



1 (a) Simplify $(m^2)^3$

$$m^6$$

(1)

(b) Simplify $x^5 \times x^8$

$$x^{13}$$

(1)

(c) Expand $4p(p^2 + 3p)$

$$4p^3 + 12p^2$$

(2)

(Total for Question 1 is 4 marks)

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- 2 Jonny wants to know how much coffee he will need for 800 people at a meeting.

Each person who drinks coffee will drink 2 cups of coffee.

10.6 g of coffee is needed for each cup of coffee.

$$10.6 \times 2 = 21.2 \text{ g}$$

Jonny assumes 68% of the people will drink coffee.

- (a) Using this assumption, work out the amount of coffee Jonny needs.

Give your answer correct to the nearest gram.

$$68\% \text{ of } 800 = 544$$

$$\begin{aligned} 544 \times 21.2 &= 11532.8 \text{ g} \\ &= 11533 \text{ g} \end{aligned}$$

$$\begin{array}{r} 11533 \\ \hline \end{array} \text{ g}$$

(4)

Jonny's assumption is wrong.

72% of the people will drink coffee.

- (b) How does this affect your answer to part (a)?

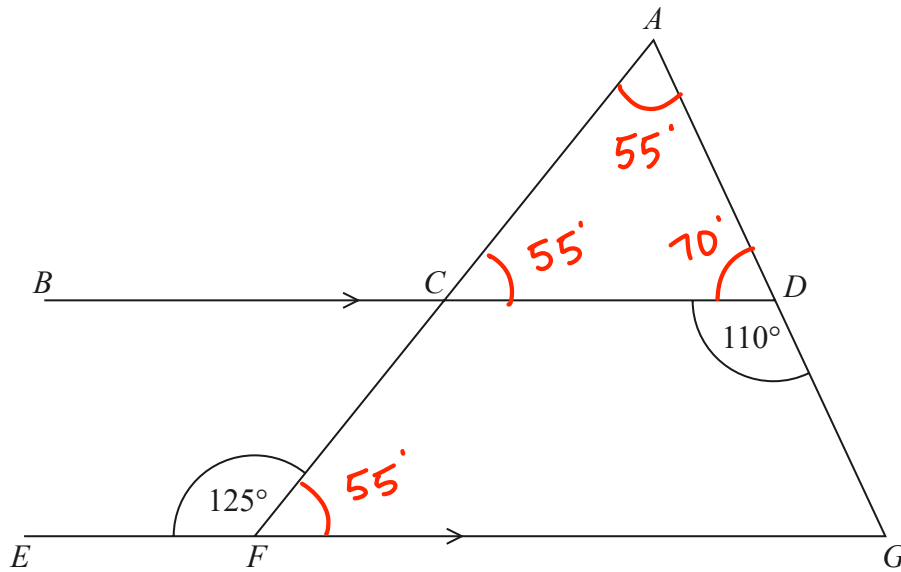
He will need more coffee

(1)

(Total for Question 2 is 5 marks)



- 3 ACF and ADG are straight lines.
 BCD and EFG are parallel lines.



Show that triangle ACD is isosceles.
 Give a reason for each stage of your working.

$$\angle CFG = 55^\circ \quad \text{angles on a straight line add to } 180^\circ$$

$$\angle ACD = 55^\circ \quad \text{Corresponding angles are equal}$$

$$\angle ADC = 70^\circ \quad \text{angles on a straight line add to } 180^\circ$$

$$\angle CAD = 55^\circ \quad \text{angles in a triangle add to } 180^\circ$$

ACD is isosceles as two of the angles are the same size

(Total for Question 3 is 5 marks)

- 4 It takes 14 hours for 5 identical pumps to fill a water tank.

How many hours would it take 4 of these pumps to fill another water tank of the same size?

$$\begin{array}{lcl} & 14 \text{ hrs} = 5 \text{ pumps} & \\ \times 5 \swarrow & & \searrow \div 5 \\ & 70 \text{ hrs} = 1 \text{ pump} & \\ \div 4 \swarrow & & \searrow \div 4 \\ & 17.5 \text{ hrs} = 4 \text{ pumps} & \end{array}$$

17.5 hours

(Total for Question 4 is 2 marks)

