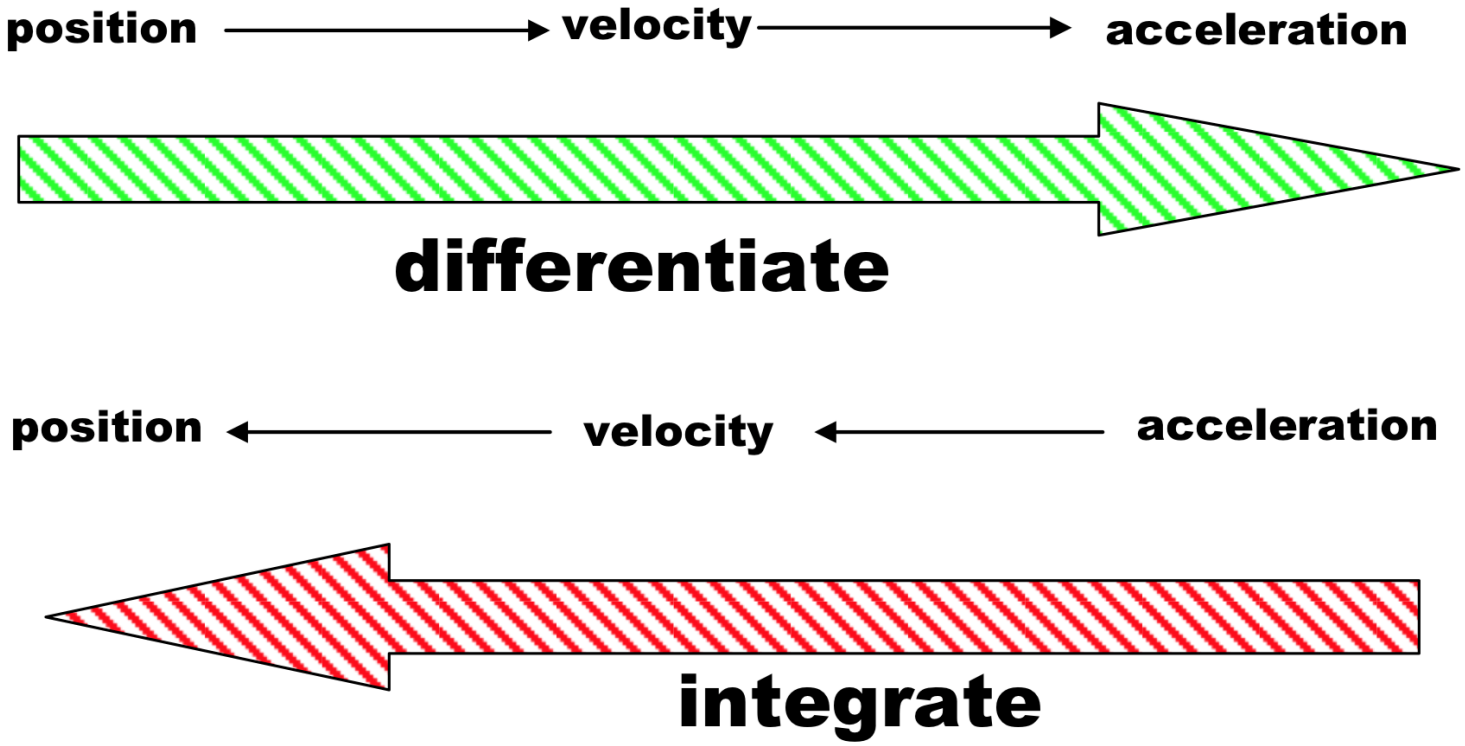
Motion in two dimensions

1	**Make sure that you are confident with vectors and vector notation** Vectors in two dimensions are covered in AS / Year 1 Maths, and you will also have met them at GCSE.
2	**Remember that any constants of integration will be vectors and so will have two components** The constant of integration is dealt with by treating the i and j components completely separately. Alternatively you can write the constant of integration as a column vector.
3	**Make sure that you know when to differentiate and when to integrate** This is a very common error. If you remember the definitions of velocity and acceleration, this shouldn't be a problem. The diagram to the right summarises the situation.



