Variable acceleration (AS)

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

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

Pre-requisites

- Confidence with simple differentiation and integration.
- Understanding of the terminology associated with AS level kinematics.

Common student errors

- Using the constant acceleration equations in situations where the acceleration is variable (especially following a gap after studying this topic explicitly).
- Forgetting the constant of integration or muddling up the constants when required to integrate twice.
- Not appreciating that the use of limits identifies the distance travelled between the two times.
- Difficulty in interpreting/applying solutions in context, especially regarding the limitations of mathematical models.

Teaching it!

- A series of videos designed to support students on this topic. (Coming soon)
- Traffic (Acceleration): GeoGebra version of 20 interactive simulations, based on a GCSE Standards Unit resource. The 'Acceleration' simulations focus on non-linear distance-time graphs.
- Moving man: Dynamic software from the PhET Colorado project, useful for exploring the links between motion-time graphs.
- Thinking constantly: An Underground Mathematics activity that explores the role of constants of integration in the context of kinematics.
- A motion graph activity that structures the move from constant to variable acceleration. (Solution)

Getting them thinking

- The acceleration of a particle P is given by $a = 6t - 4$. Initially the particle is at rest at the origin. What questions can you ask based around this piece of information?
- Sketch a velocity-time graph for the vertical motion of a skydiver, incorporating the moment at which they open their parachute. Now sketch a displacement-time graph for the same situation.
- Use calculus to derive the constant acceleration equations.