L3 WAVES
CHEAT SHEET

STUDY TIME

ABOUT THE STANDARD

- Waves has a number of different types of questions, and what they really boil down to is a thorough understanding of the **concepts** of:
  - **Energy:** transferring energy from one place to another via waves through a medium;
  - **Superposition:** adding up waves at different points in space; and
  - **Frequency:** the relationship between frequency and what we hear, and the relationship between frequency and energy.
- The **topics** you will need to familiarise yourself with apply these concepts to different situations:
  - **Interference:** uses the idea of superposition
  - **Harmonics, resonance** and **standing waves:** use the ideas of frequency and energy
  - **Beats** and the **Doppler effect:** use the idea of frequency
- The exam will be a combination of **calculation** questions, **discussion** (long answer) questions and **diagram-drawing** question

STRATEGIES FOR SUCCESS

- When answering an interference question, it is important to use the key term "**path difference**". The path difference is the extra distance waves from one source have to travel compared to the other. Once you have explained this in your answer, it is crucial that you link this idea to the **type of interference** asked about in the standard.
  - For example: "The waves from slit 1 travel 0.4m further than the waves from slit 2. This path difference is half of the wavelength, which is 0.8m. Because the path difference is a half wavelength, this means a crest will meet a trough and we will observe destructive interference, and there will be no sound."
  - The two types of interference are constructive and destructive. Constructive interference results in amplified energy, destructive interference results in diminished energy.
- There are five equations provided on the formula sheet - know these.
  - $d\sin\Theta = n\lambda$ (for any angles)
  - $n\lambda = \frac{dx}{L}$ (only for small angles)
  - $f' = f\left(\frac{V_w}{V_w \pm V_s}\right)$
  - $f = \frac{1}{T}$
  - $v = f\lambda$
  - Typically, you will need each one at least once, and before you use any equation, **always** convert to SI units (Hz, s, m, ms^{-1}). On top of these, you will need to know your mechanics formula sheet well for energy and velocity.
  - $f_B = |f_1 - f_2|$ is the equation for beats. It is not given, so it is best to know it. o It is important to understand the units of each of these variables, and how they work together. Units follow the same rules as numbers, so if you are dividing a distance by a time, such as $v = \frac{d}{t}$, you will be dividing a metre by a second, so you will get $\frac{m}{s}$ which is the unit of velocity. When in doubt about units, this is a good method for checking.

- Practise **rearranging the equations** for different variables. A very small algebraic error could cost a grade boundary.

- Doppler effect questions will have a sound-emitting source such as a car or a boat moving towards or away from an observer. When using the doppler effect equation $f' = f\left(\frac{V_w}{V_w \pm V_s}\right)$, **consider what your observed frequency should be**.
  - If the car is moving **towards** you, imagine the waves bunching up - you should have a higher frequency. Therefore, the denominator in your equation should be smaller than if the source were moving away. This means you should use the **minus sign** instead of the plus sign: $f' = f\left(\frac{V_w}{V_w - V_s}\right)$
  - If the car is moving **away** from you, imagine the waves spreading out - you should have a lower frequency. Therefore your denominator should be larger, and you should use the **plus sign** instead of the minus sign: $f' = f\left(\frac{V_w}{V_w + V_s}\right)$
- Excellence questions will generally require you to use **multiple formulae**. To make these problems easier, **write down the information** presented in the question and match what you have and what you need to the equations on your Waves and Mechanics formula sheets.
- On a similar note, some questions may say that calculations are not necessary. Even so, it is extremely useful to **write down the relevant formulae**. You can then use the formulae to explain your answer.
  - In questions like these, explore how **changing one part** of an equation affects another. For example, if you increase the period, you end up decreasing the frequency as $f = \frac{1}{T}$. Increasing the wavelength of a wave will increase the speed if frequency remains constant, as $v = f\lambda$.
- Diagrams you may need to draw are those for standing waves, showing nodes and antinodes.
- **Nodes** are points of **No D**isplacement, antinodes are the opposite (maximum displacement).
- The **fundamental frequency** is the standing wave pattern with the fewest possible nodes or antinodes. **Harmonics are multiples of the fundamental frequency**: second harmonic means $2 \times f_{fundamental}$, third is $3 \times f_{fundamental}$, and so on.

HOW TO PREPARE FOR THE EXAM

- In the end, everything comes down to understanding energy, superposition and frequency. Ensure that you understand these individually, how they relate to each other, and how they behave in each equation they are in.
- Go through the last three or four years of exam papers, along with the StudyTime Walkthrough Guide and Checklist to really consolidate your knowledge and feel prepared!