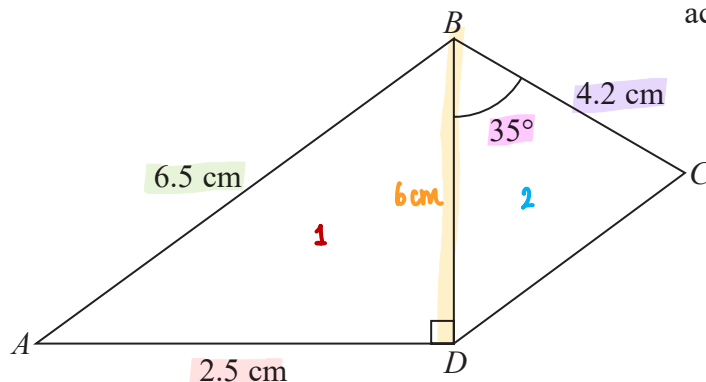
.....12800..... m<sup>2</sup>

(Total for Question 16 is 4 marks)





Diagram NOT accurately drawn



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The diagram shows  $\triangle ABD$  and  $\triangle BCD$  such that

$AB = 6.5$  cm,  $AD = 2.5$  cm,  $BC = 4.2$  cm,  $\angle CBD = 35^\circ$  and  $\angle ADB = 90^\circ$

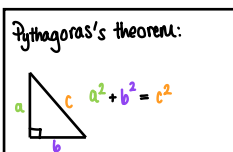
Calculate the area, in  $\text{cm}^2$  to 3 significant figures, of the quadrilateral  $ABCD$ .

There are two ways to find the area of a triangle:

①  $\frac{1}{2} \times \text{base} \times \text{height}$

②  $\frac{1}{2} ab \sin C$

For triangle 1, you can find the height using Pythagoras and then use method 1.



$$\begin{aligned} AD^2 + BD^2 &= AB^2 \\ 2.5^2 + BD^2 &= 6.5^2 \\ BD^2 &= 6.5^2 - 2.5^2 \\ BD &= \sqrt{6.5^2 - 2.5^2} \\ BD &= 6 \text{ cm} \end{aligned}$$

$$\begin{aligned} \text{Area of triangle 1} &= \frac{1}{2} \times 2.5 \times 6 \\ &= 7.5 \text{ cm}^2 \end{aligned}$$

To find the area of triangle 2, use method 2.

$$\begin{aligned} \text{Area of triangle 2} &= \frac{1}{2} \times 6 \times 4.2 \times \sin 35 \\ &= 7.2270... \end{aligned}$$

Now add your areas for the area of the quadrilateral.

$$\begin{aligned} \text{Area of quadrilateral} &= 7.5 + 7.227... \\ &= 14.727... \\ &\approx 14.7 \text{ cm}^2 \end{aligned}$$

..... 14.7 .....  $\text{cm}^2$

(Total for Question 17 is 4 marks)



18

$$\mathbf{p} = \begin{pmatrix} x \\ 2x - 1 \end{pmatrix}$$

$$\mathbf{q} = \begin{pmatrix} -9 \\ 5 \end{pmatrix}$$

The vectors  $\mathbf{p}$  and  $\mathbf{q}$  are such that  $|\mathbf{p}| = |\mathbf{q}|$

Given that  $x < 0$

find the value of  $x$ .

First you need to find  $|\mathbf{p}|$  and  $|\mathbf{q}|$

$$|\mathbf{p}| = \sqrt{(x)^2 + (2x-1)^2}$$

$$|\mathbf{q}| = \sqrt{(-9)^2 + (5)^2} = \sqrt{106}$$

Now make them equal and solve for  $x$ .

$$\begin{array}{l} \sqrt{(x)^2 + (2x-1)^2} = \sqrt{106} \\ \text{Square} \rightarrow (x)^2 + (2x-1)^2 = 106 \end{array}$$

$$\text{Expand} \rightarrow x^2 + 4x^2 - 2x - 2x + 1 = 106$$

$$\text{Simplify} \rightarrow 5x^2 - 4x + 1 = 106$$

$$-106 \rightarrow 5x^2 - 4x - 105 = 0$$

$$5x - 105 = -525$$

$$(\cancel{5x-105}^{-5})(5x+21) = 0$$

$$(x-5)(5x+21) = 0$$

$$\begin{array}{l} x - 5 = 0 \\ +5 \rightarrow x = 5 \end{array}$$

$$\begin{array}{l} 5x + 21 = 0 \\ -21 \rightarrow 5x = -21 \\ \div 5 \rightarrow x = -\frac{21}{5} \end{array}$$

