THE ACADEMY OF ST NICHOLAS	Y12 Pure	CH11 11.1,11.2,11.3,11.4, 11.5,11.6	Vectors	Lessons 5

Essential Knowledge Milestones

- be able to use vectors in two dimensions;
- be able to calculate the magnitude and direction of a vector and convert between component form and magnitude/direction form;
- be able to add vectors diagrammatically and perform the algebraic operations of vector addition and multiplication by scalars, and understand their geometrical interpretations.
- understand and be able to use position vectors;
- be able to calculate the distance between two points represented by position vectors;
- be able to use vectors to solve problems in pure mathematics and in context, (including forces).

Assumed Prior Knowledge/ Links / Interleaving

- Basic trigonometry: to convert between the different forms in which vectors can be expressed
- Pythagoras' Theorem to calculate distances between points.
- In mechanics quantities which have both magnitude and direction, such as force and velocity, are described by vectors
- Simplifying surds

Teaching Points

- Students need to be familiar with column vectors and with the use of **i** and **j** vectors in two dimensions.
- Students should be able to find a unit vector in the direction of $\boldsymbol{a}$, and be familiar with the notation $|\boldsymbol{a}|$.
- The triangle and parallelogram laws of addition should be known and students should be able to use them. Students should understand that vectors are commutative.
- Where answers are given in surds they should be simplified if possible.
- When performing operations on vectors this should also be understood geometrically, diagrams will be helpful here. Students should be able to use given diagrams but also draw their own in order to assist with questions.
- Students should understand and be able to use the conditions for parallel vectors.
- Use the classroom floor as a 2-dimensional grid to help students visualise vectors. Use the position of students in the room to illustrate concepts.
- Consider vectors in the real world, e.g. ask students to think of everyday phenomena that have a magnitude and direction e.g. forces, velocities, displacements.
- Students should know and be able to use $\overrightarrow{OB} - \overrightarrow{OA} = \overrightarrow{AB} = \mathbf{b} - \mathbf{a}$
- Students should be able to calculate the distance between two points (x_1, y_1) and (x_2, y_2) using the formula
- $d^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2$.
- Use the ratio theorem to find the position vector of a point *C* dividing *AB* in a given ratio.
- Use familiar shapes to illustrate the difference between 2 vectors and vector addition, e.g. parallelogram, rectangle.
- When solving problems using vectors only pure contexts are covered.

Potential Barriers to Access /Misconceptions

- Students sometimes make mistakes when manipulating vectors in **i** and **j** form and should be encouraged to use column vectors when possible.
- Examiners comment that students understand the simple basics of vectors but are unable to deal with the complexity of ratios. Students should be given plenty of practice in identifying points that divide line segments in a particular ratio both externally and internally.
- Taking insufficient care with notation, such as writing 5 rather than $5\boldsymbol{i}$
- Confusing position vectors with displacement vectors
- Failure to sketch the vector particularly when bearings are involved.
- Sign errors when calculating the magnitude of vectors with negative components.

Opportunities for Reasoning/Problem Solving/Proofs

- Students can prove vectors are parallel to demonstrate their reasoning skill.
- Given particular vectors, students can investigate places they can or cannot reach, for example the knights problem on a chessboard.
- Consider an aircraft landing in a cross-wind – what direction does it need to fly?
- Finding position vector of the fourth corner of a shape (e.g. parallelogram) *ABCD* with three given position vectors for the corners *A*, *B* and *C*.
- Use regular polygons to find vectors connecting different vertices and to illustrate the ratio theorem.
- Change one component of $\boldsymbol{a} = \begin{pmatrix}2\\1\end{pmatrix}, \boldsymbol{b} = \begin{pmatrix}-1\\3\end{pmatrix}, \boldsymbol{c} = \begin{pmatrix}4\\3\end{pmatrix}$ so that $\boldsymbol{a} + \boldsymbol{b}$is parallel to $\boldsymbol{c}$
- Give me an example of a vector with magnitude 5 ….now give me an unusual example

	Questions & Prompts
	• Prove that the medians of a triangle are concurrent. • Varignon's Theorem: For any quadrilateral, the midpoints of the sides form the vertices of a parallelogram • Consider 3 points A (4,2) B (5, 4) and C (2, K). Given that AB is Parallel to AC find the value of K. • Three vertices of a parallelogram ABCD are A (2,3) B (8, 4) C (7, -2). Determine the forth vertex of the parallelogram. • A plane is flying North at 300KmH-1, a wind is blowing in towards the South- East at 40 Kmh-1. Find the velocity of the plane relative to the ground.

Key Mathematical Vocabulary	Vector, scalar, magnitude, direction, component, parallel, perpendicular, modulus, dimension, ratio, collinear, scalar product, position vectors.

Personal Development	**Notes**	**Resources**
Pupils are taught to adopt a 'resilience' in their approach and work through an idea to modify answers to make sure it covers all aspects of the question asked		