

1. Solve.

$$\frac{x^2 - 22}{x + 5} = 3x$$

You must show your working.

$$x = \dots\dots\dots \text{ or } x = \dots\dots\dots \quad \mathbf{[6]}$$

2.

$$3^x \times 9^y = 27$$

Show that $y = \frac{3-x}{2}$.

[4]

3. A sequence has n th term $2n^2 + 3$.

Prove algebraically that the sum of any two consecutive terms in this sequence is always a multiple of 4.

[6]

4. Solve.

$$4x + 17 = 13 - 6x$$

$x =$ [3]

5. A straight line has equation $y = 5x + 11$.

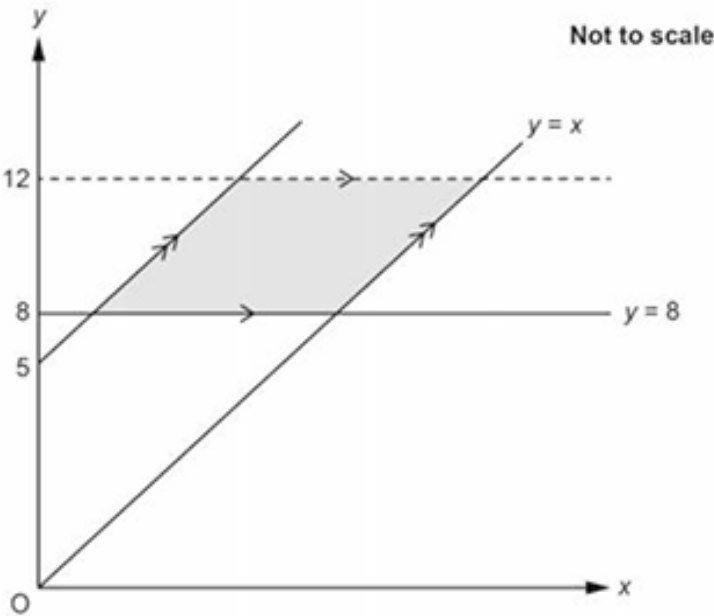
Alex says the graph of $y = 5x + 11$ passes through the point $(3, 23)$.

Is Alex correct?
Show how you decide.

because

[2]

6(a). In the diagram below, the shaded region is a parallelogram.
The parallelogram can be identified by four inequalities.
Two of the inequalities are $y > 8$ and $y > x$.



Write down the other **two** inequalities that identify the parallelogram.

[3]

(b). Work out the area of the parallelogram.
You must show your working.

..... square units **[4]**

7(a). $N = 8a^6$.

Write the following in the form.

$$N^{-1} = \dots\dots\dots a \dots\dots\dots$$

[2]

(b).

$$N^{\frac{2}{3}} = \dots\dots\dots a \dots\dots\dots$$

[2]

8. $(3x - a)(3x - a)(x^2 + 4) = 9x^4 + bx^2 - 100$

Find the **two** possible pairs of values for a and b .
You must show your working.

Pair 1: $a = \dots\dots\dots$ and $b = \dots\dots\dots$
Pair 2: $a = \dots\dots\dots$ and $b = \dots\dots\dots$ **[6]**

9. Rearrange this formula to make f the subject.

$$e = k - f$$

.....[2]

10(a). The next term in a Fibonacci sequence is found by adding together the previous two terms.
In a particular Fibonacci sequence:

- the first term is x
- the second term is 3.

Show that the fifth term in the sequence is $2x + 9$.

[2]

(b). The sixth term in the sequence is 54.

Find the value of x .

$x =$ [4]

11(a). Here is a function.



Complete the diagram below to show the **inverse** of the function.



[2]

(b). Here is a function.



When the input is 3, the output is 6.2.
When the input is 6, the output is 7.4.

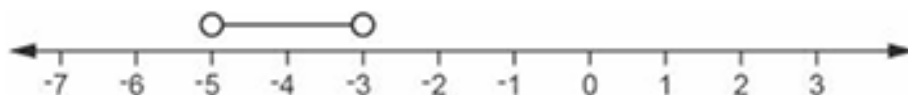
Find the value of m and the value of p .

$m =$
 $p =$ [5]

12(a). Find all the possible integer values of x that satisfy the inequality $8 < 3x - 4 \leq 19$

.....[3]

(b). An inequality is shown on the number line below.



Ryan says,

You can write this inequality as $\{x: -3 < x < -5\}$.

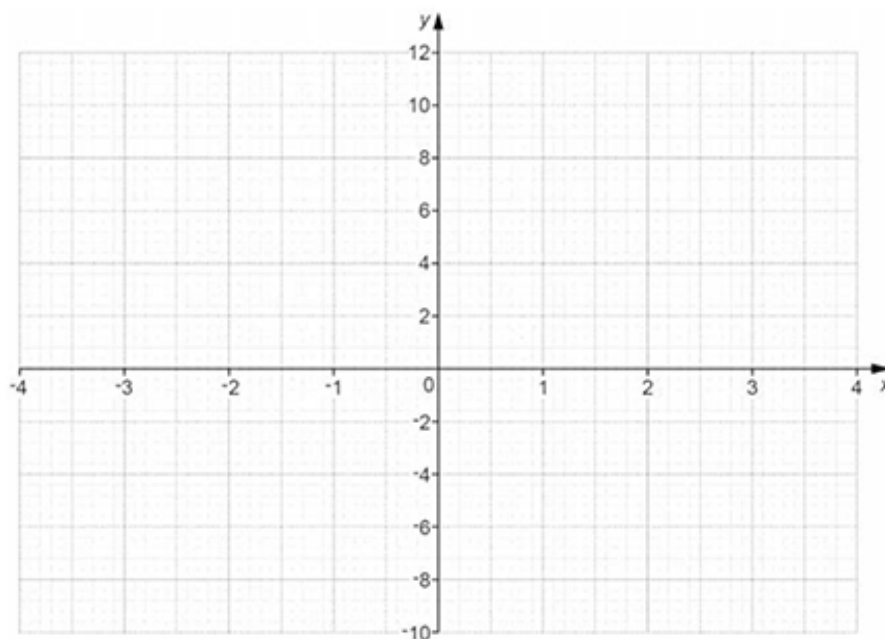
Explain why Ryan is **not** correct.

[1]

13(a). Here is a table of values for $y = x^2 - x - 6$.

x	-3	-2	-1	0	1	2	3
y	6	0	-4	-6	-6	-4	0

Draw the graph of $y = x^2 - x - 6$ for $-3 \leq x \leq 3$.



[3]

(b). Write down the equation of the line of symmetry of the graph.

..... **[1]**

(c). Use the graph to solve the equation $x^2 - x - 6 = 0$.

$x =$ or $x =$ **[2]**

14. y is directly proportional to the cube of t .

$y = 14$ when $t = 2$.

t is directly proportional to x .

$t = 16$ when $x = 4$.

Find a formula for y in terms of x .

Give your answer in its simplest form.

You must show your working.

$y =$ **[6]**

15(a). Some sequences are defined using this term-to-term rule.

$$u_{n+1} = 3u_n - 10$$

If $u_3 = 14$, show that $u_4 = 32$.

[1]

(b). If $u_3 = 14$, work out u_2 .

..... **[3]**

(c). If $u_1 = 5$, write down the value of u_{100} .

Give a reason for your answer.

$u_{100} =$ because

[2]

16(a).

Show that the equation $x^3 - 6x + 1 = 0$ has a solution between $x = 2$ and $x = 3$.

[3]

(b). Use $x = 2.5$ to find a smaller interval for the solution to $x^3 - 6x + 1 = 0$.
You must show your working.

..... **[2]**

(c). Find this solution correct to **1** decimal place.
You must show your working.

 $x =$ **[3]**

17(a). You may use these kinematics formulae to answer these questions.

$$v = u + at$$

$$v^2 = u^2 + 2as$$

A moving particle accelerates at 3 m/s^2 for 9 seconds.
The particle's final velocity after the 9 seconds is 32 m/s .

Show that the velocity of the particle at the start of the 9 seconds is 5 m/s .

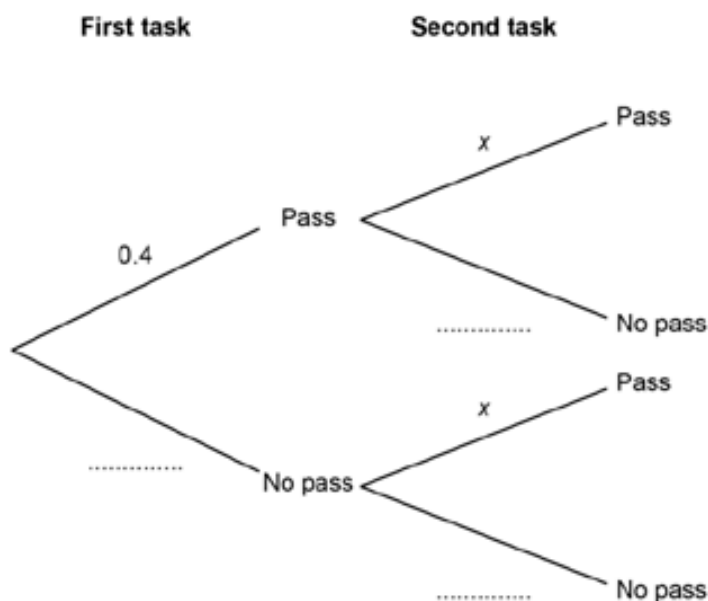
[2]

(b). Given the velocity of the particle at the start is 5 m/s , work out the distance travelled by the particle during the 9 seconds.

..... m **[3]**

The probability of the student passing the first task is 0.4.
The probability of the student passing the second task is x .

Complete the tree diagram.



[2]

(b). Write down the mathematical assumption that has been made about the two tasks.

[1]

(c). The probability of the student passing just one of these two tasks is 0.472.

Work out the value of x .

$x =$ [4]

19(a). Function A and function B are shown below.

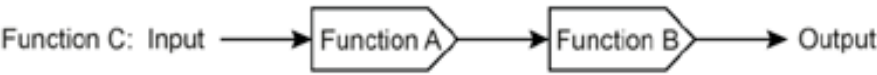


The **output** of function B is x.

Write an algebraic expression, in terms of x , for the inverse of function B.

..... [2]

(b). Function C is shown below as a composite function.



Complete the diagram below using two arithmetic operations to show function C as a single function.



[4]

20(a).
Solve by factorisation.

$5x^2 + 3x - 14 = 0$

$x = \dots\dots\dots$ or $x = \dots\dots\dots$ [3]

(b). Write $x^2 + 10x + 19$ in the form $(x + a)^2 - b$.

..... [3]

- 21.** A regular polygon has n sides.
The interior angle of the polygon is 7 times its exterior angle.

Find the value of n .

$$n = \dots\dots\dots \textbf{[4]}$$

- 22.** Four numbers are written, in ascending order, as algebraic expressions

$$a \quad a + b \quad a + 2b \quad 3a - b$$

The mean of these four numbers is 18.
The range of these four numbers is 20.

Find the value of a and the value of b .
You must show your working.

$$\begin{aligned} a &= \dots\dots\dots \\ b &= \dots\dots\dots \end{aligned} \textbf{[5]}$$

23. Solve the inequality.

$$x^2 - 144 \geq 0.$$

..... **[3]**

24. Here are the first four terms of a sequence.

$$\frac{3}{5} \quad \frac{6}{11} \quad \frac{9}{17} \quad \frac{12}{23}$$

Find the n th term of the sequence.

..... **[3]**

25. Expand and simplify.

$$(x + 4)(2x + 1)(x - 3)$$

..... **[3]**

26. A sphere has radius a cm.

A cone has radius $\frac{D}{2}$ cm and height D cm.

The volume of the sphere is equal to the volume of the cone.

Write D in terms of a .

[The volume V of a sphere with radius r is $V = \frac{4}{3} \pi r^3$.

