Kinematics

Q3 Understand, use and derive the formulae for constant acceleration for motion in a straight line; extend to 2 dimensions using vectors .

Q4 Use calculus in kinematics for motion in a straight line: $v = \frac{dr}{dt}$, $a = \frac{dv}{dt} = \frac{d^2r}{dt^2}$, $r = \int v\,dt$, $v = \int a\,dt$; extend to 2 dimensions using vectors.

E9 Use trigonometric functions to solve problems in context, including problems involving vectors, kinematics and forces.

For a brief commentary on this content go to the MEI outline SoW.

Pre-requisites

- Confidence with differentiation and integration methods.
- Use of constant acceleration ideas from AS level mechanics.

Common student errors

- Remembering that when constants of integration are vectors they will have two components.
- Combining components when applying calculus techniques to vectors.
- Use of displacement instead of velocity to determine the direction of motion.
- An inability to interpret points on a compass (e.g. not appreciating being located south-east of the origin requires a position vector of the form $a\mathbf{i} - a\mathbf{j}$, where $\mathbf{i}$ and $\mathbf{j}$ are unit vectors directed east and north respectively.
- Failing to find the magnitude of a vector when required (e.g. if asked to find speed).

Teaching it!

- A series of videos designed to support students on this topic. (Coming soon)
- An interactive resource from the PhET Colorado project that allows students to explore vectors and their resultants.
- Vector matching: A matching activity taken from the Teaching Mechanics 1 course.
- A Desmos activity version of the Vector matching above.
- A card sort activity to structure the building of solutions for vector problems. (Solution)

Getting them thinking

- How might a position-time graph differ from a displacement-time graph?
- An object has a velocity of $3t\mathbf{i} + 30\mathbf{j}$ ms^{-1} at time t s, where $\mathbf{i}$ and $\mathbf{j}$ are unit vectors directed east and north respectively. When will the object be travelling in a north-easterly direction? Will it ever travel in a northerly direction?
- Why is the equation $v^2 = u^2 + 2as$ not normally used to solve problems in two dimensions?