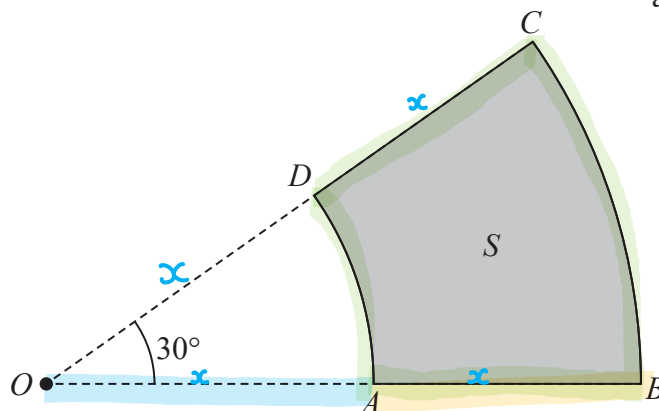
$\rightarrow$  Choose  $x = -\frac{21}{5}$  since  $x < 0$

$$x = -\frac{21}{5}$$

(Total for Question 18 is 4 marks)



Diagram NOT accurately drawn



$BOC$  is a sector of a circle, centre  $O$ , with  $\angle BOC = 30^\circ$   
The sector  $AOD$  of the circle, centre  $O$ , such that  $ODC$  and  $OAB$  are straight lines, is removed from the sector  $BOC$  to form the region  $S$ , shown shaded in the diagram.

Given that  $OA = AB$  and that the perimeter of  $S$  is 10 m,

calculate, giving your answer in terms of  $\pi$ , the length, in m, of  $AB$ .

To find  $AB$ , you need to form an expression for the circumference of  $S$  and solve for  $x$ .

Circumference of a circle =  $2\pi r$

① Find the circumference of  $BC$ .

$$BC = \left( 2\pi \times 2x \times \frac{30}{360} \right) \\ = \frac{2\pi}{3} x$$

② Find circumference of  $AD$ .

$$AD = \left( 2\pi \times x \times \frac{30}{360} \right) \\ = \frac{\pi}{6} x$$

③ Form an expression for  $S$ .

$$S = BC + AD + AB + DC \\ = \frac{\pi}{3} x + \frac{\pi}{6} x + x + x \\ = \frac{\pi}{2} x + 2x$$

④ Find  $x$ .

$$\frac{\pi}{2} x + 2x = 10 \\ x \left( \frac{\pi}{2} + 2 \right) = 10 \\ x = \frac{10}{\frac{\pi}{2} + 2} \\ x = \frac{20}{\pi + 4}$$

$$\frac{20}{\pi + 4} \text{ m}$$

(Total for Question 19 is 4 marks)



20 The temperature ( $T^{\circ}\text{C}$ ) at midday in a city was recorded each day for 50 days.

The table shows information about these temperatures.

| Temperature ( $T^{\circ}\text{C}$ ) | Number of days |
|-------------------------------------|----------------|
| $5 < T \leq 8$                      | 3              |
| $8 < T \leq 11$                     | 12             |
| $11 < T \leq 14$                    | 12             |
| $14 < T \leq 17$                    | 16             |
| $17 < T \leq 20$                    | 6              |
| $20 < T \leq 23$                    | 1              |

(a) Write down the modal class.

The modal class is the class with the highest frequency.

$14 < T \leq 17$   
(1)

(b) Calculate an estimate, to the nearest  $^{\circ}\text{C}$ , of the mean temperature at midday in this city during these 50 days.

To find the mean, you need to find the sum of the midpoint multiplied by the frequency divided by the total frequency.

$$\frac{(6.5 \times 3) + (9.5 \times 12) + (12.5 \times 12) + (15.5 \times 16) + (18.5 \times 6) + (21.5 \times 1)}{3 + 12 + 12 + 16 + 6 + 1} = 13.28$$

$$\approx 13^{\circ}\text{C}$$

$13$   
(4)

(Total for Question 20 is 5 marks)



21 The functions  $f$  and  $g$  are defined for all values of  $x$  by

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

$$g(x) = 2x^2 + 1$$

(a) Write down the range of  $g$

Since  $2x^2$  will always be positive, its minimum is  $2(0)^2 + 1 = 1$ , meaning all answers will be greater.

$$g(x) \geq 1$$

(1)