The volume V of a cone with radius r and height h is $V = \frac{1}{3} \pi r^2 h$.]

..... **[4]**

27. Work out the coordinates of the intersection of the graphs of $y = 7 - 5x$ and $y = 2x^2$.
You must show your working.

(.....,) and (.....,) [6]

28. The following kinematics formulas may be used in this question.

$$v = u + at$$

$$v^2 = u^2 + 2as$$

A particle has an initial velocity of 5 m/s.

The particle accelerates uniformly at 2 m/s² for 3 seconds.

Find the distance travelled by the particle in the 3 seconds.

.....m [4]

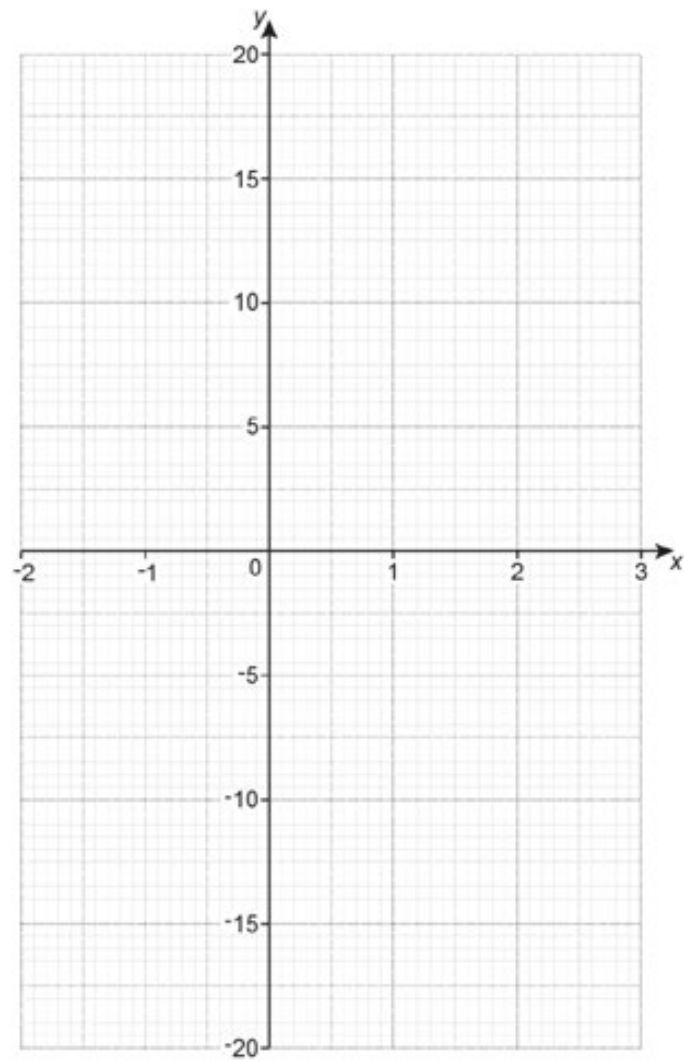
29(a).

Complete this table for $y = x^3 - 2x^2$.

x	-2	-1	0	1	2	3
y	-16		0	-1	0	

[2]

(b). Draw the graph of $y = x^3 - 2x^2$ for values of x from -2 to 3.

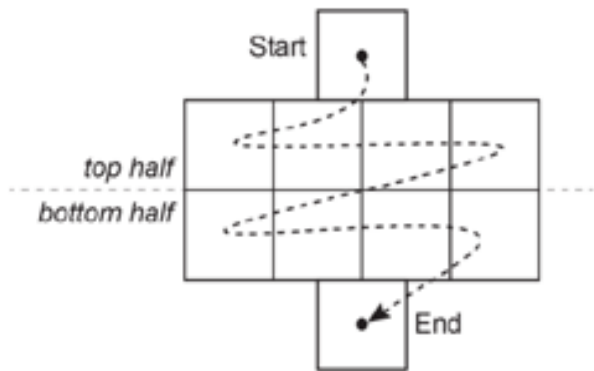


[3]

(c). Use the graph to solve the equation $x^3 - 2x^2 = 3$.
Give your answer to 1 decimal place.

..... [1]

30. Ten consecutive numbers are written in ascending order in this grid, starting from the top and working left to right.



Use algebra to prove that for any set of ten consecutive numbers written in this grid in the same way, the sum of the numbers in the top half of the grid is 25 less than the sum of the numbers in the bottom half of the grid.

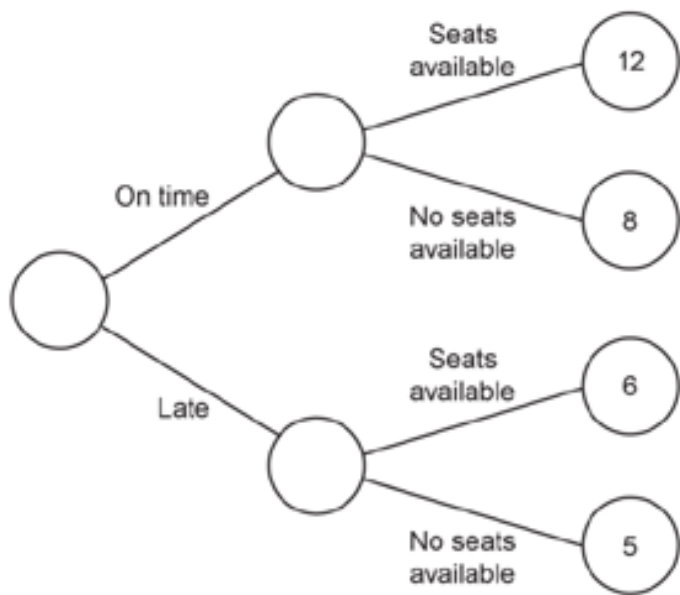
[5]

31. Kareem travels to work each day by train.

He records whether

- the train is on time or late
- there are seats available or no seats available.

Kareem’s results are shown on this partly completed frequency tree.



Kareem says

If the train is late, travellers are less likely to find seats available than if the train was on time.

Does Kareem’s data suggest he is correct?
Show how you decide.

because

[3]

32. Write as a single fraction in its simplest form.

$$4 + \frac{x^2 - 9}{(x - 7)(x + 3)}$$

[5]

33. Write $\frac{4x^6 \times 3\sqrt{x}}{2x^3}$ in the form kx^m .

[4]

34(a). $N = 4a^6$.

Write the following in the form ka^m .

$N^{-1} = \dots\dots\dots a^{\dots\dots\dots}$

[2]

(b). $N^{\frac{3}{2}} = \dots\dots\dots a^{\dots\dots\dots}$

[2]

35. $(4x + a)(4x - a)(x^2 + 2) = 16x^4 + bx^2 - 50$

Find the **two** possible pairs of values for a and b .
You must show your working.

Pair 1: $a = \dots\dots\dots$ and $b = \dots\dots\dots$
Pair 2: $a = \dots\dots\dots$ and $b = \dots\dots\dots$ **[6]**

36. Rearrange this formula to make f the subject.

$$\theta = \frac{k}{f}$$

$\dots\dots\dots$ **[2]**

37(a). The next term in a Fibonacci sequence is found by adding together the previous two terms.

In a particular Fibonacci sequence:

- the first term is 3
- the second term is x .

Show that the fifth term in the sequence is $6 + 3x$.

[2]

(b). The sixth term in the sequence is 74.

Find the value of x .

$x = \dots\dots\dots$ [4]

38(a). Here is a function.



Complete the diagram below to show the **inverse** of the function.



[2]

(b). Here is a function.



When the input is 5, the output is 8.5.
When the input is 10, the output is 11.

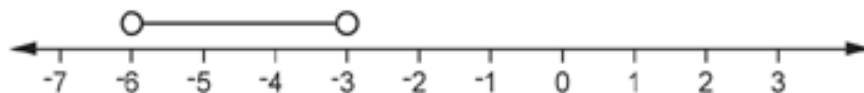
Find the value of m and the value of p .

$m = \dots\dots\dots$
 $p = \dots\dots\dots$ [5]

39(a). Find all the possible integer values of x that satisfy the inequality $10 < 3x - 2 \leq 21$.

..... **[3]**

(b). An inequality is shown on the number line below.



Taylor says,

You can write this inequality as $\{x: -3 < x < -6\}$.

Explain why Taylor is **not** correct.

..... **[1]**

40(a).

Work out.

$$\left(\frac{1}{8}\right)^{\frac{1}{3}}$$

..... **[1]**

(b). $2^x \times 4^y = 16$

Show that $y = 2 - \frac{x}{2}$.

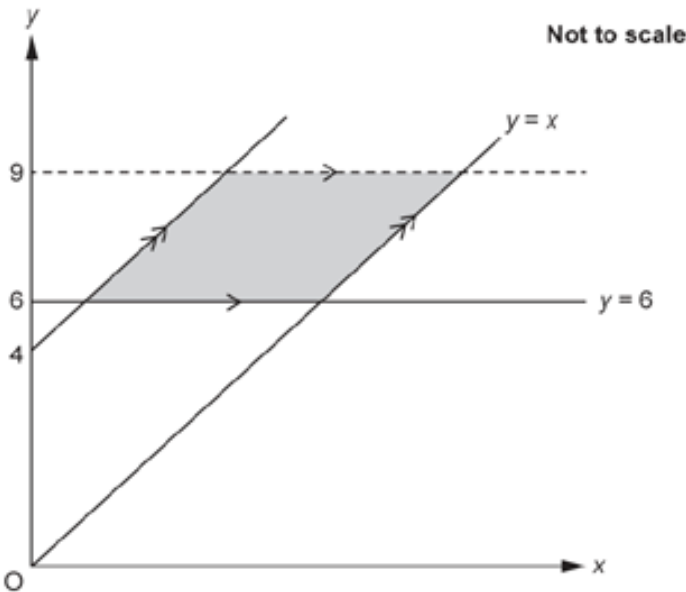
[4]

41. A sequence has n th term $2n^2 + 1$.

Prove algebraically that the sum of any two consecutive terms in this sequence is always a multiple of 4.

[6]

42(a). In the diagram below, the shaded region is a parallelogram. The parallelogram can be identified by four inequalities. Two of the inequalities are $y \geq 6$ and $y \geq x$.



Write down the other **two** inequalities that identify the parallelogram.

.....

-----[3]

(b). Work out the area of the parallelogram.
You must show your working.

..... square units **[4]**

43. Solve.

$$\frac{x^2 - 5}{x - 4} = 4x$$

You must show your working.

$x =$ or $x =$ **[6]**

44. Solve.

$$3x + 12 = 9 - 7x$$

$x =$ **[3]**

45. A straight line has equation $y = 4x + 9$.

Casey says the graph of $y = 4x + 9$ passes through the point (3, 23).

Is Casey correct?

Show how you decide.

..... because

..... **[2]**

46(a). Some sequences are defined using this term-to-term rule.

$$u_{n+1} = 5u_n - 8.$$

If $u_3 = 22$, show that $u_4 = 102$.

[1]

(b). If $u_3 = 22$, work out u_2 .

..... [3]

(c). If $u_1 = 2$, write down the value of u_{50} .
Give a reason for your answer.

$u_{50} =$ _____ because _____

[2]

47(a).

Show that the equation $x^3 - 3x - 4 = 0$ has a solution between $x = 2$ and $x = 3$.

[3]

(b). Use $x = 2.5$ to find a smaller interval for the solution to $x^3 - 3x - 4 = 0$.
You must show your working.