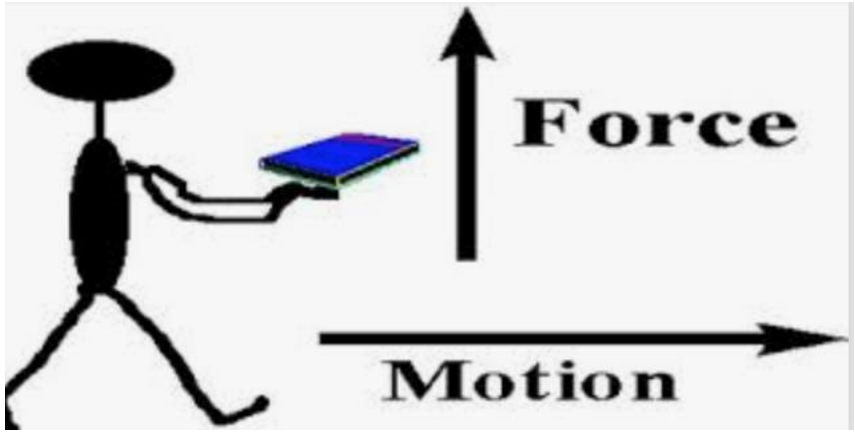
Maths	A2 Mechanics – FORCES & MOTION	Year 13

Resolving forces

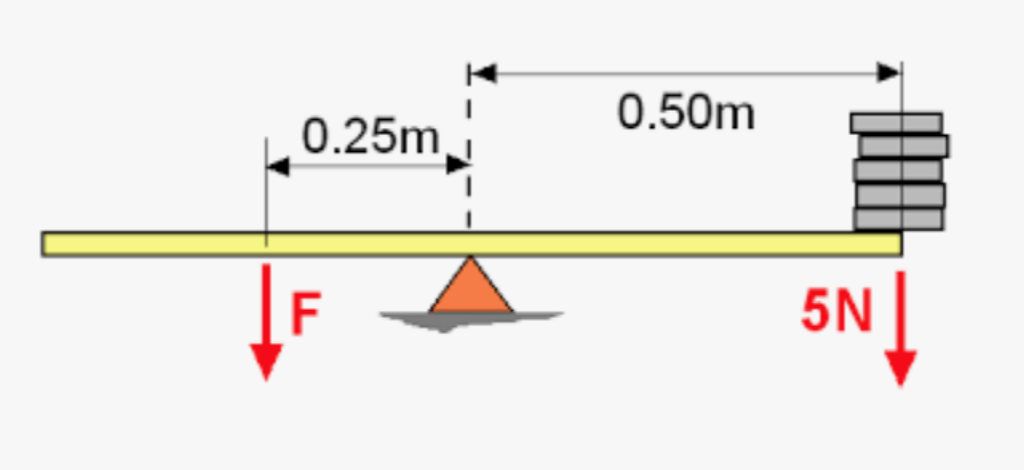
1	**Always draw a clear diagram** Make sure that you include all forces. These may include weights, normal reactions, tensions in strings etc, resistance forces. Write in any angles. Remember that friction always opposes the tendency to sliding motion.
2	**Make sure you are confident with the use of vectors, especially resolving** The technique of resolving forces underpins much of Mechanics work. It is very important that you master this. The Notes and Examples should help. If you are not confident with using sine and cosine to find the components of a vector, you must practice until you are.
3	**Remember how to deal with slopes** When dealing with a particle on a slope, it is usually best to resolve forces into components parallel to the slope and perpendicular to the slope. Draw a clear diagram and mark in the angles.
4	**Remember to state what the direction of a force is relative to** Saying that a force has a direction of, say, 67 does not tell you anything about its direction unless you also say what the 67 is relative to. Usually directions are given relative to the positive i direction.
5	**Remember the condition for equilibrium** If a particle is in equilibrium, the resultant force on it must be zero. This means that the total of the components forces in each direction must be zero.

Newton's second law in two dimensions

1	**Always draw a clear diagram** Make sure that you include all forces. These may include weights, normal reactions, tensions in strings etc, resistance forces. Write in any angles.
2	**Remember to deal with signs appropriately** Decide which direction you are taking as positive, and remember that all forces acting in the opposite direction are negative. Also remember that if the tension in a coupling turns out to be negative, then the force in the coupling is actually a thrust (compression force). Tension in a string cannot be negative!
3	**Choose which direction to resolve in sensibly** If there is motion, always resolve in the direction of motion and in the direction perpendicular to the motion.



Rigid bodies	
1	**Always draw a diagram** If you try to work without a diagram, you are very likely to make mistakes with signs, or to miss out forces.
2	**Make sure that you get the direction of moments right** Remember that anticlockwise is considered to be positive and clockwise negative. Always draw a clear force diagram and use it to consider the direction of each force.
3	**Remember to include reaction forces at a support or hinge in the force diagram** These have no effect when you take moments about the support or hinge, but you need to take them into account when you resolve forces or take moments about a different point.



