IB DP Unit Planner

# 11 SL Physics term 1 SL

TEACHER
Kristen Matherson

SUBJECT
Physics

SHARED GRADES
Year 1

START DATE
Week 4, January

DURATION
10 Weeks

COURSE PART
Topic 3: Thermal Physics and Topic 4: Waves

UNIT DESCRIPTION

## INQUIRY & PURPOSE

### Essential Understandings

Thermal physics deftly demonstrates the links between the macroscopic measurements essential to many scientific models with the microscopic properties that underlie these models.

The properties of ideal gases allow scientists to make predictions of the behaviour of real gases.

A study of oscillations underpins many areas of physics with simple harmonic motion (shm), a fundamental oscillation that appears in various natural phenomena.

There are many forms of waves available to be studied. A common characteristic of all travelling waves is that they carry energy, but generally the medium through which they travel will not be permanently disturbed.

All waves can be described by the same sets of mathematical ideas. Detailed knowledge of one area leads to the possibility of prediction in another.

Waves interact with media and each other in a number of ways that can be unexpected and useful.

When travelling waves meet they can superpose to form standing waves in which energy may not be transferred.

## CURRICULUM

### Aims & Objectives

AIMS

Appreciate scientific study and creativity within a global context through stimulating and challenging opportunities
Acquire a body of knowledge, methods and techniques that characterize science and technology
Apply and use a body of knowledge, methods and techniques that characterize science and technology
Develop an ability to analyse, evaluate and synthesize scientific information
Develop experimental and investigative scientific skills including the use of current technologies
Develop and apply 21st century communication skills in the study of science
Become critically aware, as global citizens, of the ethical implications of using science and technology

OBJECTIVES

**Demonstrate knowledge and understanding of**

- facts, concepts and terminology
- methodologies and techniques
- communicating scientific information

**Apply**

- facts, concepts and terminology
- methodologies and techniques
- methods of communicating scientific information

**Formulate, analyse and evaluate**

- hypotheses, research questions and predictions
- methodologies and techniques
- primary and secondary data
- scientific explanations

**Demonstrate the appropriate research, experimental, and personal skills necessary to carry out insightful and ethical investigations**

## Syllabus Content

**Core**

- 3. Thermal physics
  - 3.1 – Thermal concepts
    - Nature of science:
      - Evidence through experimentation: Scientists from the 17th and 18th centuries were working without the knowledge of atomic structure and sometimes developed theories that were later found to be incorrect, such as phlogiston and perpetual motion capabilities. Our current understanding relies on statistical mechanics providing a basis for our use and understanding of energy transfer in science.
    - Understandings:
      - Molecular theory of solids, liquids and gases
      - Temperature and absolute temperature
      - Internal energy
      - Specific heat capacity
      - Phase change
      - Specific latent heat
    - Applications and skills:
      - Describing temperature change in terms of internal energy
      - Using Kelvin and Celsius temperature scales and converting between them
      - Applying the calorimetric techniques of specific heat capacity or specific latent heat experimentally
      - Describing phase change in terms of molecular behaviour
      - Sketching and interpreting phase change graphs
      - Calculating energy changes involving specific heat capacity and specific latent heat of fusion and vaporization
  - 3.2 – Modelling a gas
    - Nature of science:
      - Collaboration: Scientists in the 19th century made valuable progress on the modern theories that form the basis of thermodynamics, making important links with other sciences, especially chemistry. The scientific method was in evidence with contrasting but complementary statements of some laws derived by different scientists. Empirical and theoretical thinking both have their place in science and this is evident in the comparison between the unattainable ideal gas and real gases.
    - Understandings:
      - Pressure
      - Equation of state for an ideal gas
      - Kinetic model of an ideal gas
      - Mole, molar mass and the Avogadro constant
      - Differences between real and ideal gases
    - Applications and skills:
      - Solving problems using the equation of state for an ideal gas and gas laws
      - Sketching and interpreting changes of state of an ideal gas on pressure–volume, pressure–temperature and volume–temperature diagrams