..... [2]

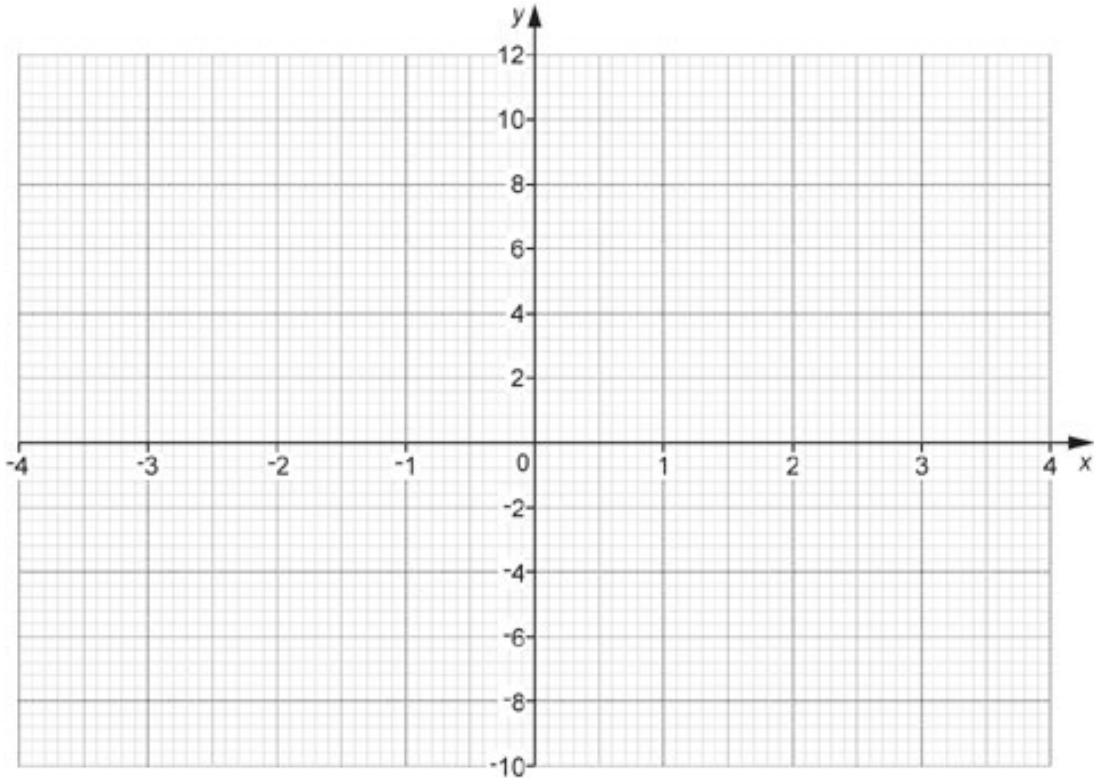
(c). Find this solution correct to **1** decimal place.
You must show your working.

$x =$ [3]

48(a). Here is a table of values for $y = x^2 - x - 8$.

x	-4	-3	-2	-1	0	1	2	3	4
y	12	4	-2	-6	-8	-8	-6	-2	4

Draw the graph of $y = x^2 - x - 8$ for $-4 \leq x \leq 4$.



[3]

(b). Write down the equation of the line of symmetry of the graph.

..... [1]

(c). Use the graph to solve the equation $x^2 - x - 8 = 0$.
Give your answers to **1** decimal place.

$x =$ or $x =$ [2]

49. y is directly proportional to the square of t .
 $y = 14$ when $t = 2$.

t is directly proportional to x .
 $t = 12$ when $x = 3$.

Find a formula for y in terms of x .
 Give your answer in its simplest form.
 You must show your working.

$y = \dots\dots\dots$ **[6]**

50(a). You may use these kinematics formulae to answer these questions.

$$v = u + at$$

$$v^2 = u^2 + 2as$$

A moving particle accelerates at 2 m/s^2 for 8 seconds.
 The particle's final velocity after the 8 seconds is 21 m/s .

Show that the velocity of the particle at the start of the 8 seconds is 5 m/s .

[2]

(b). Given the velocity of the particle at the start is 5 m/s , work out the distance travelled by the particle during the 8 seconds.

$\dots\dots\dots \text{ m}$ **[3]**

51(a). Riley and Hiro are asked to find how many solutions the equation $3(x - 1)^2 = 48$ has.

Here is **Riley's** answer.

$$\begin{aligned}3(x - 1)^2 &= 48 \\(x - 1)^2 &= 16 \\x - 1 &= 4 \\x &= 5\end{aligned}$$

There is one solution.

Here is **Hiro's** answer.

$$\begin{aligned}3(x - 1)^2 &= 48 \\(x - 1)^2 &= 16 \\x - 1 &= 4 \text{ or } x - 1 = -4 \\x &= 5 \text{ or } x = -3\end{aligned}$$

There are two solutions.

Decide who is correct, Riley or Hiro, and give the reason for your decision.

_____ is correct because _____

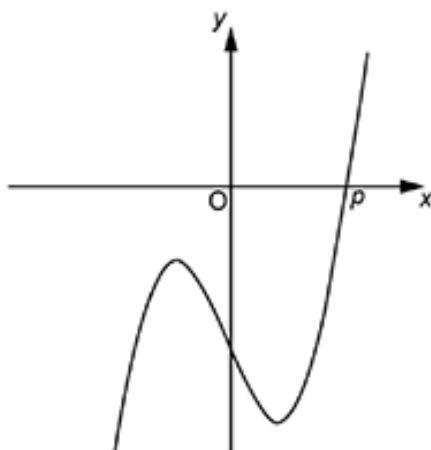
[1]

(b). Solve this equation algebraically.
Give your answers correct to **2** decimal places.
You must show your working.

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

$x = \dots\dots\dots$ or $x = \dots\dots\dots$ [4]

52(a). The graph of $y = x^5 - 60x - 200$ is sketched below.
The root of the equation $x^5 - 60x - 200 = 0$ is p .



Show that $3 < p < 4$.

[3]

(b). Find a smaller interval that contains the value of p .
You must show calculations to support your answer.

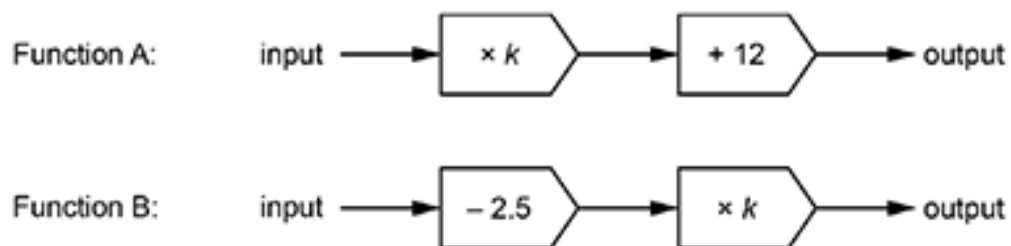
..... $< p <$ **[3]**

53. Simplify fully.

$$\frac{x^3 + x^2 - 12x}{x^3 - 16x}$$

..... [5]

54. Here are two functions.



5 is input into Function A.

5 is also input into Function B.

The output of Function A is 10 times the output of Function B.

Work out the value of k .

You must show your working.

$k =$ [5]

55(a). A sequence is defined by

$$u_{n+1} = 4u_n + 6 \text{ and } u_1 = -1.$$

Work out the value of u_2 and the value of u_3 .

$$u_2 = \dots\dots\dots$$

$$u_3 = \dots\dots\dots$$

[2]

(b). Here are the first four terms of a quadratic sequence.

-1 5 15 29

The sequence has the formula $x_n = an^2 + b$

Find the value of a and the value of b .

$$a = \dots\dots\dots$$

$$b = \dots\dots\dots$$

[3]

56. Solve this quadratic equation by factorisation.

$$2x^2 - 5x - 41 = 4x - 6$$

$$x = \dots\dots\dots \text{ or } x = \dots\dots\dots \quad \mathbf{[4]}$$

57. Solve.

$$x^{-\frac{1}{4}} = \frac{3x^{\frac{1}{2}}}{x^{\frac{1}{8}}}, \text{ where } x \neq 0$$

$$x = \dots\dots\dots \quad \mathbf{[3]}$$

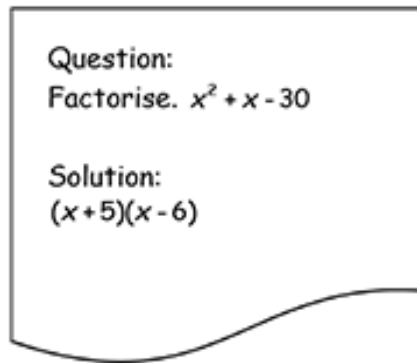
58. Find all the possible integer values that satisfy the inequality $-9 < 4x + 3 \leq 15$.

$x = \dots\dots\dots$ [3]

59(a). Here is a piece of work.

It shows a question and an incorrect solution.

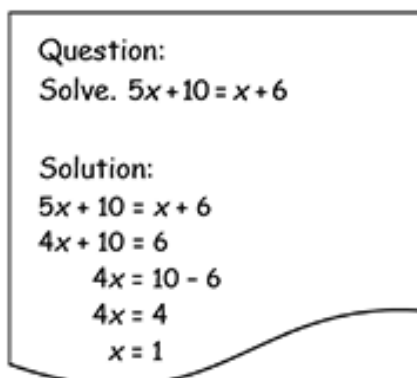
Describe the error made and write out a correct solution.



The error is _____

A correct solution is _____ [2]

(b).



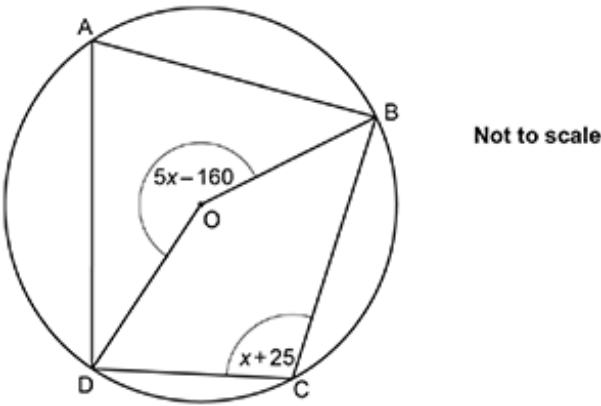
The error is _____

A correct solution is _____

[2]

60. In this question all angles are given in degrees.

A, B, C and D are points on the circumference of a circle, centre O.



Find the size of angle BCD.

..... ° [4]

61. The x -coordinates of the intersections of the graphs of $y = x^2 + ax + 6$ and $y = 5x + b$ are the solutions to the equation $x^2 + 7x + 10 = 0$.

Find the value of a and the value of b .

$a = \dots\dots\dots$

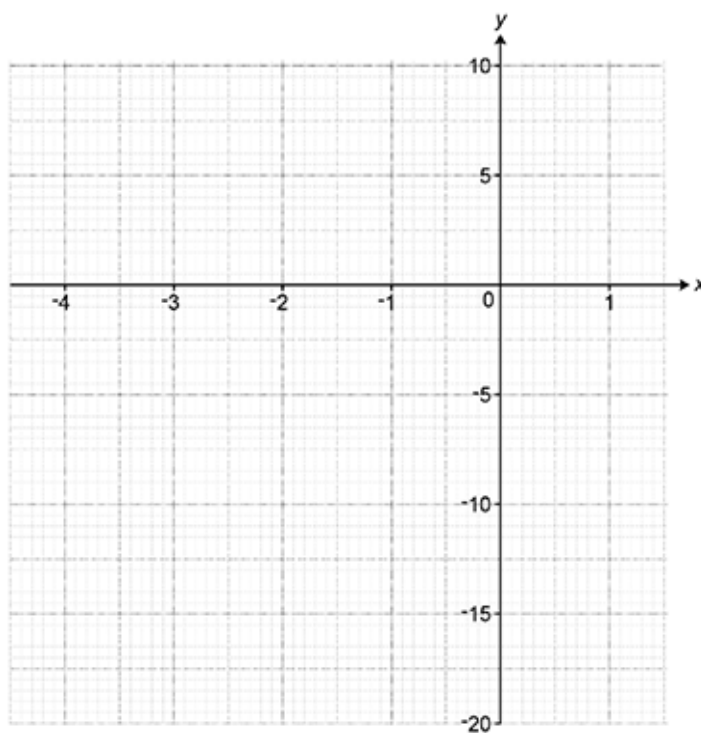
$b = \dots\dots\dots$ **[3]**

62(a). Complete the table for $y = x^3 + 3x^2$.

x	-4	-3.5	-3	-2.5	-2	-1	0	1
y	-16	-6.1	0	3.1	4		0	4

[1]

(b). Draw the graph of $y = x^3 + 3x^2$ for $-4 \leq x \leq 1$.



