

**Isaac Newton Academy A-Level Mathematics & Further Mathematics**

**Summer Independent Learning Pack**

This Independent Learning Pack is due on the **first day** of the Autumn Term  
**(Wednesday 6<sup>th</sup> September)**

Name: .....

Class: .....

Teacher: .....

Write your answers in the spaces provided. Ensure you show all your workings and draw diagrams to help you.

**You will need:**

- Pen and pencil
- Protractor and ruler
- Calculator

**What is in this pack?**

<b>A. Course Information</b>	Assessment information
<b>B. Mathematical Reasoning</b>	True or False? Rich exploration of the fundamental reasoning and concepts required for A-Level Mathematics
<b>C. Exploring Linear Graphs</b>	This topic forms a vital part of the first module of the A Level Mathematics course. You may be aware of $y = mx + c$ but will need to be familiar with other ways of representing linear graphs
<b>D. Further Mathematics</b>	<b>For Further Mathematics A-Level students only</b> Transition Day Lesson Problems Investigation (from the start of the Decision Maths module)
<b>E. Baseline Test</b>	Separate from this pack. To be completed in exam conditions Also due <b><u>Wednesday 6<sup>th</sup> September</u></b>

# A. How will I be assessed?

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The exam board for A-Level Mathematics is Edexcel. The assessment structure is as follows:

Qualification	Component	Overview	Assessment
A level Mathematics	<b>Paper 1:</b> Pure Mathematics 1	AS content assessed at A level standard	 2 hours  100 marks
	<b>Paper 2:</b> Pure Mathematics 2	Remaining pure content which builds on and incorporates AS content.	 2 hours  100 marks
	<b>Paper 3:</b> Statistics and Mechanics	Section A: Statistics (50 marks) Section B: Mechanics (50 marks)	 2 hours  100 marks

Qualification	Component	Overview	Assessment
A level Further Mathematics	<b>Paper 1:</b> Further Pure Mathematics 1	Based on the fixed core content AS content assessed at A level standard	 1.5 hours  75 marks
	<b>Paper 2:</b> Further Pure Mathematics 2	Based on the fixed core content Remaining pure content which builds on and incorporates AS content	 1.5 hours  75 marks
	<b>Paper 3:</b> Further Mathematics Option 1	Students take one of the following four options: <ul style="list-style-type: none"> <li>• Further Pure</li> <li>• Further Statistics</li> <li>• Further Mechanics</li> <li>• Decision Maths</li> </ul>	 1.5 hours  75 marks
	<b>Paper 4:</b> Further Mathematics Option 2	Students take one of the following four options: <ul style="list-style-type: none"> <li>• Further Pure</li> <li>• Further Statistics</li> <li>• Further Mechanics</li> <li>• Decision Maths</li> </ul>	 1.5 hours  75 marks

Further information about the exact content of the new 2017 course can be found here:  
<https://www.gov.uk/government/publications/gce-as-and-a-level-mathematics>

# B. Mathematical Reasoning for A-level

This task requires you to look at how deeply you understand the fundamental concepts you will use at A-level.

Name

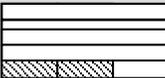
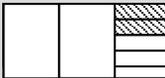
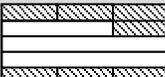
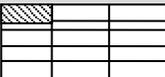
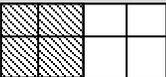
It will be evaluated for the **clarity** and **depth of explanation**, not whether you have correctly judged the statement to be True or False. You are invited to use any means available to check the answers, and deepen your explanations (including calculators, the internet, your friends).

Every A-level mathematician will be required to submit this in their Maths lesson on the first day of term.

You should expect it to take **approximately 2 hours**. For each of the following statements;

(a) decide whether it is true or false.

(b) explain why it is true/false – appealing to diagrams or “clear-cut” examples. You must go beyond “the rules I was taught”, and imagine convincing someone who has not been near a maths classroom for a while. Feel free to use extra paper.

Statement	True or False	Explanation
$\frac{2}{3} + \frac{2}{5} = \frac{4}{8}$	<p><b>False</b></p>	<div style="display: flex; justify-content: space-around;">   </div> <p>In order to add the shaded areas, they need to be comparable. This can be done by dividing both shapes into the same number of sections : below both shapes are divide into (3x5) <b>15 sections</b>.</p> <div style="display: flex; justify-content: space-around;">   </div> <p>How many shaded sections are there in both diagrams?          10 sections + 6 sections = 16 sections</p> <p>This gives the answer <math>\frac{10}{15} + \frac{6}{15} = \frac{16}{15}</math> which is <b>not</b> equal to <math>\frac{4}{8}</math></p> <div style="display: flex; justify-content: space-around;">    </div>
$3\frac{4}{12} = \frac{10}{3}$		

