UNIT 5: Vectors (2D)

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SPECIFICATION REFERENCES

10.1 Use vectors in two dimensions

10.2 Calculate the magnitude and direction of a vector and convert between component form and magnitude/direction form

10.3 Add vectors diagrammatically and perform the algebraic operations of vector addition and multiplication by scalars, and understand their geometrical interpretations

10.4 Understand and use position vectors; calculate the distance between two points represented by position vectors

10.5 Use vectors to solve problems in pure mathematics and in context, (including forces)

PRIOR KNOWLEDGE

Covered so far

- Surds

GCSE (9-1) in Mathematics at Higher Tier

G24 Vectors

KEYWORDS

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

5a. Definitions, magnitude/direction, addition and scalar multiplication (10.1) (10.2) (10.3)	Teaching time 7 hours

OBJECTIVES

By the end of the sub-unit, students should:

- 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.

TEACHING POINTS

Students need to be familiar with column vectors and with the use of **i** and **j** vectors in two dimentions.

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.

OPPORTUNITIES FOR REASONING/PROBLEM SOLVING

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?

COMMON MISCONCEPTIONS/EXAMINER REPORT QUOTES

Students sometimes make mistakes when manipulating vectors in **i** and **j** form and should be encouraged to use column vectors when possible.

5b. Position vectors, distance between two points, geometric problems (10.4) (10.5)	Teaching time 7 hours

OBJECTIVES

By the end of the sub-unit, students should:

- 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).

TEACHING POINTS

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.

OPPORTUNITIES FOR REASONING/PROBLEM SOLVING

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.

COMMON MISCONCEPTIONS/EXAMINER REPORT QUOTES

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.