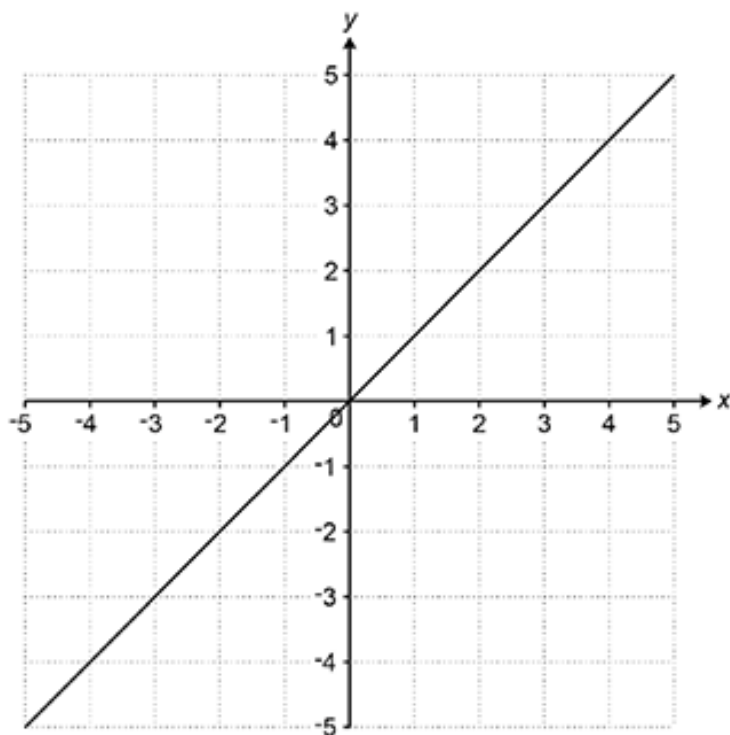
[3]

(c). The equation $x^3 + 3x^2 = k$ where k is an integer, has exactly one solution for $-4 \leq x \leq 1$.

Find the greatest possible value of k .

$k = \dots\dots\dots$ [1]

63. The graph of $y = x$ is drawn on the grid.

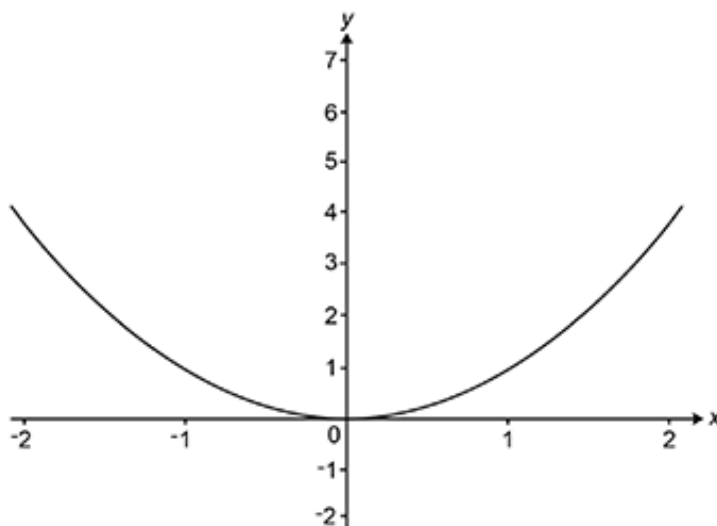


The region **R** satisfies the following inequalities.

$$y \leq x \quad y \geq -3 \quad y < -3x + 4$$

By drawing two more straight lines on the grid, find and label the region **R**.

64. The graph of $y = x^2$ is shown below for $-2 \leq x \leq 2$.



Describe the **single** transformation that maps the graph of $y = x^2$ onto the graph of $y = x^2 + 4x - 7$.

[4]

65(a). Find the next term of this sequence.

0.25 1 4 16 64

[1]

(b). In the Fibonacci sequence below, the next term is found by adding the two previous terms. The third term is 0.68 and the fourth term is 1.24.

Complete the first, second and fifth terms of the sequence.

..... 0.68 1.24

[3]

66(a). Simplify.

$$2a^3 \times 6a^4$$

..... [2]

(b). Factorise fully.

$$5x^2 - 15x$$

..... [2]

67. Write $\frac{9x^7 \times 2\sqrt{x}}{3x^4}$ in the form kx^m .

..... [4]

68. Write as a single fraction in its simplest form.

$$4 + \frac{x^2 - 49}{(x+7)(x-3)}$$

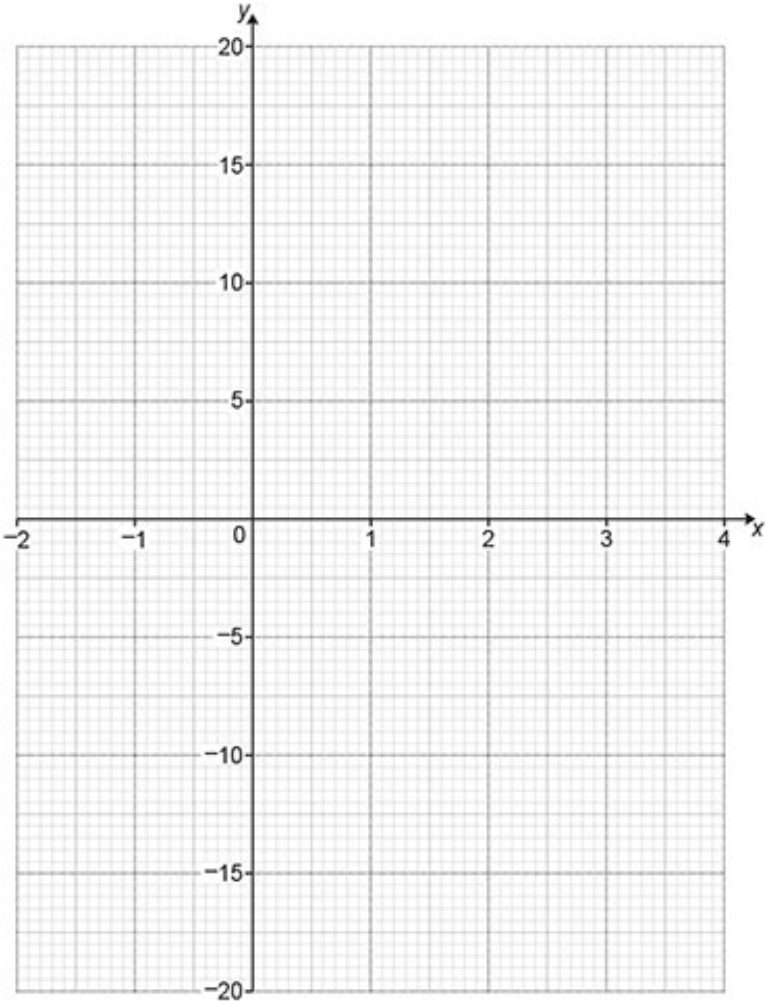
..... [5]

69(a). Complete this table for $y = x^3 - 3x^2$

x	-2	-1	0	1	2	3	4
y	-20		0	-2	-4		16

[2]

(b). Draw the graph of $y = x^3 - 3x^2$ for values of x from -2 to 4.

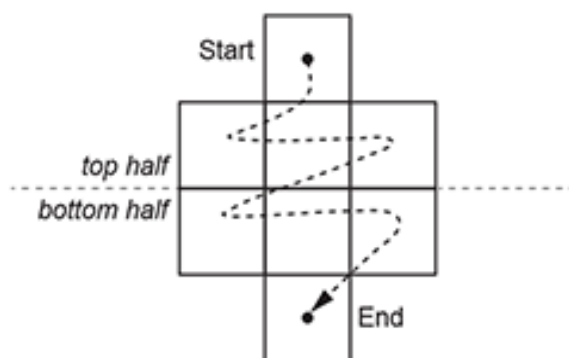


[3]

(c). Use the graph to solve the equation $x^3 - 3x^2 = 5$.
Give your answer to 1 decimal place.

..... [1]

70. Eight consecutive numbers are written in ascending order in this grid, starting from the top and working left to right.



Use algebra to prove that for **any** set of eight consecutive numbers written in this grid in the same way, the sum of the numbers in the top half of the grid is 16 less than the sum of the numbers in the bottom half of the grid.

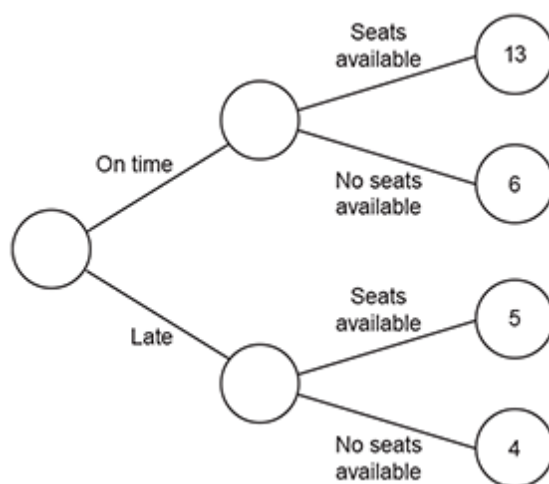
[5]

71. Jack travels to work each day by train.

He records whether

- the train is on time or late
- there are seats available or no seats available.

Jack's results are shown on this partly completed frequency tree.



Jack says

If the train is late, travellers are less likely to find seats available than if the train was on time.

Does Jack's data suggest he is correct?

Show how you decide.

_____ because _____

_____ [3]

72. Work out the coordinates of the intersection of the graphs of $y = 5 - 2x$ and $y = 3x^2$.

You must show your working.

(.....,) and (.....,) [6]

73. The following kinematics formulas may be used in this question.

$$v = u + at$$

$$v^2 = u^2 + 2as$$

A particle has an initial velocity of 0 m/s.

The particle accelerates uniformly at 3 m/s² for 4 seconds.

Find the distance travelled by the particle in the 4 seconds.

..... m **[4]**

74. Solve the inequality.

$$x^2 - 100 \geq 0.$$

..... **[3]**

75. Here are the first four terms of a sequence.

$$\frac{2}{5} \quad \frac{4}{9} \quad \frac{6}{13} \quad \frac{8}{17}$$

Find the n th term of the sequence.

..... **[3]**

76. Expand and simplify.

$$(x + 3)(4x + 1)(x - 2)$$

..... **[3]**

77. A sphere has radius x cm.

A cone has radius R cm and height $2R$ cm.

The volume of the sphere is equal to the volume of the cone.

Write R in terms of x .

[The volume V of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.

The volume V of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

..... **[4]**

78(a). Solve by factorisation.

$$3x^2 + 10x - 8 = 0$$

$x =$ or $x =$ **[3]**

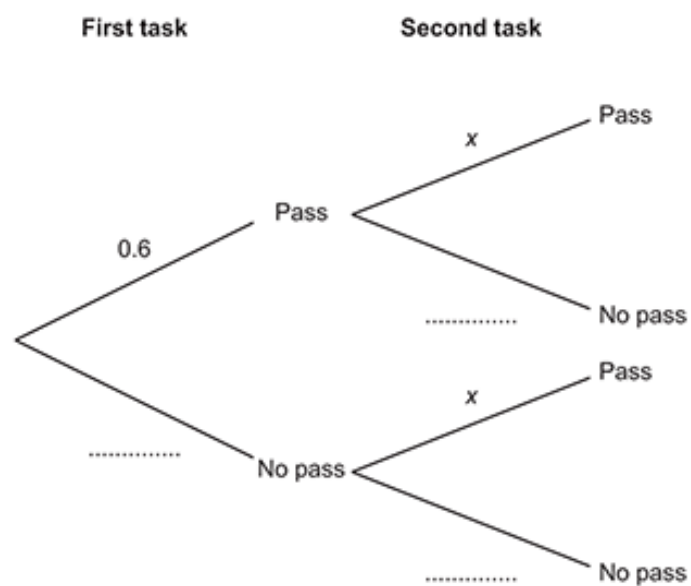
(b). Write $x^2 + 8x + 11$ in the form $(x + a)^2 - b$.

