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| **Year 2 Mechanics Units** | **Road Map** |
| In this unit you will learn about mechanics. The aims are as follows:**LG1**: Knowledge**LG2**: Application**LG3**: Skills | Assessment Grades |  |  |
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| **Themes** | **Learning Goals/Outcomes/Content** |  |  |  |
| **4. Forces at any angle (part 1)** | understand the language relating to forces; |  |  |  |
| be able to identify the forces acting on a particle and represent them in a force diagram; |  |  |  |
| understand how to find the resultant force (magnitude and direction); |  |  |  |
| be able to find the resultant of several concurrent forces by vector addition; |  |  |  |
| be able to resolve a force into components and be able to select suitable directions for resolution. |  |  |  |
| **5. Further kinematics (part 1)**  | be able to recognise when the use of constant acceleration formulae is appropriate; |  |  |  |
| be able to write positions, velocities and accelerations in vector form; |  |  |  |
| understand the language of kinematics appropriate to motion in 2 dimensions |  |  |  |
| be able to find the magnitude and direction of vectors; |  |  |  |
| be able to extend techniques for motion in 1 dimension to 2 dimensions by using vectors; |  |  |  |
| know how to use velocity triangles to solve simple problems; |  |  |  |
| understand and use *suvat* formulae for constant acceleration in 2D; |  |  |  |
| know how to apply the equations of motion to **i**, **j** vector problems; |  |  |  |
| be able to use ***v*** = ***u*** + ***a****t* , ***r*** = ***u****t* + $\frac{1}{2}$***a****t*2  etc. with vectors given in **i** , **j** or column vector form. |  |  |  |
| **6. Applications of kinematics projectiles**  | be able to find the time of flight of a projectile; |  |  |  |
| be able to find the range and maximum height of a projectile; |  |  |  |
| be able to derive formulae to find the greatest height, the time of flight and the horizontal range (for a full trajectory); |  |  |  |
| know how to modify projectile equations to take account of the height of release; |  |  |  |
| be able to derive and use the equation of the path. |  |  |  |
| **7. Forces at any angle (part 2)**  | understand that a rough plane will have an associated frictional force, which opposes relative motion (i.e. the direction of the frictional force is always opposite to how the object is moving or ‘wants’ to move); |  |  |  |
| understand that the ‘roughness’ of two surfaces is represented by a value called the coefficient of friction represented by *µ;* |  |  |  |
| know that 0 ≤ *µ* but that there is no theoretical upper limit for *µ* although for most surfaces it tends to be less than 1 and that a ‘smooth’ surface has a value of *µ* = 0;  |  |  |  |
| be able to draw force diagrams involving rough surfaces which include the frictional force |  |  |  |
| understand and be able to use the formula *F* ≤ *µR*. |  |  |  |

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| **8. Application of forces (part 1)** | know and understand the meaning of Newton's second law; |  |  |  |
| be able to formulate the equation of motion for a particle in 1-dimensional motion where the resultant force is mass × acceleration; |  |  |  |
| be able to formulate the equation of motion for a particle in 2-dimensional motion where the resultant force is mass × acceleration; |  |  |  |
| be able to formulate and solve separate equations of motion for connected particles, where one of the particles could be on an inclined and/or rough plane. |  |  |  |
| know and understand the meaning of Newton's second law; |  |  |  |
| be able to formulate the equation of motion for a particle in 1-dimensional motion where the resultant force is mass × acceleration; |  |  |  |
| be able to formulate the equation of motion for a particle in 2-dimensional motion where the resultant force is mass × acceleration; |  |  |  |

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| **9. Further kinematics (part 2)** | be able to extend techniques for motion in 1 dimension to 2 dimensions by using calculus and vector versions of equations for variable force/acceleration problems; |  |  |  |
| understand the language and notation of kinematics appropriate to variable motion in 2 dimensions, i.e. knowing the notation $\dot{r}$ and $\ddot{r}$ for variable acceleration in terms of time. |  |  |  |

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| **10. Moments** | realise that a force can produce a turning effect;  |  |  |  |
| know that a moment of a force is given by the formula force × distance giving Nm and know what the sense of a moment is; |  |  |  |
| understand that the force and distance must be perpendicular to one another; |  |  |  |
| be able to draw mathematical models to represent horizontal rod problems; |  |  |  |
| realise what conditions are needed for a system to remain in equilibrium; |  |  |  |
| be able to solve problems when a bar is on the point of tilting. |  |  |  |
| **11. Application of forces (part 2)** | be able to solve statics problems for a system of forces which are not concurrent (e.g. ladder problems), thus applying the principle of moments for forces at any angle. |  |  |  |

**Links:**

LG1: You will be able to resolve forces in two dimensions, and will learn how to extend the constant acceleration formulae of motion to 2 dimensions using vectors. You will understand and use the *F* ≤ *µR* model for friction; coefficient of friction; motion of a body on a rough surface; limiting friction and limiting equilibrium. You will understand and use Newton’s 2nd and 3rd laws. You will Use calculus in kinematics for (variable acceleration) motion in a straight line. You will understand and use moments in simple static contexts.

LG2: You will learn how to apply your knowledge of vectors to model motion under gravity in a vertical plane. You will extend your knowledge of Newton’s 2nd law to situations where forces need to be resolved and apply your knowledge of Newton’s 3rd law to problems involving smooth pulleys and connected particles. You will apply your knowledge of vectors to problems involving motion in 2 dimensions. You will apply your knowledge of moments to problems involving parallel and non-parallel coplanar forces e.g. ladder problems.

LG3: You will be able to analyse a model appropriately and interpret and communicate the implications of the analysis in terms of the situation being modelled. You should be able to solve a variety of routine and non-routine problems. You should be able to discuss assumptions relating to problems solved in this unit, for example assumptions linked to the smooth pulley. You should understand how to interpret your findings in the context of the original problem.