        - Investigating at least one gas law experimentally

- 4. Waves
    - 4.1 – Oscillations
        - Nature of science:
            - The concept of momentum and the principle of momentum conservation can be used to analyse and predict the outcome of a wide range of physical interactions, from macroscopic motion to microscopic collisions.
        - Understandings:
            - Simple harmonic oscillations
            - Time period, frequency, amplitude, displacement and phase difference
            - Conditions for simple harmonic motion
        - Applications and skills:
            - Qualitatively describing the energy changes taking place during one cycle of an oscillation
            - Sketching and interpreting graphs of simple harmonic motion examples
    - 4.2 – Travelling waves
        - Nature of science:
            - Patterns, trends and discrepancies: Scientists have discovered common features of wave motion through careful observations of the natural world, looking for patterns, trends and discrepancies and asking further questions based on these findings.
        - Understandings:
            - Travelling waves
            - Wavelength, frequency, period and wave speed
            - Transverse and longitudinal waves
            - The nature of electromagnetic waves
            - The nature of sound waves
        - Applications and skills:
            - Explaining the motion of particles of a medium when a wave passes through it for both transverse and longitudinal cases
            - Sketching and interpreting displacement–distance graphs and displacement–time graphs for transverse and longitudinal waves
            - Solving problems involving wave speed, frequency and wavelength
            - Investigating the speed of sound experimentally
    - 4.3 – Wave characteristics
        - Nature of science:
            - Imagination: It is speculated that polarization had been utilized by the Vikings through their use of Iceland Spar over 1300 years ago for navigation (prior to the introduction of the magnetic compass). Scientists across Europe in the 17th–19th centuries continued to contribute to wave theory by building on the theories and models proposed as our understanding developed.
        - Understandings:
            - Wavefronts and rays
            - Amplitude and intensity
            - Superposition
            - Polarization
        - Applications and skills:
            - Sketching and interpreting diagrams involving wavefronts and rays

- Solving problems involving amplitude, intensity and the inverse square law
- Sketching and interpreting the superposition of pulses and waves
- Describing methods of polarization
- Sketching and interpreting diagrams illustrating polarized, reflected and transmitted beams
- Solving problems involving Malus's law

- 4.4 – Wave behaviour
  - Nature of science:
    - Competing theories: The conflicting work of Huygens and Newton on their theories of light and the related debate between Fresnel, Arago and Poisson are demonstrations of two theories that were valid yet flawed and incomplete. This is an historical example of the progress of science that led to the acceptance of the duality of the nature of light.
  - Understandings:
    - Reflection and refraction
    - Snell's law, critical angle and total internal reflection
    - Diffraction through a single-slit and around objects
    - Interference patterns
    - Double-slit interference
    - Path difference
  - Applications and skills:
    - Sketching and interpreting incident, reflected and transmitted waves at boundaries between media
    - Solving problems involving reflection at a plane interface
    - Solving problems involving Snell's law, critical angle and total internal reflection
    - Determining refractive index experimentally
    - Qualitatively describing the diffraction pattern formed when plane waves are incident normally on a single-slit
    - Quantitatively describing double-slit interference intensity patterns
- 4.5 – Standing waves
  - Nature of science:
    - Common reasoning process: From the time of Pythagoras onwards the connections between the formation of standing waves on strings and in pipes have been modelled mathematically and linked to the observations of the oscillating systems. In the case of sound in air and light, the system can be visualized in order to recognize the underlying processes occurring in the standing waves.
  - Understandings:
    - The nature of standing waves
    - Boundary conditions
    - Nodes and antinodes
  - Applications and skills:
    - Describing the nature and formation of standing waves in terms of superposition
    - Distinguishing between standing and travelling waves
    - Observing, sketching and interpreting standing wave patterns in strings and pipes
    - Solving problems involving the frequency of a harmonic, length of the standing wave and the speed of the wave

## ASSESSMENT

### Formative assessment

in-class questioning, worksheets, online based quizzes.

# 11 SL Physics term 1 SL

## Summative assessment

1 x internal assessment based on two gas law experiments

1 x Paper 1 covering topics 1-4

1 x Paper 2 covering topics 1-4

## Assessment criteria

**SL Criteria**

- **Internal Assessment**
  - Individual investigation
    - B: Exploration
    - C: Analysis
    - D: Evaluation
    - E: Communication
- **External Assessment**
  - Paper 1
    - Multiple-choice questions on the core material
  - Paper 2
    - Short-answer and extended-response questions on the core material

# CONNECTIONS

## Approaches to Learning

- **Thinking**
- **Social**
- **Communication**
- **Self management**
- **Research**

## Learner Profile

**Inquirers**

Through the experimental investigations students act as inquirers.

**Knowledgeable**

Students will be expanding their knowledge with their continued education.

**Thinkers**

Students use and apply their body of knowledge to solve scientific problems.

**Communicators**

Through the internal assessment the students demonstrate their communication skills.

**Principled**

Academic honesty is an important component of the IA.

**Reflective**

Students are encouraged to reflect on their work in the IA and from the formative assessment.

## International Mindedness

The international system of measurement allows scientists to collaborate effectively. Oscillations is how time is measured and allows for a international system of time allowing for various world wide systems such as GPS.