(b) Solve the equation  $f(x) = gf(2)$

First find  $gf(x)$

$$\begin{aligned} 2(3x - 5)^2 + 1 &= 2(9x^2 - 15x - 15x + 25) + 1 \\ &= 2(9x^2 - 30x + 25) + 1 \\ &= 18x^2 - 60x + 50 + 1 \\ &= 18x^2 - 60x + 51 \end{aligned}$$

Next substitute 2 for  $gf(2)$

$$18(2)^2 - 60(2) + 51 = 3$$

Equate to  $f(x)$

$$\begin{aligned} 3x - 5 &= 3 \\ +5 & \quad \quad \quad +5 \\ 3x &= 8 \\ \div 3 & \quad \quad \quad \div 3 \\ x &= \frac{8}{3} \end{aligned}$$

$$x = \frac{8}{3}$$

(4)

(Total for Question 21 is 5 marks)



22

$$x = \sqrt{\frac{a-b}{c}}$$

$a = 8.45$  correct to 2 decimal places.

$b = 1.93$  correct to 2 decimal places.

$c = 3.415$  correct to 3 decimal places.

The upper bound of  $x$  and the lower bound of  $x$  are the same correct to  $n$  decimal places.

Calculate the value of  $x$  correct to  $n$  decimal places, for the largest integer  $n$ .

You must show all your working and give a reason for your final answer.

Here you need to calculate both the upper bound and lower bound of  $x$  and truncate to the highest decimal place. First write the boundaries for  $a$ ,  $b$  and  $c$ .

$$8.445 \leq a < 8.455$$

$$1.925 \leq b < 1.935$$

$$3.445 \leq c < 3.455$$

For the upper bound of  $x$ , you want the highest possible numerator and the lowest possible denominator and for the lower bound you want the lowest possible numerator and the highest possible denominator.

$$x_{UB} = \sqrt{\frac{8.455 - 1.925}{3.445}}$$

$$= 1.3829071\dots$$

$$x_{LB} = \sqrt{\frac{8.445 - 1.935}{3.455}}$$

$$= 1.3806856\dots$$

The decimals stop being the same at 1.38.

$$x = 1.38\dots$$

(Total for Question 22 is 5 marks)



23 (a) Factorise completely  $10a - 25ab$

The highest common factor of  $10a$  and  $-25ab$  is  $5a$ , so take this out and put the rest in brackets.

$$5a(2 - 5b)$$

$$5a(2 - 5b)$$

(2)

(b) Factorise  $x^2 - 3x - 10$

1: Multiply the first and last numbers

$$1 \times -10 = -10$$

2: What numbers add to make the middle number and the product of the first and last number

$$-5 \text{ and } 2$$

3: Split the middle term into the numbers above

$$x^2 + 2x - 5x - 10$$

4: Split down the middle.

$$x^2 + 2x \quad -5x - 10$$

1: Multiply the first and last numbers

$$1 \times -10 = -10$$

2: What numbers add to make the middle number and the product of the first and last number

$$-5 \text{ and } 2$$

3: Cancel out.

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

$$(x-5)(x+2)$$

(2)

(c) Factorise completely  $50x^2 - 72y^2$

We need to turn these numbers into two square numbers so that we can create a difference of two squares

$$\begin{aligned} &50x^2 - 72y^2 \\ &= 2(25x^2 - 36y^2) \\ &= 2[(5x - 6y)(5x + 6y)] \\ &= 2(5x - 6y)(5x + 6y) \end{aligned}$$

(2)

(Total for Question 23 is 6 marks)

→ 5: Take out what's common from each side. If nothing is common, take out 1.

$$x(x+2) - 5(x+2)$$

6: Choose the bracket that is the same and the terms in from go into the other bracket.

$$(x-5)(x+2)$$



24 The equation of a curve  $C$  is  $y = \frac{(2x-3)(kx+5)}{x}$ , where  $k$  is a constant.

The point  $A$  on  $C$  is a stationary point.

Given that the  $x$  coordinate of  $A$  is  $\frac{1}{2}$

find the value of  $k$ .

You can use the co-ordinates of point  $A$  to find  $k$ . Since point  $A$  is stationary, the gradient will be 0 so you can find the first derivative and equate to 0 for the  $k$  value.