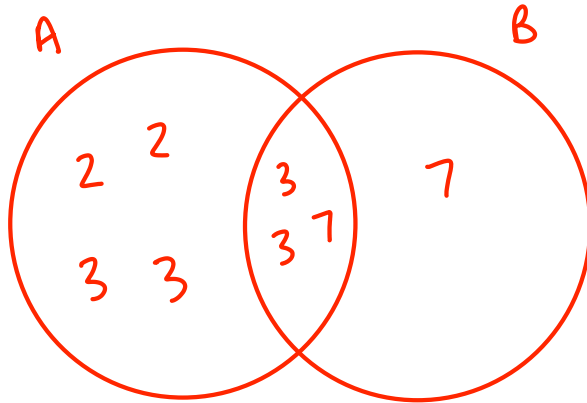


5 A and B are numbers such that

$$A = 2^2 \times 3^4 \times 7$$

$$B = 3^2 \times 7^2$$

(a) Find the highest common factor (HCF) of A and B .



$$\text{HCF} = 3 \times 3 \times 7$$

63

(1)

(b) Find the lowest common multiple (LCM) of A and B .

$$\text{LCM} = 2^2 \times 3^4 \times 7^2$$

15876

(2)

(Total for Question 5 is 3 marks)

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- 6 Lava flows from a volcano at a constant rate of $11.9\text{m}^3/\text{s}$

How many days does it take for $67\,205\,600\text{m}^3$ of lava to flow from the volcano?
Give your answer correct to the nearest day.

$$1 \text{ Second} = 11.9\text{m}^3$$

$$5647529 \text{ seconds} = 67205600\text{m}^3 \quad \downarrow \quad \times 5647529.412$$



$$\div 60 = \text{mins}$$

$$\div 60 = \text{hrs}$$

$$\div 24 = \text{days}$$

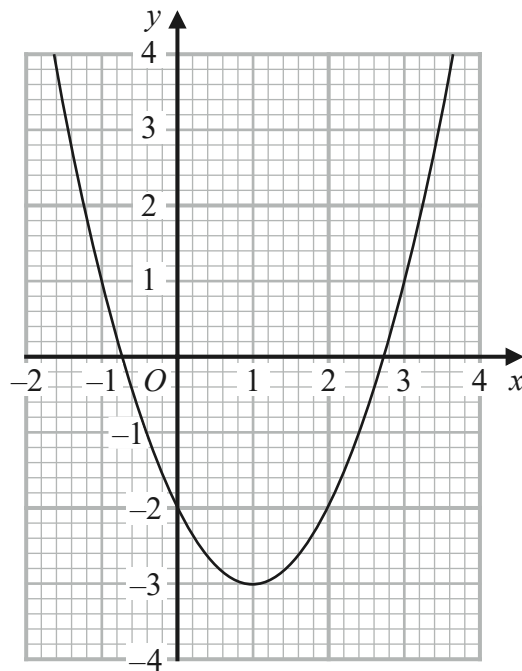
..... 65 days

(Total for Question 6 is 3 marks)

$$= 65.4 \text{ days}$$



7 Here is the graph of $y = x^2 - 2x - 2$



(a) Write down the coordinates of the turning point on the graph of $y = x^2 - 2x - 2$

(1 , -3)
(1)

(b) Write down an estimate for one of the roots of $x^2 - 2x - 2 = 0$

-0.7 or 2.7
(1)

(Total for Question 7 is 2 marks)

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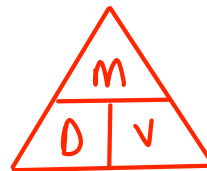
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- 8 A solid cuboid is made of metal.

The metal has a density of 9 g/cm^3
The volume of the cuboid is 72 cm^3

Work out the mass of the cuboid.



$$\begin{aligned} m &= D \times V \\ &= 9 \times 72 \end{aligned}$$

648 g

(Total for Question 8 is 2 marks)

- 9 Some people were asked if they wanted a new television.

70% of the people said yes.

80% of the people who said yes wanted a television with a large screen.

What percentage of the people asked said they wanted a television with a large screen?

80% of the 70%.

$$= 80\% \times 70\%$$

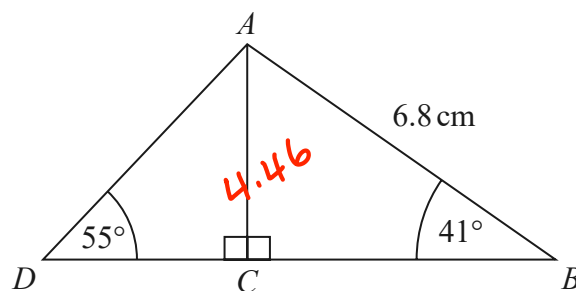
$$= 0.56$$

56%

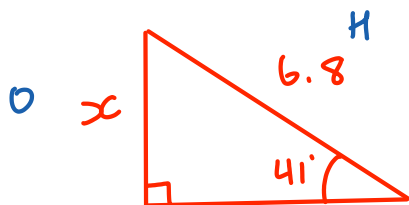
(Total for Question 9 is 2 marks)



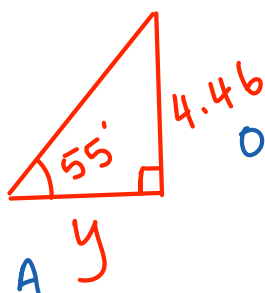
- 10 ABD is a triangle.
 C is a point on BD .



