Y12 AS Mathematics

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| 19 Kinematics | 6 lessons |
| Teaching Objectives |  |
| 1. To review knowledge of **speed**/**distance**/**time**/**acceleration** from GCSE. 2. To ensure students appreciate the distinction between **scalar** and **vector** quantities. 3. To ensure students are able to convert between relevant units eg. **metres**↔**kilometres**, **seconds**↔**hours** 4. To understand and use the language of kinematics: **position**; **displacement**; **distance travelled**; **velocity**; **speed**; **acceleration**. 5. To understand and use **displacement-time** graphs for motion in a straight line, including interpreting **gradients**. | 1. To understand and use **velocity-time** graphs for motion in a straight line, including interpreting **gradients** and **area** under graph. 2. To derive the formulae for **constant acceleration** for motion in a straight line. 3. To use the formulae for **constant acceleration** for motion in a straight line, including rearranging. 4. To ensure students can distinguish where the **constant acceleration** formulae are applicable and where they are not. |
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| Resources for advance preparation  * Desmos Activities: Book laptops/computer room * [SU: Interpreting Distance-Time Graphs](http://www.mrbartonmaths.com/resources/standard%20unit%20pdfs/SU%20Algebra%20Lessons/A6%20-%20Interpreting%20Distance%20-%20time%20graphs.pdf): Cut up card sorts (or get students to do it) * [Integral: Labelling a graph](https://integralmaths.org/pluginfile.php/4628/mod_page/content/4/Teach_Motion_labelgraph.pdf): Print page 1 on A3, page 2 on A4. Students can cut up the cards. | * [TES: Suvat Loop](https://www.tes.com/teaching-resource/suvat-loop-6191367): Print and cut out * [CIMT: One-Dimensional Motion](http://www.cimt.org.uk/projects/mepres/alevel/mechanics_ch2.pdf) & [Nuffield: Runaway Train](https://www.stem.org.uk/resources/elibrary/resource/31129/runaway-train): Requires: meter rules, balls of different masses, stopwatches |

