THE ACADEMY OF ST NICHOLAS	Y13 Pure	CH02 2.1	Functions and Graphs Modulus	Lessons 1

Essential Knowledge Milestones

- understand what is meant by a modulus of a linear function;
- be able to sketch graphs of functions involving modulus functions;
- be able to solve equations and inequalities involving modulus functions.

Assumed Prior Knowledge/ Links / Interleaving

- Rearrangement of equations

Potential Barriers to Access /Misconceptions

- Students may find it difficult to sketch graphs involving modulus functions particularly if they are combined with other functions, for example logarithms.
- In exam situations, often only the highest scoring students are able to solve modulus equations with x on both sides, or inequalities which involve the modulus function.

Teaching Points

- Define the modulus of a set of numbers as being the positive values only. e.g. $|-2| = 2$ and $|5| = 5$.
- Begin by using an ICT graph-drawing package (either using the whiteboard or students' individual devices) to sketch some linear graphs using both $y =$ and f(x) = notation, e.g. $y = 2x - 1$ or $f(x) = 2x - 1$.
- Display the graph of $y = |2x - 1|$ and discuss this with students, drawing comparisons with the 'non-modulus' graph and making sure everyone recognises that $y = |2x - 1|$ does not have any negative values of y (the graph 'bounces up' with the x-axis acting like a mirror).
- Define the term modulus function and use the general notation $y = |f(x)|$.
- Ask students to predict what the graph of $y = 2|x| - 1$ will look like and then plot it. This time the values of x that are substituted into the function cannot be negative. In other words the graph on the left of the y-axis is a reflection of the graph on the right (where the x-values are positive) with the y-axis being the line of symmetry.
- The general notation for this type of function is $y = f|x|$.
- Students should be able to sketch the graphs of $y = |ax + b|$ and use their graphs to solve modulus equations and inequalities.
- Use the graph-drawing package to sketch the graph of $y = |2x - 1|$ and $y = x$ and use these to solve $|2x - 1| = x$ by considering the points of intersection. Ask students to think about how they might solve this equation algebraically without using a graph. Solving $2x - 1 = x$ gives one solution, but how would the 'modulus' part be represented algebraically? What is the equation of the straight-line graph that represents the 'bounced' part which is now above the y-axis?
- Extend this idea to looking at inequalities, for example how to solve $|2x - 1| > x$.

Questions & Prompts

- What is the same and what is different about the equations $|ax + b| = x + 3$ and $(ax + b)^2 = (x + 3)^2$?
- Code breakers at Bletchley Park……

Opportunities for Reasoning/Problem Solving/Proofs

- What happens if we square a modulus? $|-2|^2 = 4$, so a modulus squared is always positive.
- Apply this to the modulus equation above $|2x - 1|^2 = x^2$; leading to $3x^2 - 4x + 1 = 0$.
- This quadratic gives the two solutions to the equation $y = |2x - 1|$ above. Does this always work? Does this work for inequalities?

Key Mathematical Vocabulary	modulus, transformation, composite

Personal Development	**Notes**	**Resources**
Pupils are taught that they must be honest and 'truthful' when feeding back opinions and 'respect' the views of others when discussing the math's techniques used.		