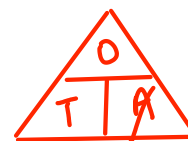
Work out the length of DC .
 Give your answer correct to 1 decimal place.



$$\sin(41) \times 6.8 = 4.46$$



$$\frac{4.46}{\tan(55)} = 3.12$$



3.1 cm

(Total for Question 10 is 3 marks)

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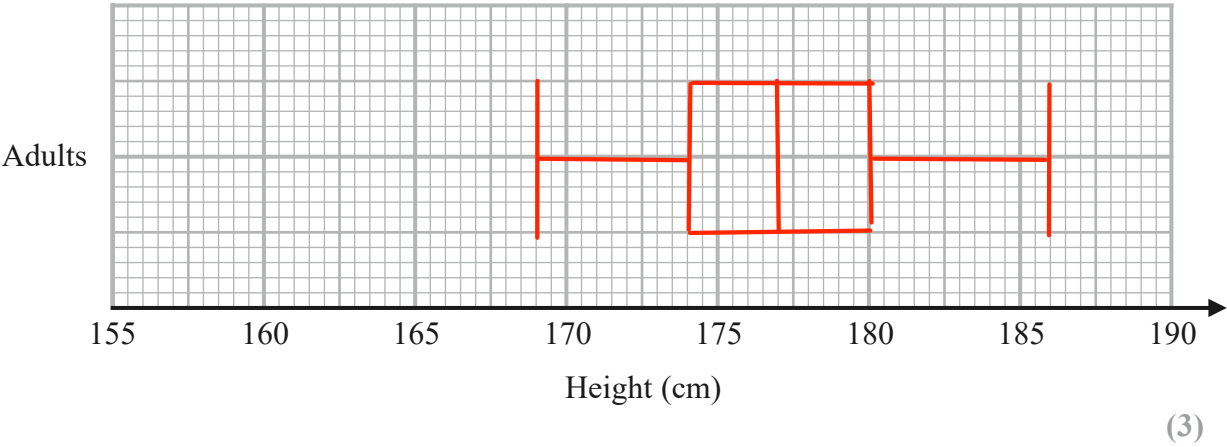
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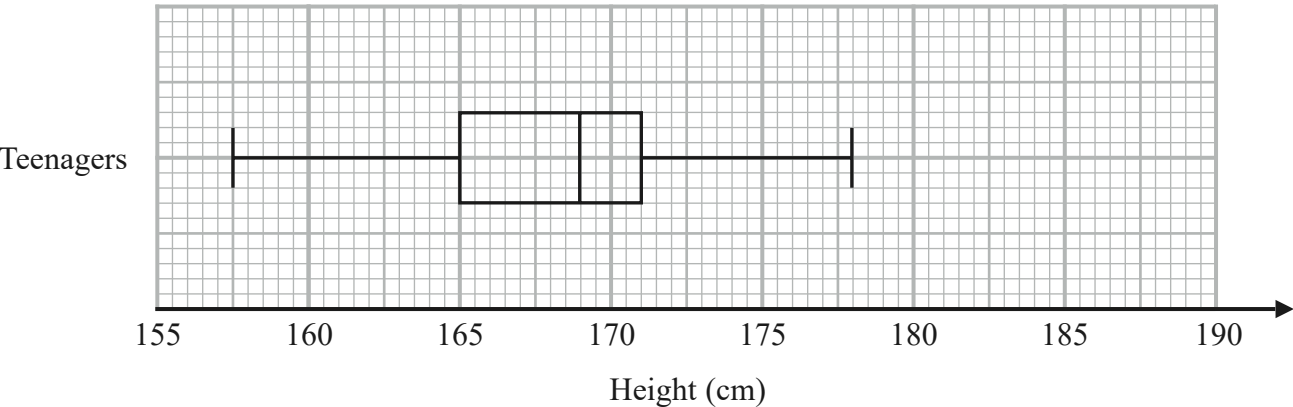
11 The table shows some information about the heights of a group of adults.

least height	169 cm
greatest height	186 cm
median	177 cm
lower quartile	174 cm
upper quartile	180 cm

(a) On the grid, draw a box plot for the information in the table.