First, expand the brackets.

$$y = \frac{(2x-3)(kx+5)}{x}$$

$$y = \frac{2kx^2 + 10x - 3kx - 15}{x}$$

$$y = 2kx + 10 - 3k - 15x^{-1}$$

Next differentiate once for the first derivative. The general rule for differentiation is "bring down the power and subtract 1."

$$y = 2kx^1 + 10x^0 - 3kx^0 - 15x^{-1}$$

$$\frac{dy}{dx} = (1)2kx^{1-1} - 15x^{-1-1}$$

$$= 2k + 15x^{-2}$$

Equate to 0 and substitute  $x = \frac{1}{2}$  for  $k$ .

$$0 = 2k + 15\left(\frac{1}{2}\right)^{-2}$$

$$0 = 2k + 60$$

$$\begin{array}{l} -60 \quad \rightarrow \quad -60 = 2k \quad \rightarrow -60 \\ \div 2 \quad \rightarrow \quad -30 = k \quad \div 2 \end{array}$$

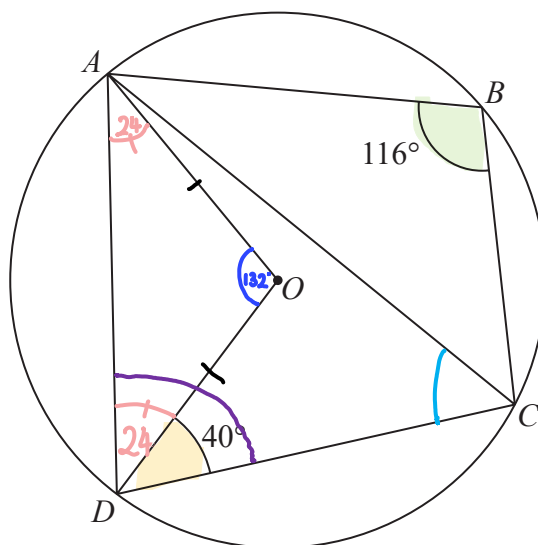
$$k = -30$$

(Total for Question 24 is 6 marks)





Diagram NOT accurately drawn



In the diagram,  $A$ ,  $B$ ,  $C$  and  $D$  are points on a circle, centre  $O$ .

$$\angle ABC = 116^\circ \text{ and } \angle ODC = 40^\circ$$

(a) Calculate, giving your reasons, the size in degrees of  $\angle OAD$ .

Opposite angles of a cyclic quadrilateral add to  $180^\circ$ .

$$\angle ABC + \angle ADC = 180$$

$$\angle ADC = 180 - \angle ABC$$

$$\angle ADC = 180 - 116$$

$$\angle ADC = 64^\circ$$

$$\angle ODA = \angle ADC - \angle ODC$$

$$\angle ODA = 64 - 40$$

$$\angle ODA = 24$$

Opposite angles of an isosceles triangle are equal.

$$\angle OAD = \angle ODA$$

$$\angle OAD = 24^\circ$$

$$\angle OAD = 24$$

(4)



(b) Calculate, giving your reasons, the size in degrees of  $\angle ACD$ .

Angles in a triangle add to  $180^\circ$ .

$$\angle ODA + \angle OAD + \angle AOD = 180$$

$$24 + 24 + \angle AOD = 180$$

$$\angle AOD = 132^\circ$$

The angle at the centre is twice the angle at the circumference.

$$\angle AOD = 2\angle ACD$$

$$132 = 2\angle ACD$$

$$66^\circ = \angle ACD$$

$$\angle ACD = 66^\circ \quad (3)$$

(Total for Question 25 is 7 marks)



26 30 people travelled from London to Manchester for a conference.  
Of these people

15 travelled by train

9 travelled by plane

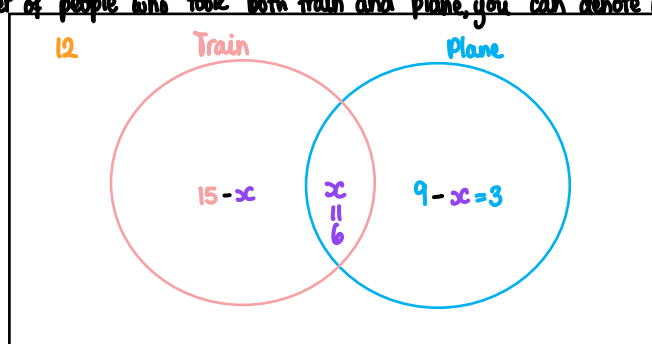
some travelled by both train and plane

12 did not travel by either train or plane

Three people are chosen at random from those who travelled by plane.

Find the probability that exactly two of these people also travelled by train.

Since you do not know the number of people who took both train and plane, you can denote it with  $x$ .



