

## Chapter 8 - Mechanics

# Modelling in Mechanics

### Chapter Overview

1. Constructing a Model
2. Modelling Assumptions
3. Quantities and Units
4. Working with Vectors

Topics	What students need to learn:	
	Content	Guidance
<b>6</b> <b>Quantities and units in mechanics</b>	6.1 Understand and use fundamental quantities and units in the S.I. system: length, time, mass.  Understand and use derived quantities and units: velocity, acceleration, force, weight.	

# What is Mechanics?

Broadly speaking, mechanics covers motion, forces and how the two inter-relate with each other.

Mechanics, broadly speaking, concerns motion, forces, and how the two interrelate.

This chapter just gives you an overview of what you'll be covering in Year 1 and how it all links together.

## Forces

You will later encounter force diagrams. This considers the forces acting at a particular point. Some forces you might consider...

**The bridge!**  
 $F = ma$

Newton's 2<sup>nd</sup> Law allows us to connect the force world ( $F$ ) with the motion world (acceleration  $a$ ) if the object is moving.

- Forces can be considered as vectors.
- The **magnitude** of the force vector gives the 'size' of the force.
- We often **consider forces in a particular direction**. e.g. If the object above is stationary, the forces left must equal the force right, and forces up equal forces down (Newton's 1<sup>st</sup> Law).
- Often we need to consider the forces at multiple different points if objects are connected, e.g. with pulleys:

## Motion

At GCSE you may have encountered displacement-time and velocity-time graphs:

Given **constant acceleration** we have 5 quantities of motion ("*suvat*"):

- $s$  = displacement
- $u$  = initial velocity
- $v$  = final velocity
- $a$  = acceleration
- $t$  = time

which we will see are linked by various equations:

$$s = ut + \frac{1}{2}at^2$$

$$s = \left(\frac{u+v}{2}\right)t$$

$$v^2 = u^2 + 2as$$

$$v = u + at$$

If the **acceleration is not constant**, we can specify displacement/velocity/acceleration as a function of time and differentiate/integrate to change between them.

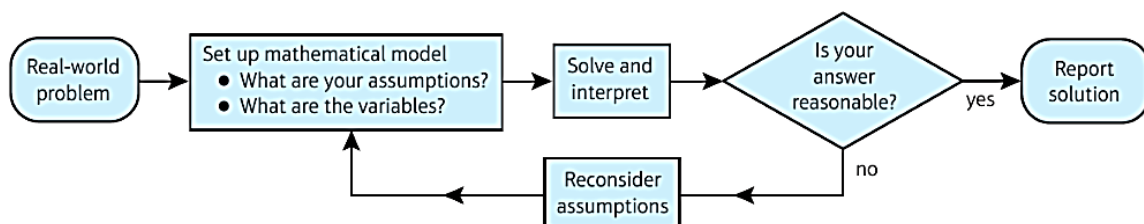
$$s = 2t^3 + 3t \rightarrow v = \frac{ds}{dt} = 6t^2 + 3$$

## 1. Constructing a Model

Why use a mathematical model?



The solution to a mathematical model needs to be interpreted in the context of the original problem. You may need to refine the model and reconsider your original assumptions.



**Example** *(Textbook)*

The motion of a basketball as it leaves a player's hand and passes through the net can be modelled using the equation  $h = 2 + 1.1x - 0.1x^2$ , where  $h$  m is the height of the basketball above the ground and  $x$  m is the horizontal distance travelled.

- a Find the height of the basketball:    i when it is released    ii at a horizontal distance of 0.5 m.
- b Use the model to predict the height of the basketball when it is at a horizontal distance of 15 m from the player.
- c Comment on the validity of this prediction.