The box plot below shows the distribution of the heights of a group of teenagers.



(b) Compare the distribution of the heights of the adults with the distribution of the heights of the teenagers. **Tip: You have to compare the median and either the range or IQR**

The median height is greater for the adults, suggesting that they are taller
The range is smaller for the adults, suggesting that their heights vary less

(2)

(Total for Question 11 is 5 marks)



- 12 Show that $(x-1)(x+3)(x-5)$ can be written in the form $ax^3 + bx^2 + cx + d$ where a, b, c and d are integers.

$$\begin{aligned}(x-1)(x+3) &= x^2 + 3x - x - 3 \\ &= x^2 + 2x - 3\end{aligned}$$

$$\begin{aligned}&(x^2 + 2x - 3)(x - 5) \\ &= x^3 - 5x^2 + 2x^2 - 10x - 3x + 15 \\ &= x^3 - 3x^2 - 13x + 15\end{aligned}$$

(Total for Question 12 is 3 marks)

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13 An expression for the n th term of the sequence of triangular numbers is $\frac{n(n+1)}{2}$

Prove that the sum of any two consecutive triangular numbers is a square number.

$$\frac{n(n+1)}{2} + \frac{(n+1)(n+2)}{2}$$

$$= \frac{n^2 + n}{2} + \frac{n^2 + 3n + 2}{2}$$

$$= \frac{2n^2 + 4n + 2}{2}$$

(Total for Question 13 is 3 marks)

$$= n^2 + 2n + 1$$

$$= (n+1)(n+1)$$

$$= (n+1)^2$$

$\therefore$ always a square number

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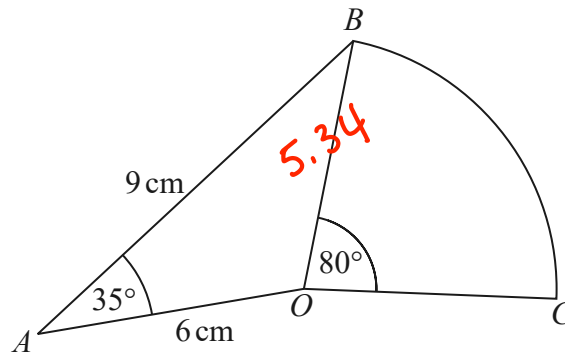
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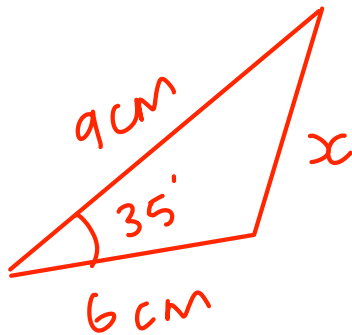
14 OAB is a triangle.

OBC is a sector of a circle, centre O .



Calculate the area of OBC .

Give your answer correct to 3 significant figures.



$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$x^2 = 9^2 + 6^2 - 2(9)(6) \cos(35)$$

$$x^2 = 28.531\dots$$

$$x = \sqrt{28.53} = 5.34$$

$$\frac{80}{360} \times \pi \times 5.34^2 = 19.9$$

19.9 cm²

(Total for Question 14 is 4 marks)



15 (a) Factorise $a^2 - b^2$

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

(1)

(b) Show that $2^{40} - 1$ is the product of two consecutive odd numbers.

$$\sqrt{2^{40}} = 2^{20}$$

$$(2^{20} + 1)(2^{20} - 1)$$

2^{20} is even $\therefore 2^{20} + 1$ and $2^{20} - 1$
are two consecutive odd numbers

(2)

(Total for Question 15 is 3 marks)