Now, you can solve for  $x$  since the total of the Venn diagram must equal 30.

$$12 + (15 - x) + x + (9 - x) = 30$$

$$36 - x = 30$$

$$-x = -6$$

$$x = 6$$

Now, you can calculate the probability:

$$3 \left( \frac{3}{6+3} \times \frac{6}{9-1} \times \frac{6-1}{9-2} \right) = 3 \left( \frac{3}{9} \times \frac{6}{8} \times \frac{5}{7} \right)$$

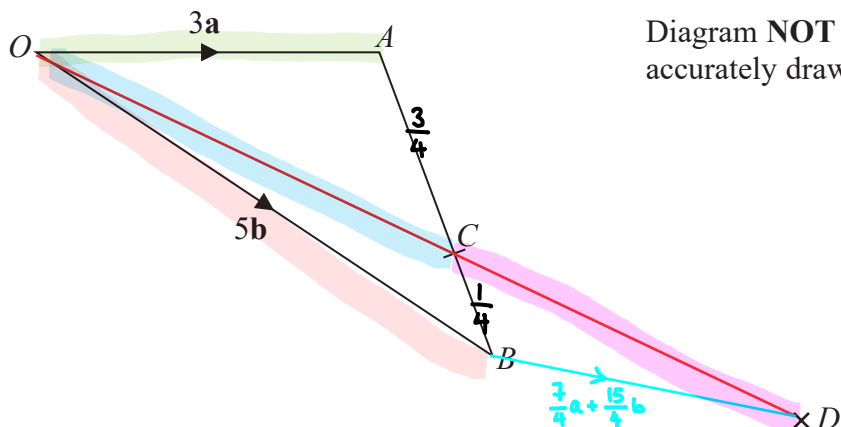
$$= \frac{15}{28}$$

$\frac{15}{28}$

(Total for Question 26 is 6 marks)



27



The diagram shows  $\triangle OAB$  and a point  $D$  which is outside the triangle.

The point  $C$  lies on  $AB$  such that  $AC = 3CB$   **$AC : CB = 3 : 1$**

The point  $D$  is such that  $\vec{BD} = \frac{7}{4}\mathbf{a} + \frac{15}{4}\mathbf{b}$  where  $\vec{OA} = 3\mathbf{a}$  and  $\vec{OB} = 5\mathbf{b}$

Find the ratio  $OC : CD$

$$\begin{aligned}\vec{AB} &= \vec{AO} + \vec{OB} \\ \vec{AB} &= -3\mathbf{a} + 5\mathbf{b} \\ \vec{AC} &= \frac{3}{4}\vec{AB} \\ \vec{AC} &= \frac{3}{4}(5\mathbf{b} - 3\mathbf{a}) \\ \vec{CB} &= \frac{1}{4}\vec{AB} \\ \vec{CB} &= \frac{1}{4}(5\mathbf{b} - 3\mathbf{a})\end{aligned}$$

$$\begin{aligned}\vec{OC} &= \vec{OA} + \vec{AC} \\ \vec{OC} &= (3\mathbf{a}) + \frac{3}{4}(5\mathbf{b} - 3\mathbf{a}) \\ \vec{OC} &= 3\mathbf{a} + \frac{15}{4}\mathbf{b} - \frac{9}{4}\mathbf{a} \\ \vec{OC} &= \frac{3}{4}\mathbf{a} + \frac{15}{4}\mathbf{b}\end{aligned}$$

$$\begin{aligned}\vec{CD} &= \vec{CB} + \vec{BD} \\ \vec{CD} &= \frac{1}{4}(5\mathbf{b} - 3\mathbf{a}) + \frac{7}{4}\mathbf{a} + \frac{15}{4}\mathbf{b} \\ \vec{CD} &= \frac{5}{4}\mathbf{b} - \frac{3}{4}\mathbf{a} + \frac{7}{4}\mathbf{a} + \frac{15}{4}\mathbf{b} \\ \vec{CD} &= \mathbf{a} + 5\mathbf{b}\end{aligned}$$

$$\begin{aligned}\vec{OC} &= \frac{3}{4}\mathbf{a} + \frac{15}{4}\mathbf{b} : \vec{CD} \\ \frac{3}{4}\mathbf{a} + \frac{15}{4}\mathbf{b} : \mathbf{a} + 5\mathbf{b} \\ \text{Take out } \frac{3}{4} &\rightarrow \frac{3}{4}(\mathbf{a} + 5\mathbf{b}) : \mathbf{a} + 5\mathbf{b} \\ \div (\mathbf{a} + 5\mathbf{b}) &\rightarrow \frac{3}{4} : 1 \\ \times 4 &\rightarrow 3 : 4\end{aligned}$$

3:4

(Total for Question 27 is 5 marks)

TOTAL FOR PAPER IS 100 MARKS



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