Example

Statement	True or False	Explanation
$\frac{5}{9} \times \frac{4}{5} = \frac{4}{9}$		
$\frac{10}{21} \div \frac{2}{3} = \frac{5}{7}$		
$\left(4\frac{1}{2}\right)^2 = 16\frac{1}{4}$		

Statement	True or False	Explanation
$\frac{2x + 4}{y + 6} = \frac{2x + 2}{y + 3}$		
$\frac{c}{d} + \frac{a}{b} = \frac{ad + bc}{bd}$		
$6 \times \frac{x+1}{2y+3} = \frac{6x+6}{12y+18}$		

Statement	True or False	Explanation
$5^{-1} = 0.2$		
$(10000)^{\frac{1}{2}} = 5000$		
$\sqrt{48} + \sqrt{27} = \sqrt{75}$		

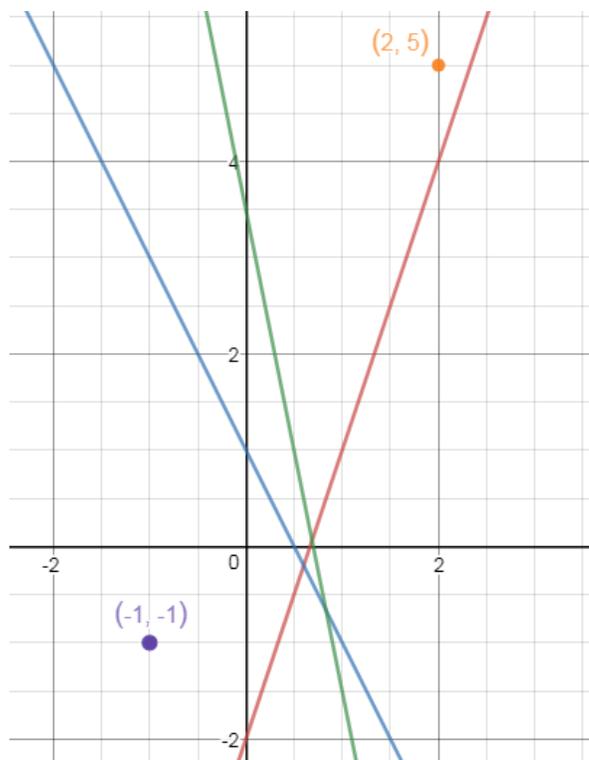
Statement	True or False	Explanation
$\frac{(-4 + 1)}{(-3 - 6)} = -1$		
$(1-x)^2 \equiv (x-1)^2$		
$(-1)^{-1} = -1$		

Statement	True or False	Explanation
$x^2+25=0$ has no solutions		
If $3 - 2x > 5$ then $x > -1$		
If $a^2 + b^2 = c^2$ and all three number are integers then it <u>must be true</u> that $a=3, b=4$ and $c=5$		

# C. Exploring Linear Graphs

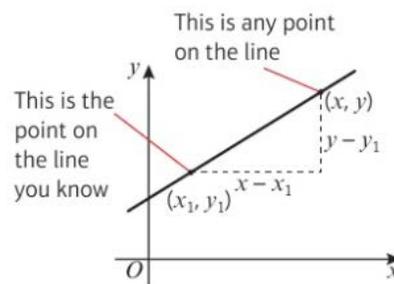
For each of the lines below:

- Find the equation of the line
- Write the equation of a line that is parallel
- Write the equation of a line that is perpendicular



- The equation of a line with gradient  $m$  that passes through the point with coordinates  $(x_1, y_1)$  can be written as**  

$$y - y_1 = m(x - x_1).$$



Find the equation of the line that connects the two coordinates shown on the graph paper. Write your answer in the form  $y = mx + c$  **and** in the form  $y - y_1 = m(x - x_1)$ .

What are the benefits of writing the equation of a line in the form  $y - y_1 = m(x - x_1)$ ?

### Challenge

Consider the line passing through points  $(x_1, y_1)$  and  $(x_2, y_2)$ .

**a** Write down the formula for the gradient,  $m$ , of the line.

**b** Show that the general equation of the line can be written in the form  $\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$

**c** Use the equation from part **b** to find the equation of the line passing through the points  $(-8, 4)$  and  $(-1, 7)$ .

The space below is provided for your workings for this section. Continue onto separate paper if required.