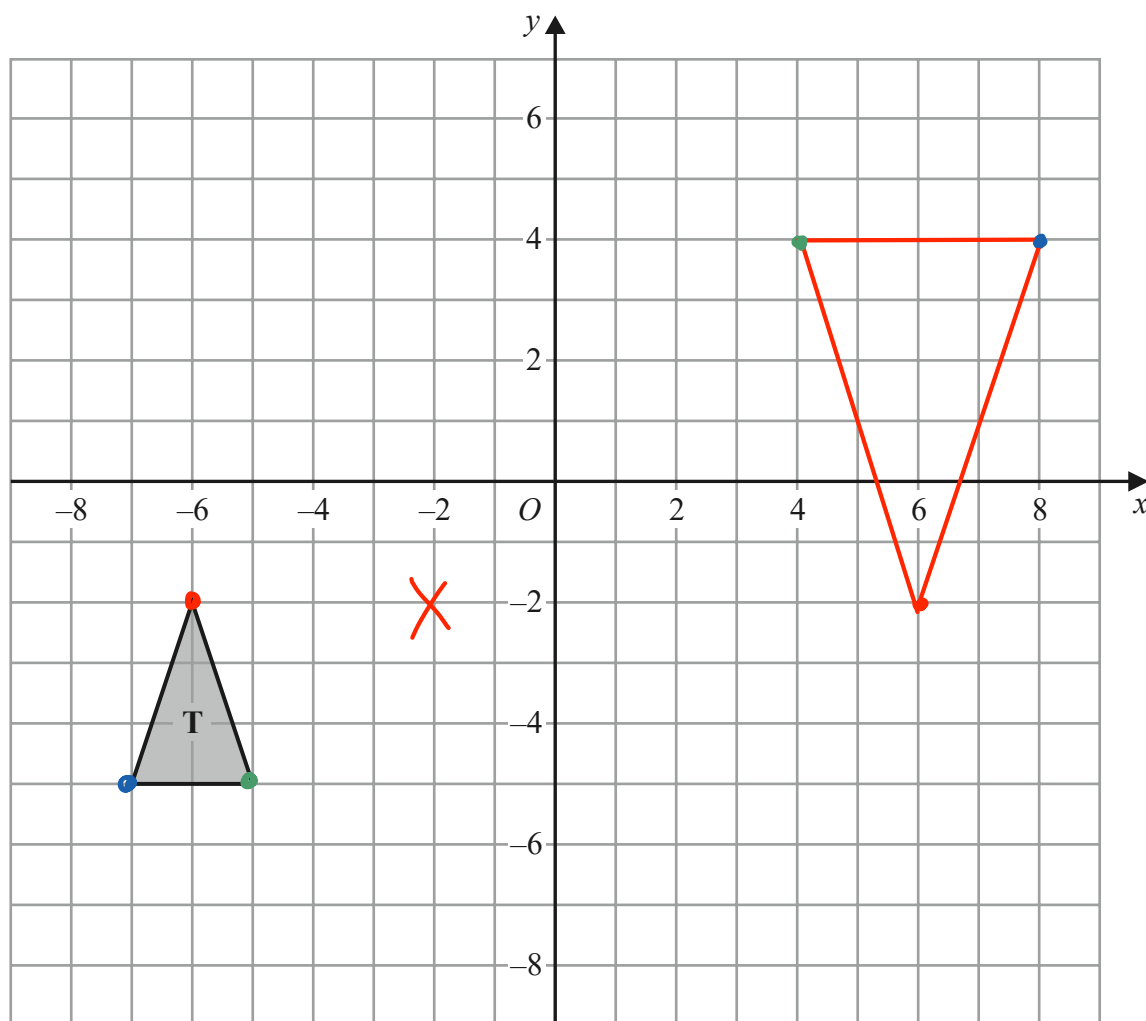
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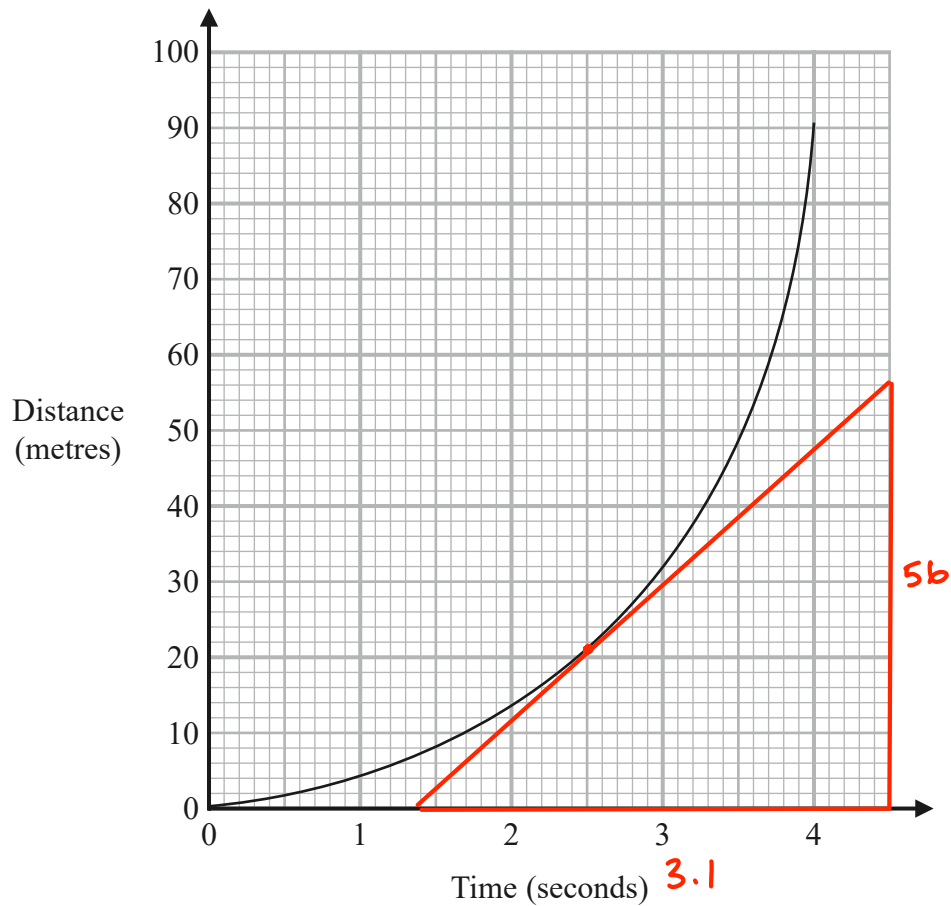