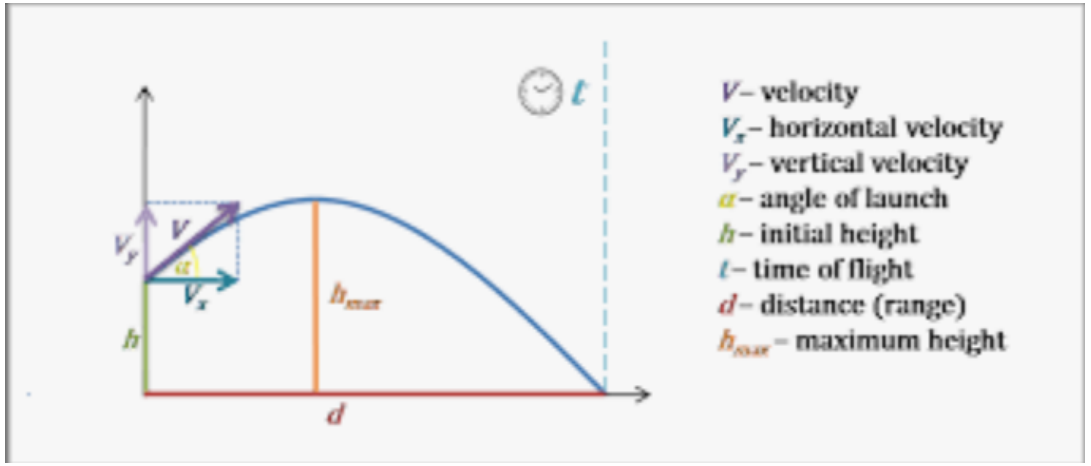
Maths	A2 Mechanics – PROJECTILES	Year 13

Introduction

1	**Make sure that you are fluent with the constant acceleration equations** This must be thoroughly understood before you tackle this section, including working in two dimensions.
2	**Remember that the only force acting on a projectile is gravity** It is common for students to believe that there is some kind on force acting on the projectile to make it move. This is incorrect. A projectile must have an initial velocity, and a force will have been required to give it this initial velocity – for example, if you throw a ball, a force from your arm accelerates the ball to its initial velocity. However, as soon as the ball has left your hand, i.e. as soon as it becomes a projectile, the force from your arm ceases to act upon it and the only force it is subjected to (ignoring air resistance) is the gravity force, which gives a constant acceleration of g, vertically downwards.
3	**Remember that the horizontal velocity of a projectile does not change** This is linked to 3, above. Remember Newton's first law – because there is no horizontal force acting on a projectile, only a vertical force due to gravity, the horizontal velocity of a projectile must remain constant throughout its flight.
4	**Don't assume that a projectile always lands on the same level it started from** When finding the position that a projectile lands, or its time of flight, always check to see what the vertical displacement is relative to its starting point. A common mistake is to assume that it starts and finishes on the same level, so that its path is symmetrical, meaning its time of flight is twice the time to maximum height and its range is twice the horizontal displacement at maximum height. It saves time to find range and time of flight in this way if the projectile does land at the same level as it starts, but make sure you check it does or you will get the wrong answer!

General equations

1	**Don't confuse the displacement-time graph of a projectile with its path** Remember that the path of a projectile is the route it follows through the air. The path of the projectile is shown by a graph of its vertical displacement against its horizontal displacement. This will look similar to a graph of vertical displacement against time for the projectile because the horizontal component of the projectile's velocity is constant.
2	**Make sure you can find the path equation from the equations for horizontal and vertical displacement in terms of time** Make sure that you are confident with the algebra involved – this is a very useful technique throughout maths.



Maths	A2 Mechanics – A MODEL FOR FRICTION	Year 13

Working with friction	
1	**Always draw a clear diagram Make sure that you include all forces**. These may include weights, normal reactions, tensions in strings etc, resistance forces. Write in any angles. Remember that friction always opposes the tendency to sliding motion.
2	**Remember the difference between mass and weight** On a force diagram, you need to use weight which is equal to mg and is measured in Newtons. Mass is measured in kilograms. Make sure that you read questions carefully and note whether you are told the mass or the weight.
3	**Make sure that you can resolve forces confidently** You should have mastered this technique in section 1. Resolving forces is an essential skill in this section and in most areas of Mechanics, so it is important that you can do this confidently.
4	**Use the relationship F = μR in appropriate situations** In most examples you will meet, sliding is either occurring or about to occur, so that friction is limiting and F=μR can be used. However, if there is no motion, and you are not told that sliding is about to occur, you cannot use F=μR . In cases where no motion is occurring, F$\leq \mu$R .