Demonstrate understanding of wave systems Level 3 Credits 4

Subject Reference		Physics 3.3			
Title		Demonstrate understanding of wave systems			
Level	3	**Credits**	4	**Assessment**	External

This achievement standard involves demonstrating understanding of wave systems.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Demonstrate understanding of wave systems.	• Demonstrate in-depth understanding of wave systems.	• Demonstrate comprehensive understanding of wave systems.

Assessment is limited to a selection from the following:

Interference (quantitative) of electromagnetic and sound waves, including multi-slit interference and diffraction gratings;
Standing waves in strings and pipes;
Harmonics;
Resonance;
Beats;
Doppler Effect (stationary observer for mechanical waves).

Relationships:

$d \sin\theta = n\lambda$ $\qquad$ $n\lambda = \frac{dx}{L}$

$f' = f \frac{v_w}{v_w \pm v_s}$

Achievement criteria

The level of performance that you will gain will be determined by the complexity of the questions, and how you answer them. You need to be able to describe and explain Wave systems and use mathematical methods to solve problems.

Minor errors (computational - an error that relates to a mathematical calculation e.g. an error created when cancelling incorrectly or an error when entering the numbers into a calculator or transcription - an error created when writing) will not be penalised if the process used to determine the solution is clearly indicated and is valid.

Achievement

Make sure you can:

- Identify or describe aspects of phenomena, concepts, or principles.
- Solve problems involving a single process. The relevant concept or principle will be transparent, the method will be straightforward (a formula will need no more than a simple rearrangement), and the information will be directly usable.
- Recognise correct concept/phenomenon/principle and give a simple descriptive answer in both written and diagrammatic form, for example:
    - The Doppler Effect.
    - Standing waves in strings and air columns.
    - Harmonics.
    - Why the same note played on one instrument sounds different on another instrument.
- Recognise the correct concept and apply reasonable mathematical skills, for example, calculating the n^{th} order maximum for diffraction grating interference pattern.

Achievement with Merit

Make sure you can:

- Meet criteria for Achievement.
- Give accurate explanations in terms of phenomena, concepts, principles, and/or relationships.
- Solve problems where the relevant concept or principle is not immediately obvious, the method involves the use of a complex formula or rearrangement, or the information is not directly usable or immediately obvious. It may involve using a complex formula or rearrangement or some deduction as to the relevant concept or principle.

Achievement with Excellence

Make sure you can:

- Give concise and accurate explanations that show clear understanding in terms of phenomena, concepts, principles, and/or relationships. Your answers will typically have minimal irrelevancies. In other words, you cannot include any explanations that are not relevant. Do not guess!
- Solve complex problems that involve more than one process. The recognition of at least two different concepts must be involved.
- Show numerical accuracy, correct rounding and use SI units in answer.

Wave systems and interference of waves

You should be able to:

- ❑ Identify transverse/longitudinal waves and their properties (e.g. electromagnetic, seismic, sound, water, waves in springs and strings).
- ❑ Define the terms: velocity, frequency, period, wavelength, amplitude and phase of transverse and longitudinal waves Use the equations $v = f\lambda$ and $f = 1/T$ to calculate unknowns in a wave system.
- ❑ Apply factors affecting the speed of waves in elastic media.
- ❑ Construct a graphical description of travelling waves i.e. displacement-position graphs at a fixed time and displacement-time graphs at a given position.
- ❑ Describe the electromagnetic spectrum.
- ❑ Analyse interference patterns using the ideas of constructive and destructive interference.
- ❑ Describe and explain diffraction, and double source interference, of electromagnetic waves and sound.
- ❑ Calculate the fringe spacing for Young's experiment.
- ❑ Consider multiple source interference of electromagnetic waves; diffraction grating.

Standing Waves and music

You should be able to:

- ❑ Describe the reflection of pulses from free and fixed ends.
- ❑ Produce graphs of the superposition of two travelling waves; standing waves (nodes and antinodes)
- ❑ Describe standing waves in strings and pipes. Explain how standing waves can be produced by: a string fixed at both ends, a column of air open at one end, a column of air open at both ends.
- ❑ Explain how the combination of different harmonics makes musical instruments unique.
- ❑ Use the terms "fundamental frequency", "harmonics" and "resonance" to describe modes of vibration of a standing wave.

The Doppler Effect

You should be able to:

- ❑ Describe and explain the phenomena of beats as a special case of interference and calculate the beat frequency.
- ❑ Explain the Doppler Effect for a stationary observer using wave theory.
- ❑ Calculate the observed frequency/wavelength of light or sound that has undergone a Doppler shift.
- ❑ Explain applications of the Doppler Effect.

Advice from previous years

(Thanks to http://www.studyit.org.nz/)

- Understand that a physics problem involves a process(es) to find a physical quantity.
- Show all working of your calculations including any rearrangement of formulae.
- Be aware of the appropriate use of significant figures and units. You may use both negative index (for example, m s^{-2}) and slash notation (for example, m/s^2) when writing units. However, the examination paper will supply data using negative index notation.
- In the examination, make sure you read all questions carefully. That way, you are clear about what is being asked for, and what information is given.
- Understand that Doppler shift is dependent only on velocity, not distance.
- Know when to use (-) or (+) in the Doppler formula.
- Do not confuse the speed of sound with the speed of light.
- Recognise that all electromagnetic radiations (light, radio, microwaves, etc) travel at the speed of light.
- Understand and be able to describe the unique properties of a diffraction grating (compared with a double-slit).
- Understand the difference between closed and open pipes in forming harmonics, and be able to use the relationship between pipe length and wavelength in calculations.
- Recognise that $n\lambda = dx/L$ is an approximation based on sine ≈ tangent, and is only accurate for small angles (that is, when L is much larger than x). $n\lambda = d\sin\theta$ is a more accurate formula.