On the grid, enlarge triangle **T** by scale factor -2 with centre of enlargement $(-2, -2)$

(Total for Question 16 is 2 marks)



17 Here is a distance-time graph.



- (a) Find an estimate of the gradient of the graph at time 2.5 seconds.
You must show how you get your answer.

$$\text{gradient} = \frac{\text{rise}}{\text{run}} = \frac{56}{3.1}$$

- (b) What does the gradient of the graph represent?

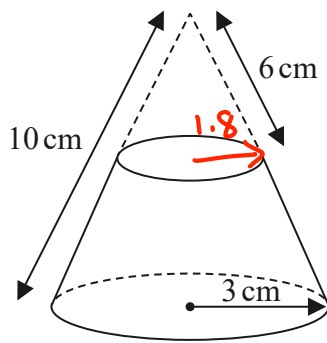
The speed

(1)

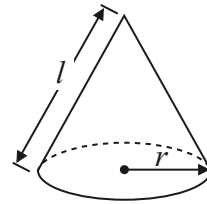
(Total for Question 17 is 4 marks)



- 18 A solid frustum is made by removing a small cone from a large cone as shown in the diagram.



Curved surface area of cone = $\pi r l$



The slant height of the small cone is 6 cm.
The slant height of the large cone is 10 cm.
The radius of the base of the large cone is 3 cm.

Calculate the total surface area of the frustum.
Give your answer correct to 3 significant figures.

$$10 \div 6 = 1.\dot{6} \text{ (Scale factor)}$$

$$3 \div 1.\dot{6} = 1.8$$

$$\text{Top area} = \pi \times 1.8^2 = 10.18$$

$$\text{Bottom area} = \pi \times 3^2 = 28.27$$

$$\begin{aligned} \text{Frustum} &= (\pi \times 3 \times 10) - (\pi \times 1.8 \times 6) \\ &= 60.32 \end{aligned}$$

$$\begin{aligned} \text{Total SA} &= 10.18 + 28.27 + 60.32 \\ &= 98.77 \end{aligned}$$