..... **[3]**

- 79.** A regular polygon has n sides.
The interior angle of the polygon is 15 times its exterior angle.
- Find the value of n .

$n = \dots\dots\dots$ [4]

- 80(a).** A student attempts two tasks.
The result of each task is either “Pass” or “No pass”.
- The probability of the student passing the first task is 0.6.
The probability of the student passing the second task is x .
- Complete the tree diagram.



[2]

(b). Write down the mathematical assumption that has been made about the two tasks.

[1]

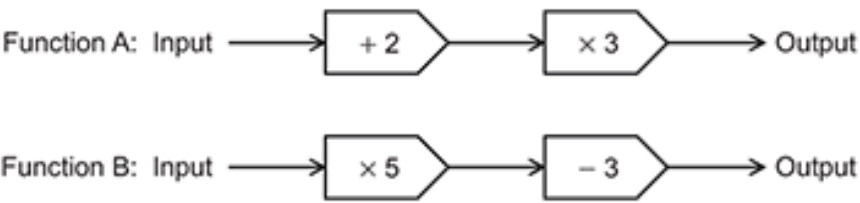
(c). The probability of the student passing just one of these two tasks is 0.528.

Work out the value of x .

$x =$

[4]

81(a). Function A and function B are shown below.



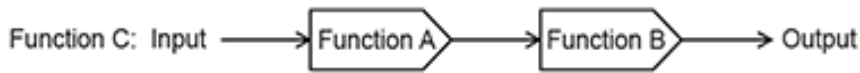
The **output** of function B is x .

Write an algebraic expression, in terms of x , for the inverse of function B.

.....

[2]

(b). Function C is shown below as a composite function.



Complete the diagram below using two arithmetic operations to show function C as a single function.



[4]

82. Four numbers are written, in ascending order, as algebraic expressions.

a $a + b$ $a + 2b$ $3a - b$

The mean of these four numbers is 27.
The range of these four numbers is 24.

Find the value of a and the value of b .
You must show your working.

$a = \dots\dots\dots$

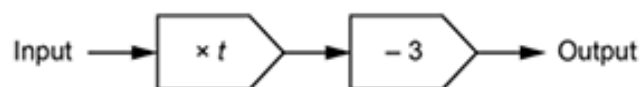
$b = \dots\dots\dots$ [5]

83. Write as a single fraction in its simplest form.

$$8 - \frac{5x+32}{2x+3}$$

..... **[4]**

84(a). Here is a function.



When the input is 6, the output is 19.

Find the value of t .

$t =$ **[3]**

(b). Here is a function.
When the input is x , the output is y .



Write an algebraic expression for x in terms of y .

..... **[2]**

85. Factorise fully $30x^2 + 2x - 12$.

..... **[3]**

86(a). By factorising, find the roots of $y = x^2 + 16x + 55$.

$x =$ and $x =$ **[3]**

(b).

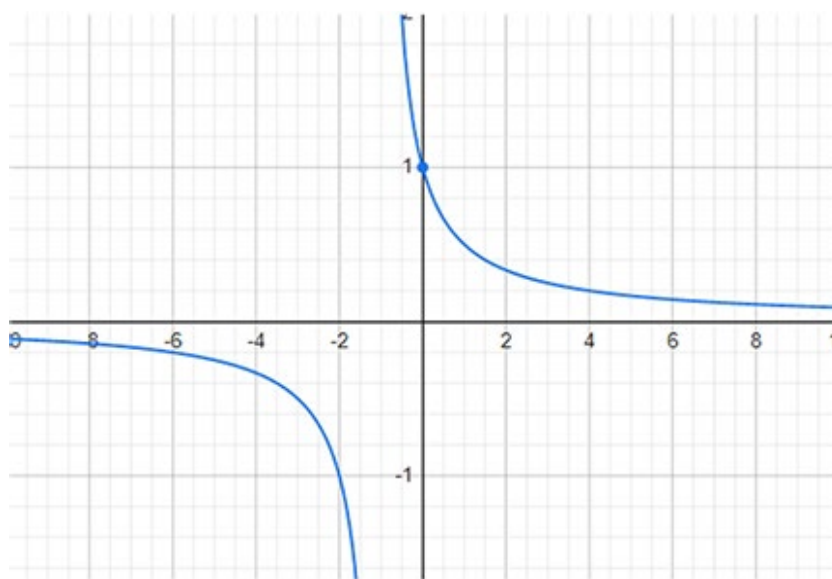
- i. Write $y = x^2 + 16x + 55$ in the form $y = (x + a)^2 - b$.

$y = \dots\dots\dots$ [3]

- ii. Write down the coordinates of the turning point of the graph of $y = x^2 + 16x + 55$

($\dots\dots\dots$, $\dots\dots\dots$) [2]

87(a). The graph of $y = \frac{1}{x+3}$ is drawn on the grid for $-6 \leq x \leq 1$.



There are no values of x for which $\frac{1}{x+3} = k$.

Find the value of k .

$k = \dots\dots\dots$ [1]

(b).

- i. **Use the graph** to find approximate solutions to the equation $\frac{1}{x+3} = 2x + 4$
 Give your answers to **1** decimal place.
 Show your working on the graph.

$x = \dots\dots\dots$ or $x = \dots\dots\dots$ **[4]**

- ii. Show algebraically that $\frac{1}{x+3} = 2x + 4$ has the same solutions as $2x^2 + 10x + 11 = 0$.

[4]

88. Find all the possible integer values that satisfy the inequality $-1 < x + 2 \leq 4$.

$\dots\dots\dots$ **[3]**

89(a). The next term in a Fibonacci sequence is found by adding together the two previous terms.

- i. The first and second terms of a particular Fibonacci sequence are x and $2y$.

Show that the fourth term of the sequence can be written as $x + 4y$.

[2]

- ii. The fourth term of the same Fibonacci sequence is 11.
The seventh term of the sequence is 47.

Work out the value of x and the value of y .
You must show your working.

$x = \dots\dots\dots$

$y = \dots\dots\dots$ **[6]**

(b). Here are the first four terms of a sequence.

1 $\sqrt{5}$ 5 $5\sqrt{5}$

Write an expression for the n th term.

$\dots\dots\dots$ **[2]**

(c). Here are the first four terms of a quadratic sequence.

-1 -1 1 5

The n th term is $n^2 + bn + c$.

Find the value of b and the value of c .

$$b = \dots\dots\dots$$

$$c = \dots\dots\dots \text{ [3]}$$

90. Solve algebraically.

$$\begin{aligned}x^2 + y^2 &= 8 \\ y &= x + 4\end{aligned}$$

$$x = \dots\dots\dots$$

$$y = \dots\dots\dots \text{ [5]}$$

91(a). Describe the error in the method and give the correct answer.

Question:

Rearrange $y = 4x - 15$ to make x the subject.

Solution:

$$y = 4x - 15$$

$$y - 15 = 4x$$

$$x = \frac{y-15}{4}$$

Error is _____

Correct answer [2]

(b).

Question:

Rearrange $A = \frac{x^2}{9}$ to make x the subject, where $x > 0$.

Solution:

$$A = \frac{x^2}{9}$$

$$\sqrt{A} = \sqrt{\frac{x^2}{9}}$$

$$\sqrt{A} = \frac{x}{9}$$

$$x = 9\sqrt{A}$$

Error is _____

Correct answer [2]

92. You may use these kinematics formulae to answer this question.

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

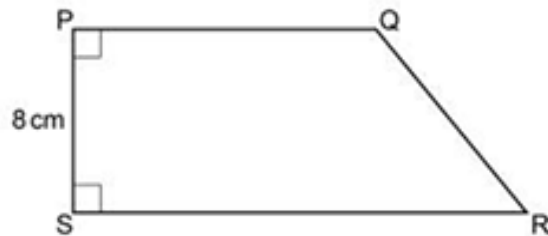
A particle has an initial velocity of 5 m/s.

After 15 seconds the particle has a velocity of 14 m/s.

Work out the distance the particle has travelled after 15 seconds.

..... m **[4]**

93. The diagram shows a quadrilateral, PQRS.



Not to scale

PS = 8 cm.

Angle QPS = Angle PSR = 90° .

SR is 4 cm longer than PQ.

The area of quadrilateral PQRS is $A \text{ cm}^2$.

Write a simplified expression for the length PQ in terms of A.

You must show your working.

..... [5]

94. The k th term of a sequence is r^k , where $r \neq 0$.
The seventh term is equal to five times the third term.

Find the value of r , giving your answer correct to **3** decimal places.

$r =$ [4]

95. The graph of $y = 2x + 5$ intersects the graph of $x^2 + y^2 = 10$ at two points.

Use an algebraic method to work out the coordinates of the two points.
You must show your working.

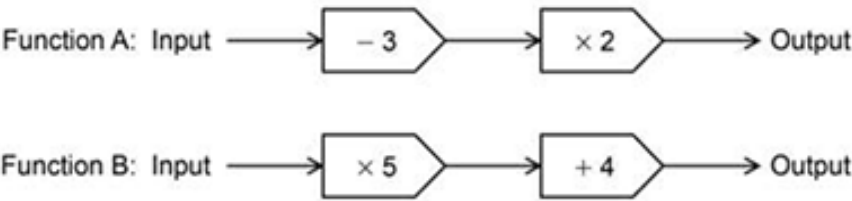
(..... ,) and (..... ,) [6]

96. Write $(2x + 5)(x - 4)$ in the form $2(x + a)^2 - b$.

You must show your working.

..... [5]

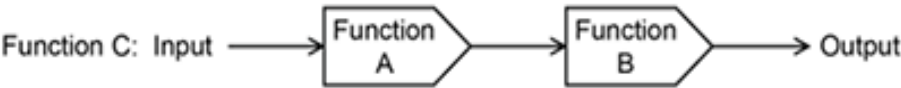
97(a). Here are two functions.



Write an algebraic expression for the output of function A when the input is x .

..... [1]

(b). Here is a composite function C.



The input to function C is x .
The output from function C is $3x - 5$.

Find the value of x .
You must show your working.

$$x = \dots\dots\dots [5]$$

98(a). Here are two pieces of work.

Each shows a question and the **first line** of an incorrect solution.

For each part, describe the error made in the first line of the solution.
You do **not** need to complete the solution.

Question:
Simplify. $\frac{3}{x-4} - \frac{2}{x+1}$

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

[1]

(b).

Question:
Solve. $x^2 + 5x - 2 = 0$

Solution:
$$x = \frac{-5 \pm \sqrt{5^2 + 4 \times 1 \times (-2)}}{2 \times 1}$$

[1]

99(a).

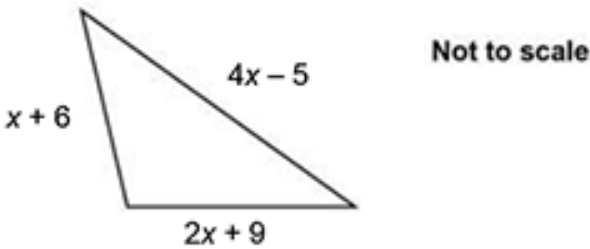
Show that the equation $x^3 + x^2 - 20 = 0$ has a solution between $x = 2$ and $x = 3$.

