**Y13 A level Mathematics**

**42 Projectiles 1 week**

## Teaching objectives

**a** To understand and use the language of kinematics: position; displacement; distance travelled; velocity; speed; acceleration

**b** To be able to model motion under gravity in a vertical plane using vectors and be able to formulate the equations of motion of a projectile using vectors

**c** To know how to find the position and velocity at any time of a projectile and find range and maximum height

**d** To be able to find the initial velocity of a projectile given sufficient information

**e** To be able to eliminate time from the component equations that give the horizontal and vertical displacement to obtain the equation of the trajectory

**f** To be able to solve simple problems involving projectiles

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| Resources for advance preparation |  |

Some good detailed powerpoints - <https://haringeymath.wordpress.com/mechanics-2/> and <https://www.tes.com/teaching-resource/a-level-further-maths-projectiles-lesson-6148018>

Questions on projectiles - <https://www.tes.com/teaching-resource/alevel-maths-mechanics-2-kinematics-m2-6095965>

Powerpoint of past exam questions by topic - <https://www.tes.com/teaching-resource/ocr-mechanics-2-m2-revision-big-exam-style-questions-powerpoint-11205087>

Lots of mechanics resource links - <http://www.resourceaholic.com/p/mechanics.html>

Questions by topic - <http://www.physicsandmathstutor.com/past-papers/a-level-physics/aqa-unit-2-by-topic/>

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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 | Remind students of suvat and vertical motion by asking them to complete a short experiment. They simply drop a ball from a height, use their phones to time how long until it reaches the ground and from this they should be able to calculate the height dropped from and velocity it hits the ground at. | If needed after the starter use mymaths motion in a vertical plane – <https://app.mymaths.co.uk/871-resource/motion-in-a-vertical-plane>  To remind students of key concepts  Then use the phet colarado interactive projectile to discuss motion in 2 dimensions and the best angle for the greatest range. <https://phet.colorado.edu/sims/projectile-motion/projectile-motion_en.html>  Following this discuss how to split the motion into horizontal and vertical components and lead through simple examples of questions starting and ending at ground level. Questions from old resources should be fine for this. Ensure that the range and greatest height are consistently covered. | Ensure throughout the module that students are always very clearly stating the equations used and the direction. Also helpful if they are also stating the point. Ie at greatest height, etc | A consolidation homework of a couple of simple problems where the projectile starts and ends at ground level would be good after this first lesson. |
| 2 | From a question covered last lesson ask students to find the position of the projectile at a certain time. The MEI geogebra sheet will be useful to check answers <https://www.geogebra.org/m/RnDmZyE5> | From discussion of the starter lead onto also finding the speed at any point on the projectile. Again use of old resource questions would be good for this. Make sure the problems are still where the projectile starts and ends at ground level. | For finding the speed discuss with students the horizontal component of any projectile and the assumptions in its speed remaining constant. | Questions from this link could be used as homeworks <https://www.tes.com/teaching-resource/alevel-maths-mechanics-2-kinematics-m2-6095965> |
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| 3 | To introduce horizontal motion from a height ask students what will hit the ground first, a bullet dropped from someone’s hand or a bullet fired from the same height from a gun. | Discuss the starter and with a diagram and using suvat explore the fact that without air resistance they will hit the ground at the same time.  Next have students estimate the speed that a projectile you roll off a table hits the ground at. Discuss and work through the horizontal motion starter question again encouraging students to draw a diagram and clearly state the direction and equations used.  The STEM interactive sheets <https://www.stem.org.uk/resources/elibrary/resource/35724/projectiles>  Would help to model this situation and look at the effect of different velocities on the range.  Consolidate the key skills of finding the speed and distance at any time through use of old resource questions or from the links above. | As an extension students could work out the initial velocity needed to reach certain distances horizontally.  If any students are having trouble at this point separating the horizontal and vertical motion the STEM activity here should help  <https://www.stem.org.uk/resources/elibrary/resource/26329/episode-207-projectile-motion> | Questions outlining the key concepts so far would be good homework at this point. Maybe print out a selection from an old resource and students order easy – challenging and complete the ones they know they need to work on |
| 4 | Start with the equation of the trajectory of a projectile on the board and challenge students to derive it. You could have some steps to this displayed or hints on the board for any that struggle. | Emphasise this key skill of eliminating time from the equations and the usefulness of knowing the equation of the trajectory.  Following all of this algebra and to consolidate the skills developed so far now would be a good time for students to complete an experiment. The putting the shot experiment is perfect for this. <https://www.tes.com/teaching-resource/projectiles-putting-the-shot-6354171>  There are some resources needed but all students phones will have the required cameras / video capacity to easily cope with this. | Good practice here for students to work together and to also present their findings in a clear way, again demonstrating that they can clearly state the equations used and direction. | Some good questions on here that have solutions to display the following lesson <https://www.examsolutions.net/tutorials/projectiles-exam-questions/>  Students could complete a revision sheet / display at this point of all the key situations / concepts covered. A good summary of these here <http://www.a-levelmathstutor.com/m-2Dmotion-projectiles.php> |
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| 5 | Have a big past exam question waiting for students to work on in groups. Choose one that has many stages so that students can see the progression. | Go through the question but emphasise that in the next A level questions will not be as structured and this lesson is practice on those new types.  The powerpoint below would be perfect for that, choosing the less structured questions.  <https://www.tes.com/teaching-resource/ocr-mechanics-2-m2-revision-big-exam-style-questions-powerpoint-11205087> | Important that at this stage students are aware of any specific types of questions or key concepts that they still need to work on | Questions from the powerpoint for consolidation homework would be good at this stage. |