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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 | [Mr Carter: Speed, Distance and Time](http://www.mrcartermaths.com/#Speed_Distance_and_Time)  Quick GCSE recap | Calculating average speeds where unit conversion is necessary: [Don Steward: Speeding](http://donsteward.blogspot.co.uk/2012/04/speeding.html)  Calculating average speeds in two part journeys: [Don Steward: Decreasingly Speedy](http://donsteward.blogspot.co.uk/2011/06/horse.html) | **Notes**  The key thing here is to ensure students are aware that units need to ‘match’ in these kinds of calculation  You might want to show students how to abuse the [degrees-minutes-seconds button](https://www.youtube.com/watch?v=rDX93WuCCUw) for time calculations!  **Possible Extension Qs**  [NRich: Olympic Problems](http://nrich.maths.org/7322) | **Plenary Activity**  [Increasingly Difficult Questions: Speed Distance Time](http://taylorda01.weebly.com/uploads/4/2/3/8/42387051/speed_distance_time_01.pdf)  **Homework**  [Increasingly Difficult Questions: Speed Distance Time (2)](http://taylorda01.weebly.com/uploads/4/2/3/8/42387051/speed_distance_time_2_01.pdf)  [(answers)](http://taylorda01.weebly.com/uploads/4/2/3/8/42387051/speed_distance_time_2_01_answers.pdf) |
| 2 | [Graphing Stories: Distance from Camera](http://graphingstories.com/2eu)  Students should watch video and sketch a graph, possibly on mini-whiteboards | **High-Tech Option** [Desmos: Function Carnival](https://teacher.desmos.com/carnival) Sketching graphs from a video and checking accuracy [Desmos: Distance-Time Graphs](https://teacher.desmos.com/polygraph/custom/560ad68f7701c303063305f5) Comparing graphs and using technical vocabulary to describe them  **Low-Tech Option** [SU: Interpreting Distance-Time Graphs](http://www.mrbartonmaths.com/resources/standard%20unit%20pdfs/SU%20Algebra%20Lessons/A6%20-%20Interpreting%20Distance%20-%20time%20graphs.pdf) matching graphs to data | Desmos allows you to set up a ‘room code’ so you can see students’ responses, freeze their screens and share anonymised graphs with the whole class for discussion. | **Plenary Activity**  Draw out interesting/instructive responses and misconceptions for discussion with the class. |
| 3 | [SU: The swimming race](http://www.mrbartonmaths.com/resources/standard%20unit%20pdfs/SU%20Algebra%20Lessons/A5%20-%20Interpreting%20Distance%20-%20time%20graphs%20with%20a%20computer.pdf)  (Scroll down to the last page)  Students could work in pairs to find and fix errors. Discuss these as a class. | [Integral: Labelling a graph](https://integralmaths.org/pluginfile.php/4628/mod_page/content/4/Teach_Motion_labelgraph.pdf) Students should find acceleration and distance travelled for each ‘section’ of the journey.  [STEM Learning: Distance-time and Velocity-time Graphs](https://www.stem.org.uk/resources/elibrary/resource/27340/distance-time-and-velocity-time-graphs) Translate between word expressions, algebraic expressions, and graphical representations of this motion. | **Possible Extension Qs**  [NRich: Speedo](http://nrich.maths.org/7109)  Teacher notes and session plan are included at STEM Learning. | **Plenary Activity**  [UM: Discussing Distance](https://undergroundmathematics.org/introducing-calculus/discussing-distance)  [UM: Speed vs Velocity](https://undergroundmathematics.org/introducing-calculus/speed-vs-velocity)  Distinguishing between scalar and vector quantities  **Homework**  [Integral: Graphs of motion](https://integralmaths.org/pluginfile.php/4628/mod_page/content/4/Teach_Motion_motiongraphs.pdf) All three graphs represent the same situation. Students should use the information from the s-t graph and the v-t graph to complete all three graphs.  Note that the missing parts of the displacement-time graph will only be approximate but by calculating the area under the v-t graph, the idea that the s-t graph is curved here should emerge. |
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| 4 | [Standards Unit O2: Exploring equations of Motion](http://www.mrbartonmaths.com/resources/standard%20unit%20pdfs/SU%20Others/O2%20-%20Exploring%20Equations%20of%20Motion.pdf) in pairs (extended starter) | [OCR: Activity 2](http://www.ocr.org.uk/Images/179309-suvat-equations-learner-activity.doc) Guides students through the derivation process of the *SUVAT* equations. This activity [MEI: Deriving the Formula](https://integralmaths.org/pluginfile.php/4641/mod_page/content/3/Deriving%20the%20formula.pdf) could be used as scaffolding for the last part.  [MEI: Constant Acceleration Matching](http://mei.org.uk/files/sow/18-kinematics-res.pdf) Practise using the formulae. This could be used as a noughts-and-crosses activity in pairs. Students check each other’s answers. | **Notes**  [OCR: Teacher Notes](http://www.ocr.org.uk/Images/179302-suvat-equations-topic-exploration-pack.pdf) Notes to accompany the OCR resource  **Possible Extension Qs**  [NRich: Cannon Balls](http://nrich.maths.org/5987) | **Plenary Activity**  [TES: Suvat Loop](https://www.tes.com/teaching-resource/suvat-loop-6191367) each student has a card. Pick one to read their question, the answer will be on another student’s card. This student reads the next question etc. |
| 5 | [Mr Carter: Rearranging Formulae](http://www.mrcartermaths.com/#Rearranging_Formulae)  [Mr Carter: Quadratic Formulae](http://www.mrcartermaths.com/#Quadratic_Formula)  (Checking necessary prior-knowledge) | [OCR: Activity 3](http://www.ocr.org.uk/Images/179309-suvat-equations-learner-activity.doc) Practise rearranging the *SUVAT* equations.  [Integral: Constant Acceleration Matching Problems](https://integralmaths.org/pluginfile.php/4641/mod_page/content/3/Teach_ConstAcc_identify.pdf) Interpreting the language of kinematics problems. | **Possible Extension Qs**  [UM: One windy day](https://undergroundmathematics.org/vector-geometry/one-windy-day)  [UM: Thinking Constantly](https://undergroundmathematics.org/calculus-meets-functions/thinking-constantly)  Ask each pair of students to divide it into six sections  (← like this).  Students should place statements in the appropriate section. | **Plenary Activity**  Discussion:*Can an object have a negative acceleration but still be speeding up?*  **Homework:** [Integral: Topic Assessment w/ Solutions](https://integralmaths.org/pluginfile.php/4636/mod_resource/content/2/m1casswl9s.pdf) |
| 6 | Quick recap of all the constant acceleration formulae | Bringing together what has been learnt for problem solving: [STEM Learning: Exploring Mechanics](https://www.stem.org.uk/resources/elibrary/resource/32653/exploring-mechanics) (Short Investigation 4)  [CIMT: One-Dimensional Motion](http://www.cimt.org.uk/projects/mepres/alevel/mechanics_ch2.pdf) (Activity 7 - Gallileo’s rolling ball experiment) [Nuffield: Runaway Train](https://www.stem.org.uk/resources/elibrary/resource/31129/runaway-train) | **Notes**  [STEM Learning: Exploring Mechanics](https://www.stem.org.uk/resources/elibrary/resource/32653/exploring-mechanics) (Student Material 4 & Teacher Material 2) | **Plenary Activity**  [NRich: Dangerous Driver?](http://nrich.maths.org/6417) establish the validity of the claims made using *SUVAT* equations. |

**Extra resources**

* Multiple choice questions from Integral: [The Constant Acceleration Formulae](https://integralmaths.org/pluginfile.php/4640/mod_resource/content/2/m1c1qwc4b.pdf)
* Multiple choice questions from Integral: [Further Examples](https://integralmaths.org/pluginfile.php/4646/mod_resource/content/2/m1c2qwe3z.pdf)