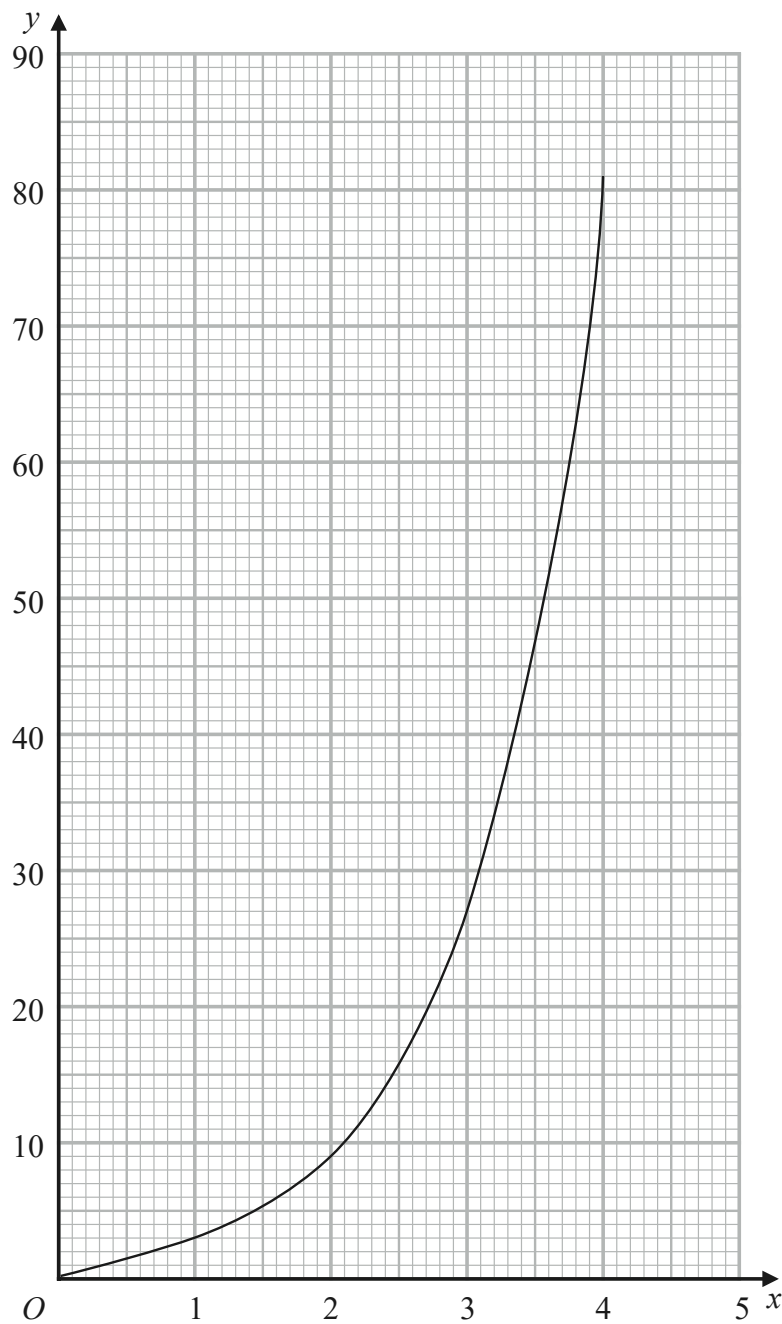
98.8 cm²

(Total for Question 18 is 5 marks)



19 Sana needs to draw the graph of $y = 3^x$ for $0 \leq x \leq 4$

She draws the graph shown on the grid.



Write down one thing Sana has done wrong.

The graph should not go through (0,0)

(Total for Question 19 is 1 mark)



20 Prove algebraically that $0.1\dot{2}\dot{3}$ can be written as $\frac{61}{495}$

Tip: If there is one recurring digit multiply by 10. If there are two recurring digits multiply by 100...

$$\begin{array}{r} 100x = 12.3\overline{23} \\ - \quad x = 0.1\overline{23} \\ \hline \end{array}$$

$$\begin{array}{l} 99x = 12.2 \\ x = \frac{12.2}{99} \end{array} \xrightarrow{\times 10} \frac{122}{990} \xrightarrow{\div 2} \frac{61}{495}$$

(Total for Question 20 is 3 marks)



21 Solve $\frac{1}{x+4} + \frac{3}{2-2x} = 1$

$$\begin{aligned} & (x+4)(2-2x) \\ &= 2x - 2x^2 + 8 - 8x \\ &= -2x^2 - 6x + 8 \end{aligned}$$

$$\frac{1(2-2x)}{(x+4)(2-2x)} + \frac{3(x+4)}{(x+4)(2-2x)}$$

$$= \frac{2-2x}{-2x^2-6x+8} + \frac{3x+12}{-2x^2-6x+8}$$

$$= \frac{x+14}{-2x^2-6x+8} = 1$$

$$x+14 = -2x^2-6x+8$$

$$2x^2 + \overset{+7}{7}x + \overset{\times 12}{6} = 0$$

$$2x^2 + 4x \mid + 3x + 6 = 0$$

$$2x(x+2) \mid 3(x+2) = 0$$

$$(2x+3)(x+2) = 0$$

$$x = -3/2$$

$$x = -2$$

(Total for Question 21 is 4 marks)



- 22 Given that the vector $a\begin{pmatrix} 2 \\ 6 \end{pmatrix} + b\begin{pmatrix} 8 \\ 2 \end{pmatrix}$ is parallel to the vector $\begin{pmatrix} 13 \\ 6 \end{pmatrix}$
find an expression for b in terms of a .

