**Y13 A level Mathematics**

**39 Kinematics 1 week**

## Teaching objectives

**a** Understand the language of kinematics appropriate to motion in 2 dimensions. Know the difference between, displacement, distance from and distance travelled; velocity and speed, and between acceleration and magnitude of acceleration.

**b** Be able to extend the scope of techniques from motion in 1 dimension to that in 2 dimensions by using vectors.

**c** Be able to find the cartesian equation of the path of a particle when the components of its position vector are given in terms of time.

**d** Be able to use vectors to solve problems in kinematics.

**e** Use trigonometric functions to solve problems in context, including problems involving vectors, kinematics and forces.

**Resources for advance preparation:**

**Underground maths:**

[**One windy day**](https://undergroundmathematics.org/vector-geometry/one-windy-day)

[**r9200**](https://undergroundmathematics.org/trigonometry-triangles-to-functions/r9200)

[**r8557**](https://undergroundmathematics.org/trigonometry-compound-angles/r8557)

[**r6009**](https://undergroundmathematics.org/vector-geometry/r6009)

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|  | **Starter** | **Main teaching**Including key questions, key teaching points, models and resources | **Notes**Including Support and Extension | **Consolidation/Plenary**Including key questions and homework |
| 1 | Recap derivation of suvat equations from velocity/time graphs. | Check understanding of difference between **displacement, distance from and distance travelled; velocity and speed, and between acceleration and magnitude of acceleration.** Relate to vector forms stressing importance of position vectors and write vector forms of suvat equations.This Geogebra file relates to the Jan 2007 OCR M1 Question 6 and shows the path of a particle as time changes. <https://www.geogebra.org/m/a9q3nrbE#material/fNPNT2WS> | Ask students to show how suvat equations can be derived by integrating from a constant acceleration | Dr Frost A level 2017: <https://www.drfrostmaths.com/resource.php?rid=408>Edexcel Y2 text book Chapter 8 ‘Madasmaths’ mechanics booklet: <https://madasmaths.com/archive/maths_booklets/mechanics/m1_m2_kinematics_using_calculus.pdf>  |
| 2 | [**One windy day**](https://undergroundmathematics.org/vector-geometry/one-windy-day) | Introduce projectiles and the idea of representing horizontal and vertical motion in terms of time. Consider the path of a projectile and annotate to show features of the horizontal or vertical motion at start; max height; landing.Be explicit about the difference between what the direction of the displacement vector and the direction of the velocity vector represent. | Common Errors: Not remembering that when constants of integration are vectors they will have two components.Combining components when applying calculus techniques in vectors.Use of displacement instead of velocity to determine direction |
| 3 | Re-cap differentiation and integration of polynomials | Explain that can differentiate and integrate components of a vector to move between displacement; velocity and acceleration.Relate magnitude of vectors to distance; speed and magnitude of acceleration.Emphasise the need for a vector form for the constant of integration and that this needs both components to be found.* Discuss models that use vectors and how realistic they might be. E.g. Relative to an origin on a long, straight beach, the position of a speedboat is modelled by a vector  where and  are unit vectors perpendicular and parallel to the beach. Distances are in metres and the time  is in seconds.

Suggest why this model for the motion of the speedboat is unrealistic for large t. |
| 4 | Re-cap simple rearranging of parametric equations to find cartesian form.[Solomon C4 parametrics worksheet](http://pmt.physicsandmathstutor.com/download/Maths/A-level/C4/Worksheets-Notes/Solomon/C4%20Differentiation%20A%20-%20Questions.pdf)  | Model how to establish the cartesian equation of the path of an object moving in 2D with position given in terms of time. | General motion <http://mei.org.uk/files/sow/38-kinematics-res.pdf> |