[3]

(b). Find this solution correct to 1 decimal place.
You must show calculations to support your answer.

$x =$ [4]

100(a). The sides of this triangle are given in centimetres.
The perimeter of the triangle is 80 cm.



Find the length of each side of the triangle.
You must show your working.

..... cm, cm and cm [5]

(b). Is the triangle above a right-angled triangle?
Use calculations to show how you decide.

..... because

.....

..... [3]

101(a). Here are the first four terms of a sequence.

$\frac{1}{3}$

$\frac{4}{8}$

$\frac{7}{15}$

$\frac{10}{24}$

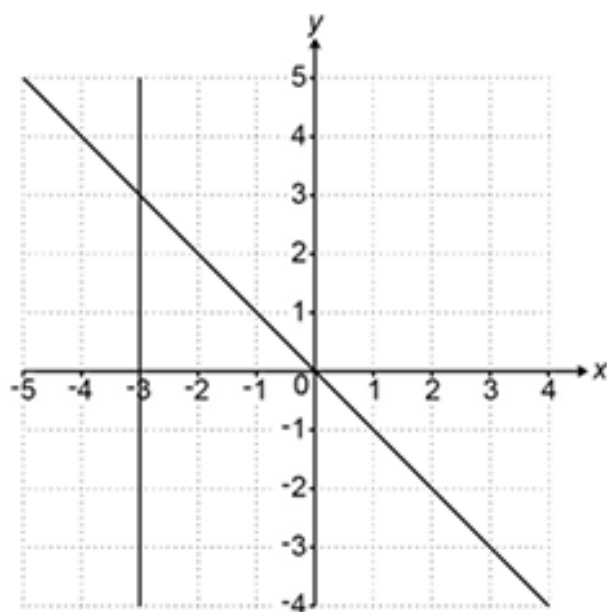
Find the next term.

..... [1]

(b). Find the n th term.

..... [3]

102. The graphs of $x = -3$ and $y = -x$ are drawn on the grid.



The region **R** satisfies the following inequalities.

$$x \geq -3 \qquad y \leq -x \qquad y - 2 < \frac{1}{3}x$$

By drawing one more line, find and label the region **R**.

[5]

103(a). Factorise.

$$4x^2 - 25$$

..... [2]

(b). Solve by factorisation.

$$2x^2 - 5x - 12 = 0$$

$x = \dots\dots\dots$ or $x = \dots\dots\dots$ [3]

(c). Solve.

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

$x = \dots\dots\dots$ [4]

104. Ariel, Blake and Casey work in a cafe.

Customers give spare change as tips.

At the end of each week, Ariel, Blake and Casey share the total amount of tips between them in the ratio matching the number of hours they worked that week.

This week:

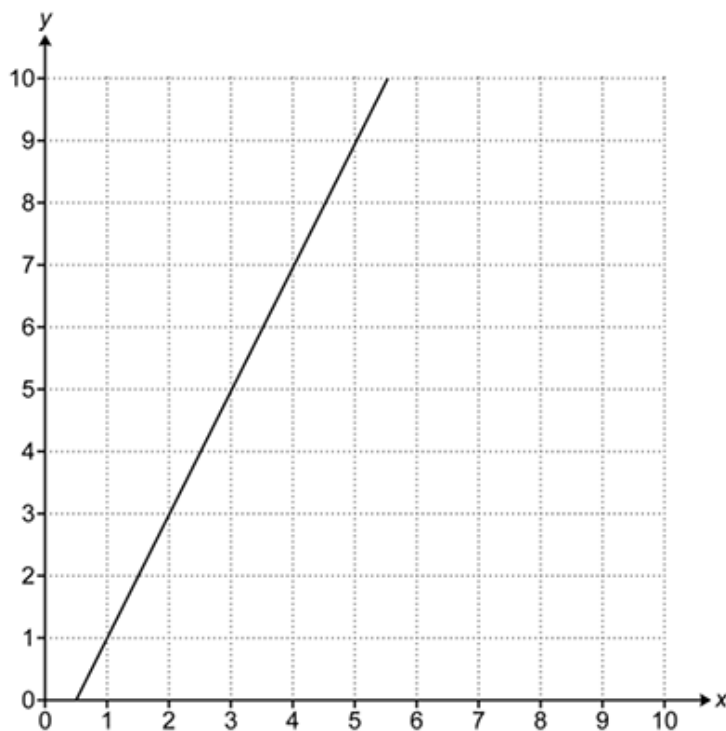
- Ariel's share of the tips was £25.50.
- Blake worked three times as many hours as Ariel.
- Casey worked 4 more hours than Ariel.
- The total hours worked by Ariel, Blake and Casey was 89 hours.

Calculate the total amount of tips received this week.

You must show your working.

£ [6]

105. The graph of $y = 2x - 1$ is drawn on this one centimetre grid.



The region **R** satisfies these inequalities.

$$y \geq 2x - 1$$

$$y \leq 7$$

$$x + y \geq 8$$

Show that the area of region **R** is 3 cm².

[6]

106(a).

Write $x^2 + 4x + 1$ in the form $(x + a)^2 - b$.

..... **[3]**

(b). Use your answer from part **(a)** to solve.

$$x^2 + 4x + 1 = 0$$

Give your answers in exact form.

You must show your working.

$x = \dots\dots\dots$ or $x = \dots\dots\dots$ **[2]**

107. You are given that

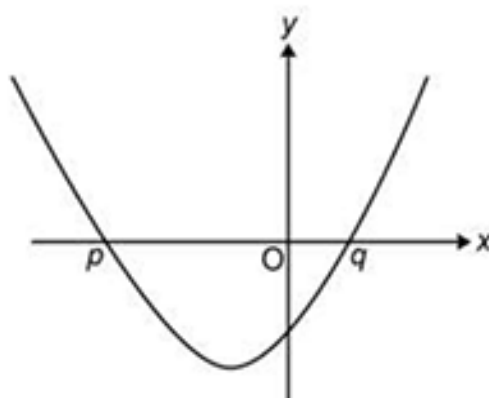
$$\frac{9a^k \times a^5}{ma^3} = \frac{3a^4}{4}$$

where k and m are integers.

Find the value of k and the value of m .

$k = \dots\dots\dots$ and $m = \dots\dots\dots$ **[4]**

108. The graph of $y = x^2 + 8x - 4$ is shown below.
The roots of the equation $x^2 + 8x - 4 = 0$ are at p and q .



- i. Calculate y when $x = 1$.

$y = \dots\dots\dots$ **[1]**

- ii. Without solving the equation, explain why q must lie between 0 and 1.

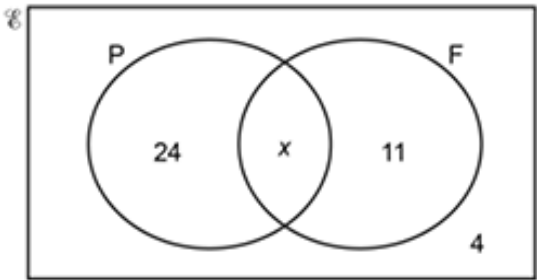
[2]

- iii. Explain why using a method of iteration is not the most appropriate way of finding a solution to this equation.

[1]

109(a). In a survey about snacks, some students were asked whether they like popcorn (P) and whether they like fruit (F).

The Venn diagram shows some of the results.
 x students liked both types of snacks.



The ratio of the number of students who liked popcorn to the number who liked fruit was 3 : 2.

Work out the **total** number of students in the survey.

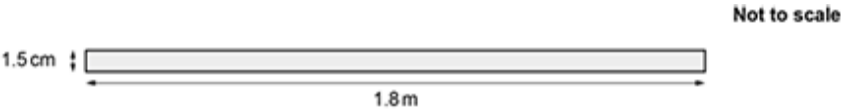
..... **[4]**

(b). One of the students is selected at random.

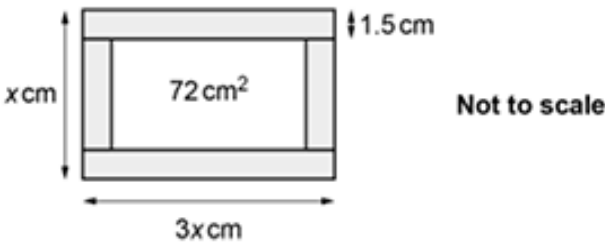
Find the probability that this student does **not** like fruit given that they like popcorn.

..... **[2]**

110. Li is making some wooden frames.
Li has a strip of wood 1.8 m long and 1.5 cm wide.



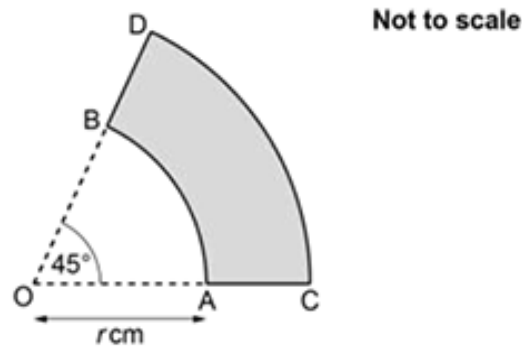
Each frame will be made from four pieces of wood cut from the strip to form a rectangle, as shown below.



The width of each frame is x cm.
The length of each frame is $3x$ cm.
The area enclosed by each frame must be 72 cm^2 .

Work out the maximum number of frames Li can make from the 1.8 m length of wood.
You must show your working.

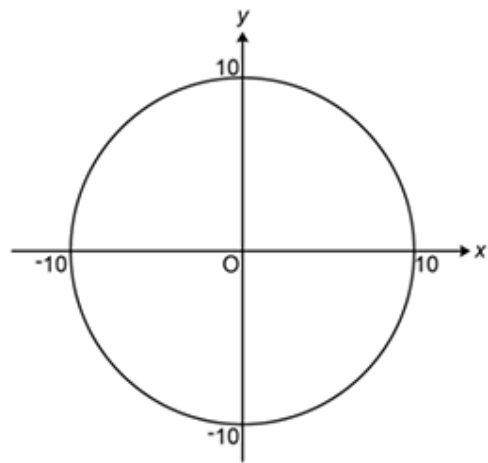
111. The diagram shows a shaded shape made by removing sector OAB from sector OCD. Both sectors have an angle of 45° . The radius, OA, of the smaller sector is r cm. The ratio of radius OA to radius OC is 3 : 4.



Work out, in terms of π and r , the **total** length of arc AB and arc CD.
Give your answer in its simplest form.
You must show your working.

..... cm **[5]**

112. The graph below shows a circle with centre (0, 0) and equation $x^2 + y^2 = 100$.



Show that the point (8, -6) lies on the circumference of the circle.

113(a). A car accelerates at 6.08 m/s^2 for 10.3 seconds from an initial velocity of 4.92 m/s .

Amaya rounds each value to 1 significant figure.

Amaya uses the rounded values and the formula

$$s = ut + \frac{1}{2}at^2$$

to estimate the distance travelled in the 10.3 seconds.

Amaya's answer is 250 metres.

Using Amaya's method, show that their answer is wrong.

[4]

(b). Rearrange this formula to make x the subject.

$$E = \frac{1}{2}kx^2$$

..... **[3]**

114. Use algebra to prove that an odd number multiplied by a number that is 4 more than that odd number always gives an answer that is an odd number.