$$2a + 8b = 13x \quad \times 3$$

$$6a + 2b = 6x$$

$$\begin{array}{r} 6a + 24b = 39x \\ - 6a + 2b = 6x \\ \hline \end{array}$$

$$\begin{array}{l} \div 11 \quad \downarrow \quad 22b = 33x \quad \downarrow \quad \div 11 \\ \quad \quad 2b = 3x \quad \downarrow \quad \div 11 \end{array}$$

$$6a + 2b = 6x$$

$$6a + 3x = 6x$$

$$6a = 3x$$

$$b = 3a$$

(Total for Question 22 is 3 marks)

$$\text{If } 3x = 2b \text{ and } 3x = 6a$$

$$\begin{array}{l} \div 2 \quad \downarrow \quad 2b = 6a \quad \downarrow \quad \div 2 \\ \quad \quad b = 3a \quad \downarrow \quad \div 2 \end{array}$$

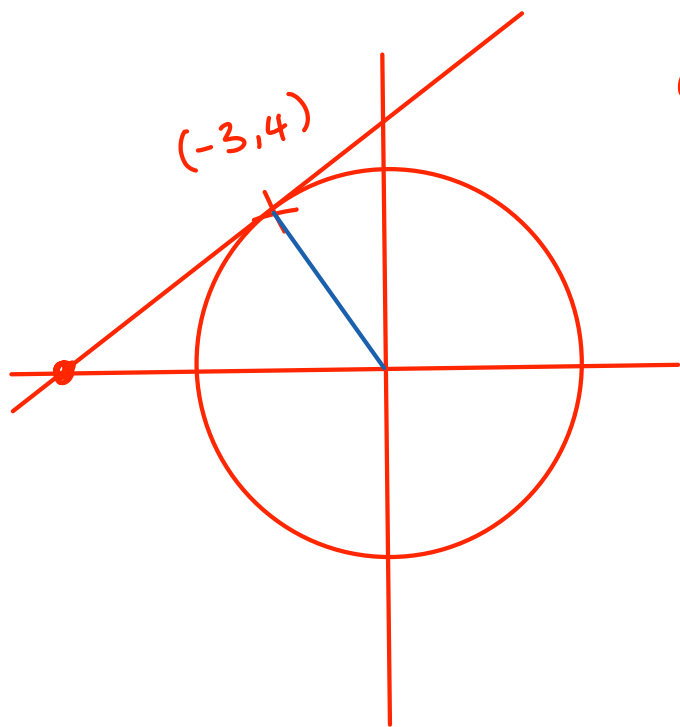
23 A circle has equation $x^2 + y^2 = 25$

The point P with coordinates $(-3, 4)$ lies on the circle.

Alex says that the tangent to the circle at P crosses the x -axis at the point $(-8, 0)$

Is Alex correct?

You must show how you get your answer.



$$\text{Gradient } OP = -\frac{4}{3}$$

$$\text{Gradient tangent} = \frac{3}{4}$$

$$y = \frac{3}{4}x + c$$

$$4 = \frac{3}{4}(-3) + c$$

$$4 = -\frac{9}{4} + c$$

$$c = \frac{25}{4}$$

$$y = \frac{3}{4}x + \frac{25}{4}$$

$$(-8, 0) \quad 0 = \frac{3}{4}(-8) + \frac{25}{4}$$

$$0 \neq \frac{1}{4}$$

NO, $y = \frac{3}{4}x + \frac{25}{4}$ does not pass through $(-8, 0)$

(Total for Question 23 is 4 marks)



24 There is a total of y counters in a box.

There are x pink counters and 5 blue counters in the box.
The rest of the counters are green.

$$x:y = 1:3$$

$$\text{Total} = 3x$$

Freda takes at random two counters from the box.

Find, in terms of x , an expression for the probability that Freda takes two counters of the same colour.

Give your answer as a fraction in the form $\frac{ax^2 + bx + c}{dx^2 + ex}$ where a, b, c, d and e are integers.

$$P, P = \frac{x}{3x} \times \frac{x-1}{3x-1} = \frac{x^2 - x}{9x^2 - 3x}$$

$$B, B = \frac{5}{3x} \times \frac{4}{3x-1} = \frac{20}{9x^2 - 3x}$$

$$G, G = \frac{2x-5}{3x} \times \frac{2x-6}{3x-1} = \frac{4x^2 - 22x + 30}{9x^2 - 3x}$$

$$\frac{x^2 - x}{9x^2 - 3x} + \frac{20}{9x^2 - 3x} + \frac{4x^2 - 22x + 30}{9x^2 - 3x}$$

$$= \frac{5x^2 - 23x + 50}{9x^2 - 3x}$$

(Total for Question 24 is 5 marks)

TOTAL FOR PAPER IS 80 MARKS