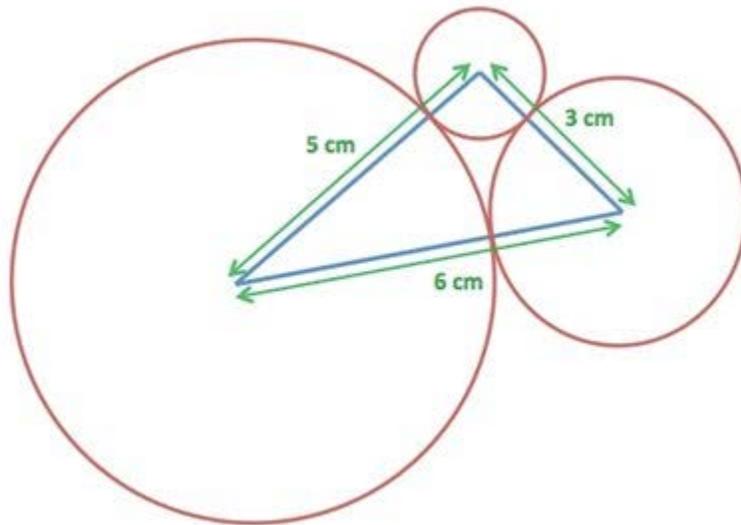
## D. Further Mathematicians Only

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Below are some of the questions from the Transition Day lesson. Complete each one showing your workings fully.

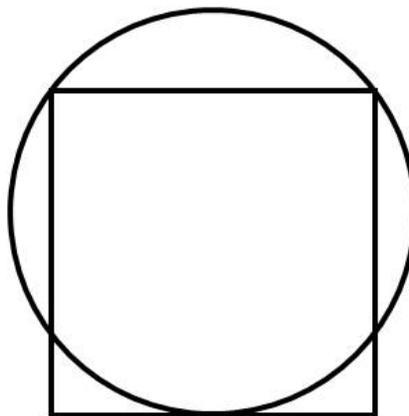
### Question 1

A triangle has lengths of 5cm, 6cm and 3cm. Circles are drawn at each of the vertices of the triangle so that each circle just touches the other two circles. Find the three radii of the three circles.



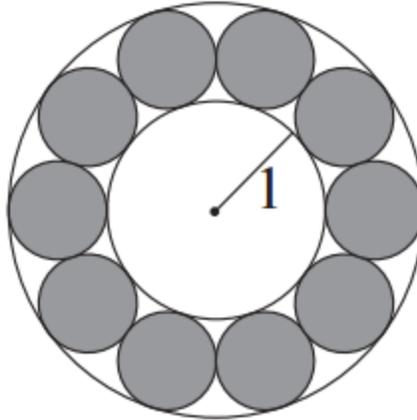
### Question 2

The diagram shows a square of side length 8cm, and a circle. The circle passes through the two top vertices of the square, and the midpoint of the bottom side of the square. What is the radius of the circle?



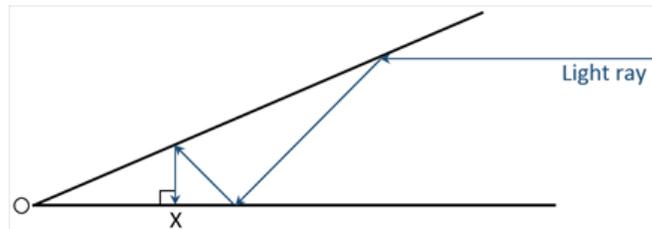
Question 3

The diagram shows ten equal discs that lie between two concentric circles – an inner circle and an outer circle. Each disc touches two neighbouring discs and both circles. The inner circle has radius 1. What is the radius of the outer circle?



Question 4

Two mirrors are joined at a fixed angle at O, and a ray of light is shone into the angle between them, parallel to one of the mirrors. As shown in the diagram, it reflects three times before hitting the lower mirror at X at an angle of  $90^\circ$ , causing the ray to re-emerge along its original path.



- a) What is the angle between the two mirrors?
- b) If the distance OX is 1cm, then what was the distance between the original ray and the lower mirror?

# FM Investigations: Decision Mathematics

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## Investigation 1:

Imagine you are working in a college library. One afternoon, 1280 different books arrive. They all need to be sorted alphabetically. Assuming that each comparison between two books takes just 1 second, what is the fastest way of sorting the books alphabetically?

Hint: You might want to research the following terms to help you:

- Bubble sort
- Insertion sort
- Merge sort
- Quick sort

These are known as 'sorting algorithms' and are essential in not only a study of Mathematics but in computer science and programming.

For the solution see:

<http://ed.ted.com/lessons/what-s-the-fastest-way-to-alphabetize-your-bookshelf-chand-john#watch>

## Investigation 2:

How would you multiply  $24 \times 16$ ? Is that that only way?

Research the 'Russian Peasant' method of multiplication. Have a go – did it work?

If you're stuck, go to: <https://www.youtube.com/watch?v=xrUCL7tGKaI>

Does this method always work? **Why** does it work?