[4]

115(a). Write as a single fraction in its simplest form.

$$\frac{3}{n+1} - \frac{6n}{2n^2+3}$$

..... **[4]**

(b). Simplify.

$$\frac{x^2 + 2x - 15}{3x^2 - 5x - 12}$$

..... **[5]**

116. Solve this inequality.

$x^2 - 5x - 14 < 0$

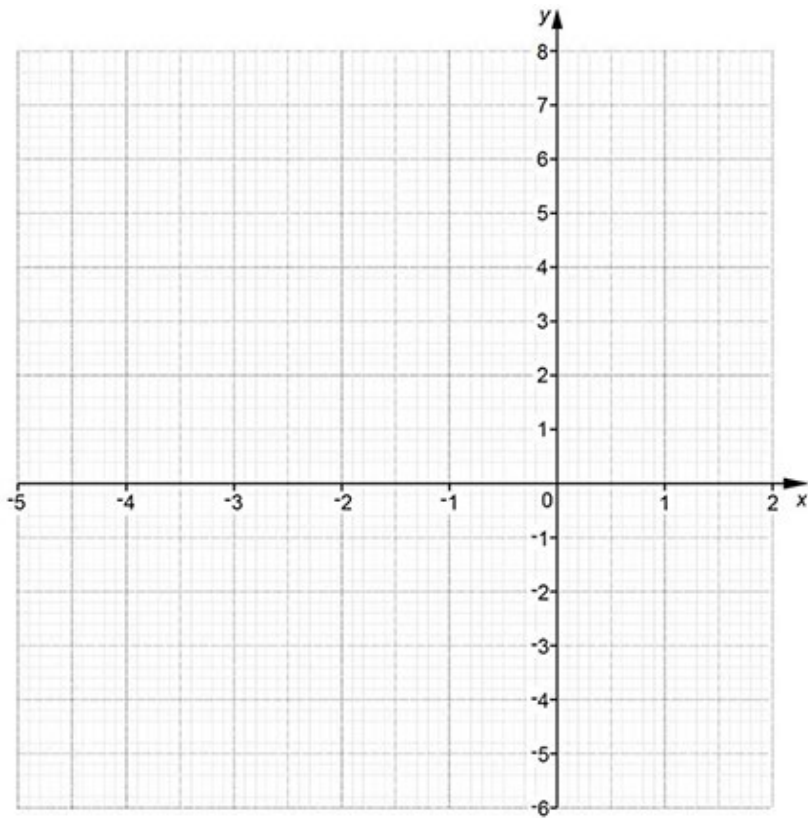
Give your answer using set notation.
You must show your working.

..... [5]

117(a). Here is a table of values for $y = x^2 + 3x - 3$.

x	-5	-4	-3	-2	-1	0	1	2
y	7	1	-3	-5	-5	-3	1	7

Draw the graph of $y = x^2 + 3x - 3$ for $-5 \leq x \leq 2$.



[3]

(b). Write down the equation of the line of symmetry of the graph.

..... **[1]**

(c). Use the graph to solve the equation $x^2 + 3x - 3 = 0$.
Give your answers to **1** decimal place.

$x =$ or $x =$ **[2]**

118. $(x + 3)(2x + a)(bx + 2) = 6x^3 + 10x^2 - 32x - 24$

Find the value of a and the value of b .

$a =$

$b =$ **[2]**

119(a). y is inversely proportional to the square root of x .
 $y = 6$ when $x = 49$.

Find a formula linking x and y .

..... **[3]**

(b). Find the value of x when $y = 30$.

$x = \dots\dots\dots$ **[3]**

120(a).

Show that the equation $x^3 + 2x - 2 = 0$ has a solution between $x = 0$ and $x = 1$.

[3]

(b). Find this solution correct to **1** decimal place.
You must show your working.

$x = \dots\dots\dots$ **[4]**

121(a). The following kinematics formulas may be used in this question.

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

The initial velocity of a particle is 16 m/s.

The acceleration of the particle is -5 m/s^2 .

After t seconds, the particle has travelled 24 m.

Show that $5t^2 - 32t + 48 = 0$.

[3]

(b). Show that the particle is stationary when it has travelled 25.6 m.

[3]

(c). Solve $5t^2 - 32t + 48 = 0$.

$t = \dots\dots\dots$ [3]

122. Rearrange this formula to make a the subject.

$$\frac{4a+1}{a} = \frac{2b-3}{5}$$

$\dots\dots\dots$ [5]

123. Multiply out and simplify.

$$2(x+3) - (x-4)$$

$\dots\dots\dots$ [2]

124. Simplify fully.

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

..... **[5]**

125. $3x + y^2 = 7$ and $6x + z = 8$.

Write z in terms of y .

Give your answer in its simplest form.

..... **[4]**

126. n is a positive integer.

Prove that $(2n - 1)(n + 5)(n - 2) + 3n(n + 1)$ is always even.

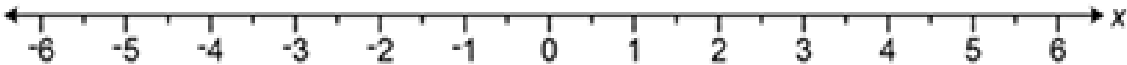
..... [6]

127(a). Solve the inequality.

$3(x - 2) > x$

..... [3]

(b). Show your answer to **part (a)** on the number line.



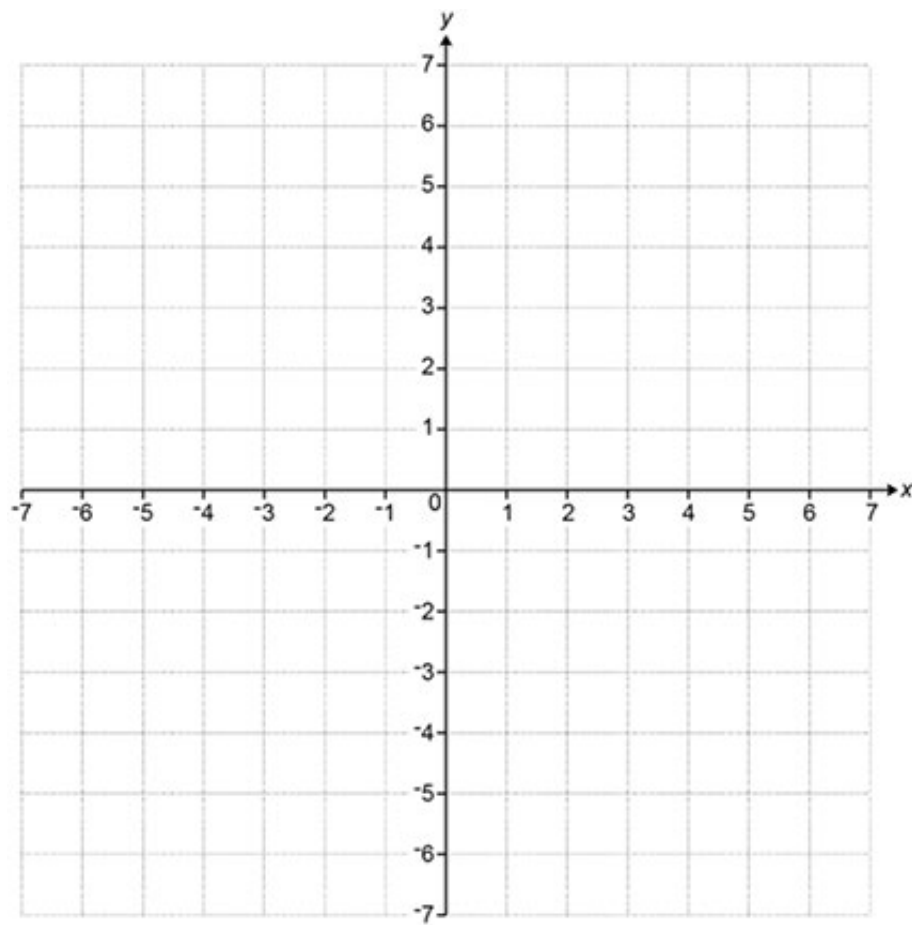
[2]

128(a). Complete the table for $y = 1 + \frac{6}{x}$.

x	-6	-3	-2	-1	1	2	3	6
y	0		-2	-5	7	4	3	2

[1]

(b). Draw the graph of $y = 1 + \frac{6}{x}$ for $-6 \leq x \leq 6$, $x \neq 0$.



[3]

129. Li, Jamie and Morgan play a computer game.

Li goes first and scores n points.

- Jamie scores 7 points more than 5 times the number of points scored by Li.
- Morgan scores 13 less points than Jamie.
- The three people score a total of 628 points.

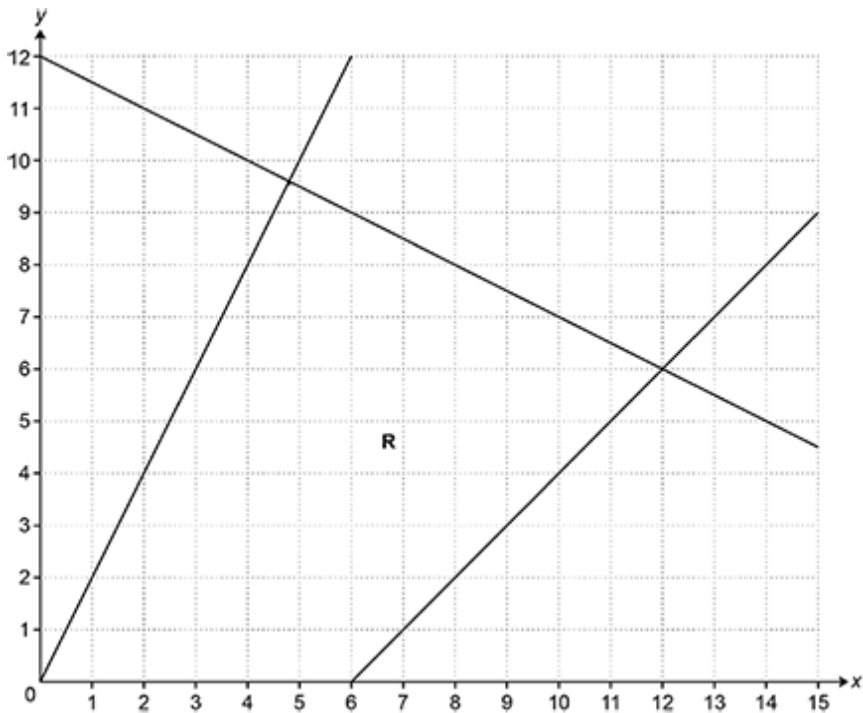
Work out how many points they each score.
You must show your working.

Li =

Jamie =

Morgan = [7]

130(a). The region **R** is shown on this grid.



Region **R** is defined by four inequalities.

One of the inequalities is $y \geq 0$.

Use the symbols $\leq$ and $\geq$ to complete the other three inequalities.

$$y \geq 0$$

$$y \dots\dots\dots 2x$$

$$x + 2y \dots\dots\dots 24$$

$$y \dots\dots\dots x - 6$$

[2]

(b). The inequality $y \geq 0$ is replaced by a new inequality.

Region **R** is then a trapezium.

The point (6, 0) is still one of the corners of Region **R**.

Write down the new inequality.

..... **[3]**

131. Find the coordinates of the turning point of the graph of $y = x^2 - 8x + 5$.

(..... ,) **[4]**

132. Here are the first four terms of a quadratic sequence.

4 7 14 25

The n th term is $an^2 + bn + c$.

Find the values of a , b and c .

$a = \dots\dots\dots$

$b = \dots\dots\dots$

$c = \dots\dots\dots$ **[4]**

133. Solve algebraically.

$$y = x + 4$$

$$(x - 4)^2 + y^2 = 82$$

You must show your working.

$x = \dots\dots\dots$ $y = \dots\dots\dots$

$x = \dots\dots\dots$ $y = \dots\dots\dots$ **[5]**

134. Simplify.

$$a^{15} \div a^5$$

..... **[1]**

135(a). Sasha and Taylor are asked to find how many solutions the equation $5(x + 2)^2 = 45$ has.

Here is **Sasha's** answer.

$$\begin{aligned} 5(x+2)^2 &= 45 \\ (x+2)^2 &= 9 \\ x+2 &= 3 \\ x &= 1 \end{aligned}$$

There is one solution.

Here is **Taylor's** answer.

$$\begin{aligned} 5(x+2)^2 &= 45 \\ (x+2)^2 &= 9 \\ x+2 &= 3 \text{ or } x+2 = -3 \\ x &= 1 \text{ or } x = -5 \end{aligned}$$

There are two solutions.

