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| **Year 1 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** | | |  |  |  |
| **8a. Introduction to mathematical modelling and standard S.I units of length, time and mass** | understand the concept of a mathematical model, and be able to abstract from a real-world situation to a mathematical description (model); | | |  |  |  |
| know the language used to describe simplifying assumptions; | | |  |  |  |
| understand the particle model; | | |  |  |  |
| be familiar with the basic terminology for mechanics; | | |  |  |  |
| be familiar with commonly-made assumptions when using these models; | | |  |  |  |
| be able to analyse the model appropriately, and interpret and communicate the implications of the analysis in terms of the situation being modelled; | | |  |  |  |
| understand and use fundamental quantities and units in the S.I. system: length, time and mass; | | |  |  |  |
| Understand that units behave in the same way as algebraic quantities, e.g. meters per second. m/s = m × 1/s = ms-1. | | |  |  |  |
| **8b. Definitions of force, velocity, speed, acceleration, weight and displacement; Vector and scalar quantities** | understand and use derived quantities and units: velocity, acceleration, force, weight; | | |  |  |  |
| know the difference between position, displacement and distance; | | |  |  |  |
| know the difference between velocity and speed, and between acceleration and magnitude of acceleration; | | |  |  |  |
| know the difference between mass and weight (including gravity); | | |  |  |  |
| understand that there are different types of forces. | | |  |  |  |
| **9a. Graphical representation of velocity, acceleration and displacement** | be able to draw and interpret kinematics graphs, knowing the significance (where appropriate) of their gradients and the areas underneath them. | | |  |  |  |
| **9b. Motion in a straight line under constant acceleration; *suvat* formulae** | recognise when it is appropriate to use the *suvat* formulae for constant acceleration; | | |  |  |  |
| be able to solve kinematics problems using constant acceleration formulae; | | |  |  |  |
| be able to solve problems involving vertical motion under gravity. | | |  |  |  |

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| **10a. Newton’s first law, force diagrams, equilibrium, introduction to i, j system of vectors** | understand the concept of a force; understand and use Newton’s first law. |  |  |  |
| **10b. Newton’s second law, ‘*F* = *ma*’, connected particles (no resolving forces or use of *F* = *μR*); Newton’s third law: equilibrium, problems involving smooth pulleys.** | understand and be able to use Newton’s second law for motion in a straight line (restricted to forces in two perpendicular directions or simple cases of forces given as 2D (**i**, **j**) vectors.); |  |  |  |
| understand and use Newton’s third law; equilibrium of forces on a particle and motion in a straight line; application to problems involving smooth pulleys and connected particles. |  |  |  |
| **11a. Variable force; Calculus to determine rates of change for kinematics (differentiation)** | be able to use calculus (differentiation) in kinematics to model motion in a straight line for a particle moving with variable acceleration; |  |  |  |
| understand that gradients of the relevant graphs link to rates of change; |  |  |  |
| know how to find max and min velocities by considering zero gradients and understand how this links with the actual motion (i.e. acceleration = 0). |  |  |  |
| **11b. Use of integration for kinematics problems i.e. *r* = , *v*=** | be able to use calculus (integration) in kinematics to model motion in a straight line for a particle moving under the action of a variable force; |  |  |  |
| understand that the area under a graph is the integral, which leads to a physical quantity; |  |  |  |
| know how to use initial conditions to calculate the constant of integration and refer back to the problem. |  |  |  |

**Links:**

LG1: You should know and know how to use fundamental quantities and units in the S.I. system for length, time and mass. You need to know and know how to use derived quantities and units including velocity, acceleration, force and weight. You will learn and be able to use the language of kinematics, and graphs for kinematics. You should know and be able to use the formulae for constant acceleration for motion in a straight line. You should know and use weight and motion in a straight line under gravity and gravitational acceleration. You need to know the concept of a force and know and use Newton’s first, second and third law. You will learn how to use calculus in kinematics for motion in a straight line.

LG2: You should be able to apply your knowledge of standard units to change freely between related standard units in numerical and algebraic contexts. You will learn how to apply your knowledge of kinematics to draw displacement – time and velocity – time graphs to represent a practical activity such as throwing a ball up in the air. You will apply your knowledge of Newton’s laws to solve problems involving smooth pulleys and connected particles. You will apply your knowledge of calculus to model motion in a straight line and to find maximum and minimum velocities.

LG3: You should 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 such as recognising when it is appropriate to use the suvat formulae and solving kinematics problems using constant acceleration formulae. 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, explaining how zero gradients link to actual motion and understanding that gradients link to rates of change, also in context.