Decide who is correct, Sasha or Taylor, and give the reason for your decision.

_____ is correct because _____

..... **[1]**

(b). Solve this equation algebraically.

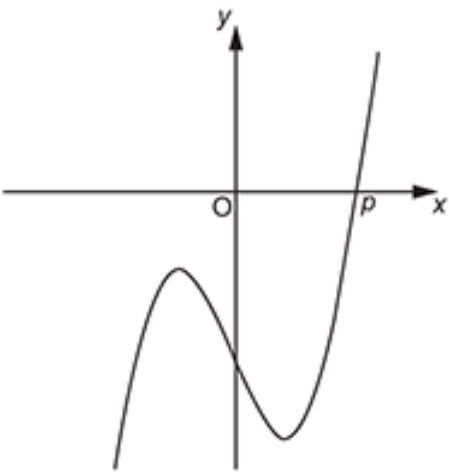
Give your answers correct to **2** decimal places.

You must show your working.

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

$x =$ or $x =$ **[4]**

136(a). The graph of $y = x^5 - 70x - 150$ is sketched below.
The root of the equation $x^5 - 70x - 150 = 0$ is p .



Show that $3 < p < 4$.

[3]

(b). Find a smaller interval that contains the value of p .
You must show calculations to support your answer.

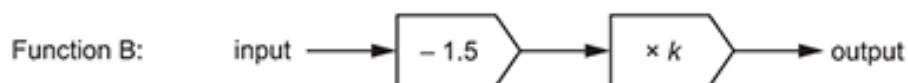
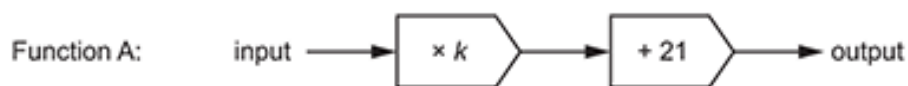
..... $< p <$ [3]

137. Simplify fully.

$$\frac{x^3 + 8x^2 + 15x}{x^3 - 9x}$$

..... [5]

138. Here are two functions.



5 is input into Function A.

5 is also input into Function B.

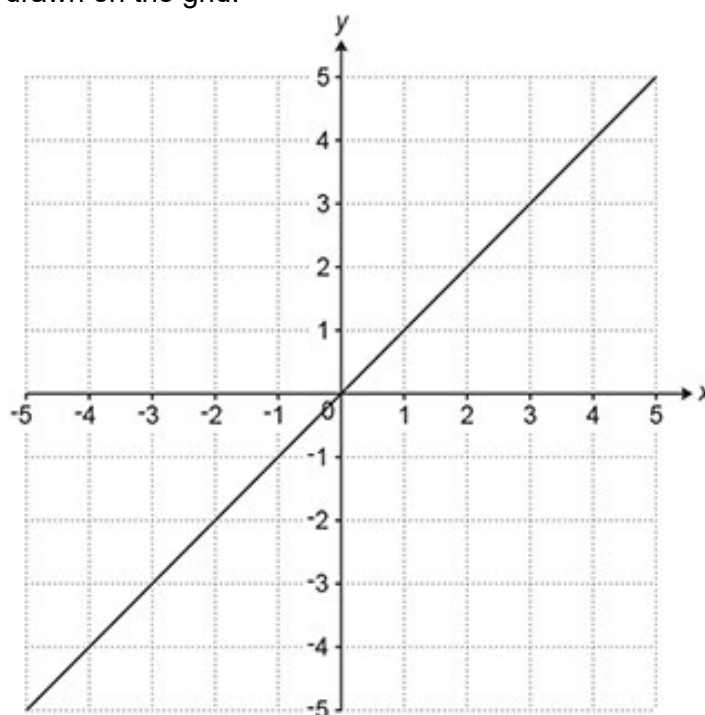
The output of Function A is 10 times the output of Function B.

Work out the value of k .

You must show your working.

$k = \dots\dots\dots$ **[5]**

139. The graph of $y = x$ is drawn on the grid.



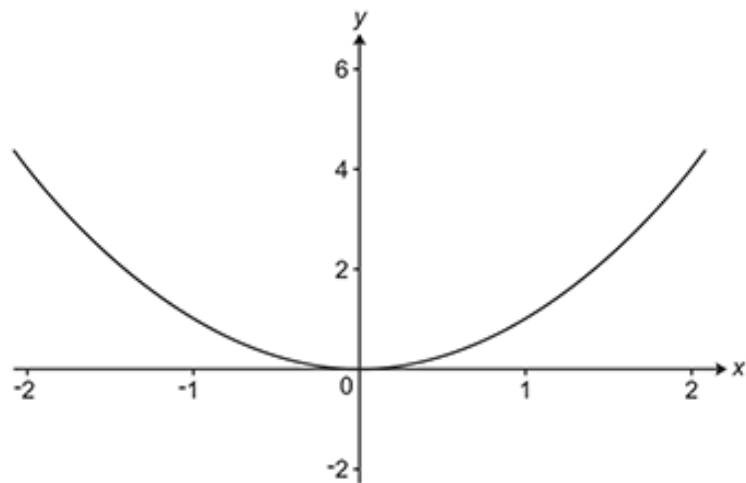
The region **R** satisfies the following inequalities.

$$y \geq x \quad y \leq 2 \quad y < -2x - 3$$

By drawing two more straight lines on the grid, find and label the region **R**.

[6]

140. The graph of $y = x^2$ is shown below for $-2 \leq x \leq 2$.

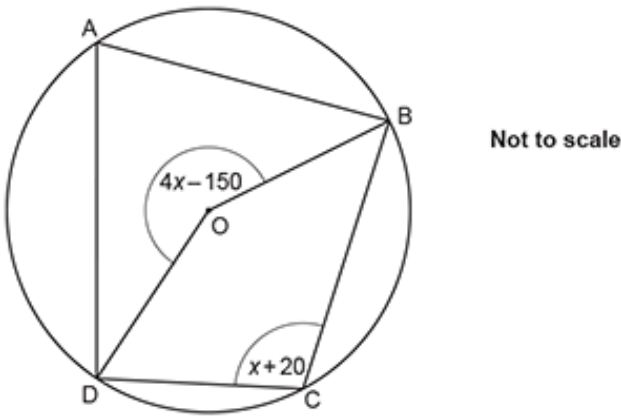


Describe the **single** transformation that maps the graph of $y = x^2$ onto the graph of $y = x^2 + 6x - 5$.

..... [4]

141. In this question all angles are given in degrees.

A, B, C and D are points on the circumference of a circle, centre O.



Find the size of angle BCD.

..... ° [4]

142. The x -coordinates of the intersections of the graphs of $y = x^2 + ax + 7$ and $y = 3x + b$ are the solutions to the equation $x^2 + 8x + 13 = 0$.

Find the value of a and the value of b .

$a =$

$b =$ **[3]**

143(a). Find the next term of this sequence.

1 3 9 27 81

[1]

(b). In the Fibonacci sequence below, the next term is found by adding the two previous terms.
The third term is 0.83 and the fourth term is 1.29.

Complete the first, second and fifth terms of the sequence.

..... 0.83 1.29

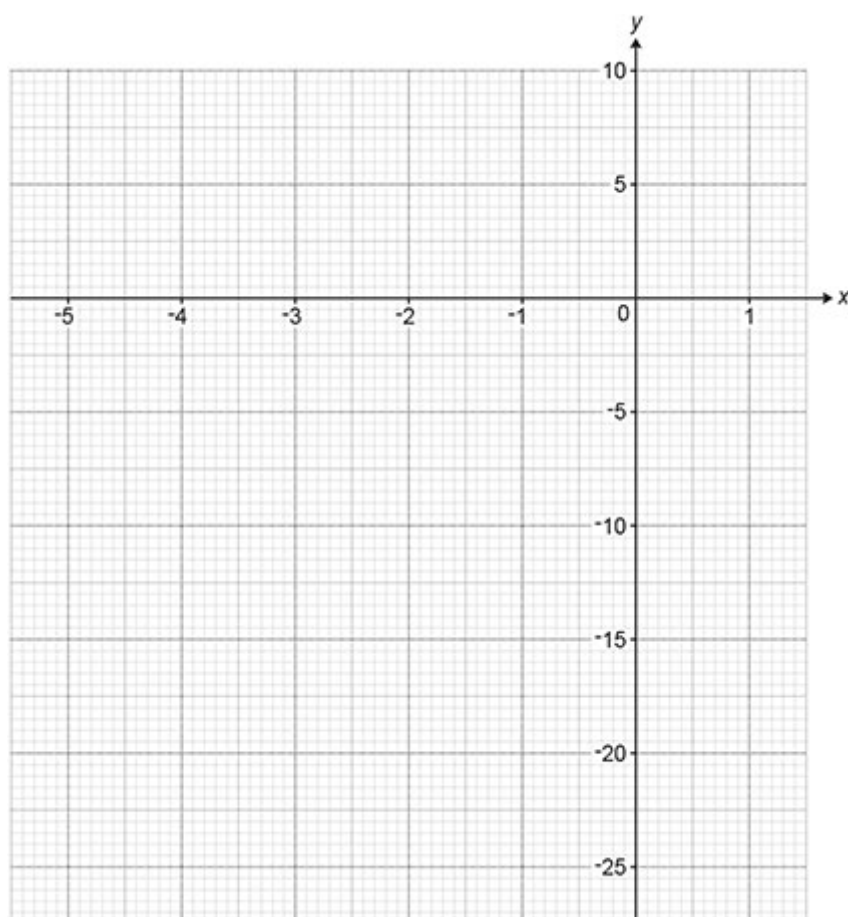
[3]

144(a). Complete the table for $y = x^3 + 4x^2$.

x	-5	-4.5	-4	-3	-2	-1	0	1
y	-25	-10.1	0	9	8		0	5

[1]

(b). Draw the graph of $y = x^3 + 4x^2$ for $-5 \leq x \leq 1$.



[3]

(c). The equation $x^3 + 4x^2 = k$, where k is an integer, has exactly one solution for $-5 \leq x \leq 1$.

Find the greatest possible value of k .

$k = \dots\dots\dots$ **[1]**

145(a). Simplify.

$$3a^2 \times 4a^5$$

$\dots\dots\dots$ **[2]**

(b). Factorise fully.

$$4x^2 - 12x$$

$\dots\dots\dots$ **[2]**

146(a). A sequence is defined by

$$u_{n+1} = 3u_n + 7 \text{ and } u_1 = -2.$$

Work out the value of u_2 and the value of u_3 .

$$u_2 = \dots\dots\dots$$

$$u_3 = \dots\dots\dots$$

[2]

(b). Here are the first four terms of a quadratic sequence.

$$\begin{array}{cccc} -2 & 7 & 22 & 43 \end{array}$$

The sequence has the formula $x_n = an^2 + b$.

Find the value of a and the value of b .

$$a = \dots\dots\dots$$

$$b = \dots\dots\dots$$

[3]

147. Solve this quadratic equation by factorisation.

$$2x^2 - 6x - 24 = 5x - 3$$

$$x = \dots\dots\dots \text{ or } x = \dots\dots\dots$$

[4]

148. Solve.

$$x^{-\frac{1}{2}} = \frac{5x^{\frac{1}{3}}}{x^{\frac{2}{3}}}, \text{ where } x \neq 0$$

$$x = \dots\dots\dots [3]$$

149. Find all the possible integer values that satisfy the inequality $-10 < 3x + 2 \leq 8$.

$$x = \dots\dots\dots [3]$$

150. Below is a question with an incorrect solution.

Describe the error made and write out a correct solution.

Question:
Factorise. $x^2 + x - 20$

Solution:
 $(x + 4)(x - 5)$

The error is

A correct solution is

[2]

END OF QUESTION PAPER