Earth and Space Science Y12 and Y13

It is essential with the problems facing planet Earth that students have a working knowledge of how all the Earth system (geosphere, atmosphere, hydrosphere and biosphere) are intimately linked with each other and the Solar System. How the Earth system interacts with humans and how we humans affect them are also crucial.

The new Y12 and 13 subject, Earth and Space Science (ESS), develops earth, ocean, atmosphere and astronomy contexts.

In year 11 students hopefully have directly experienced aspects of the Earth system and the Solar System through field and laboratory investigations and the awareness and exploration of major earth and solar system events. Some content would have underpinned these contexts, but wider content is left for ESS in years 12 and 13.

Note though that students can take ESS in years 12 and 13 even when they have done no Planet Earth and Beyond (PEB) topics in year 11.

In years 12 and 13 students will develop key ideas even further in local, national, international and astronomical contexts by studying interesting and relevant topics underpinned by relevant content.

The mixture of internal and external standards allows the assessment of such courses.

Planning an Earth and Space science course

1. Because students may not have done any PEB based topics in y11, teachers may need to go back to topics studied in years 9 and 10 and the student's general knowledge to find out the extent of their knowledge about key aspects of Earth Sciences and Astronomy.
2. The PEB strand at L7 and 8 of NZC allows for considerable flexibility in course design. Depending on the students' interest, the resources of the community and the nature of the local area courses can be designed in
    a. Earth and Space Science
    b. Geology
    c. Marine Science
    d. Astronomy

    Outlines of the above courses are shown below.
3. Formulate the big ideas that will give an overview of each module within the programme. Students can actively help with this and so develop ownership of the course
4. Link back to key competencies
5. Decide what assessments you will use after you have formed the course.

Earth and Space Science: Year 12

Key Concepts or Big ideas

- Earth scientists and astronomers use repeatable observations and testable ideas to understand and explain our planet and beyond.
- Scientists use a range of investigative methods such classifying and identifying, pattern seeking, exploring, investigating models, and fair testing.
- Earth is a complex and changing system of interacting rock, water, air, and life.
- Earth is dynamically part of the Solar System and Beyond

Learning Outcomes
Students will develop:

- The methodology and understanding of different types of scientific investigations that are necessary to gain information on and understand Earth and astronomical processes
- The ability to use scientific conventions when communicating complex ideas to a wider audience
- An ability to understand the science on national and global issues to justify a point of view
- An understanding of how the internal heat source of Earth and the external heat source of the Sun together drive the Earth System
- An understanding of how interacting processes within planet Earth cause extreme planetary events
- An understanding of the life cycles of stars, planets and moons, considering energy changes.

Possible Learning Activities

- Carry out an investigation showing the relative energy from the sun at different times of the day or over two or three seasons
- Find a local telescope and look at nebulae, stars of different colour, planets, and open and closed clusters
- Relate different star colours and masses to their life cycles
- Follow the passage of selected planets in the night sky over several months
- Find out how the planets in our solar system formed
- Uses models, diagrams, photographs, and texts, to demonstrate the key processes within the geosphere such as the importance of tectonic plate movement.
- Go on a field trip to a local geological feature and study the relationship between the type of rocks and the feature
- Uses models, diagrams, photographs, and texts, to demonstrate the causes of extreme events such as volcanoes, hurricanes and tsunamis
- Understand how the heat energy from the Sun and the centre of the Earth drive important Earth cycles and processes.
- Recognise how the thermohaline circulation distributes heat around the world

- Explain how the electromagnetic spectrum can be used for space exploration
- Explore the relationship between weather, climate and other natural phenomena to predict events such as the arrival of seasons as developed in Mātaurangi Māori

Possible assessments

- ESS 2.1 Carry out a practical Earth and Space Science investigation
- ESS 2.3 Investigate geological processes in a New Zealand locality
- ESS 2.5 Demonstrate understanding of extreme Earth events
- ESS 2.6 Demonstrate understanding of stars and planetary systems
- ESS 2.7 Demonstrate understanding of physical principles related to the Earth System.

Earth and Space Science: Year 13

Key Concept or Big idea

- Understand the interdependence and interconnectedness of parts and processes of the Earth System and Solar System.

Learning Contexts – Outcomes

- Research a socio-scientific issue in an Earth and Space Science context
- Explore evidence to understand geological events
- Study the interactions between ocean and atmosphere in cycling carbon
- Understand how different types of waves transfer energy in the earth and solar system
- Understand how density drives the thermohaline current
- Consider the implications of space exploration.

Possible Learning Activities

- Use techniques such as modelling and satellite images to understand Earth and Space system processes.
- Understand that human activities are unbalancing the cycles of the Earth system with significant consequences for all parts of the Earth System
- Learn about some of the space probes that have visited different parts of the Solar System, not only other planets and moons but also asteroids and comets.
- Describe how to detect bodies such as Kuiper Belt Objects and extrasolar planets
- Study various techniques such as tree ring dating, and ice core data, from glaciers or Antarctica, as indications of climate fluctuations and geological history
- Sunspot cycles and solar flares and the effects on modern communications
- How Polynesians discovered and navigated around Pacific islands using Astronomy and knowledge of ocean currents.
- Recognising the vast distance and time scales of the universe

- Explain the role of the ocean in absorbing excess carbon dioxide and the effect on the ocean's acidity on ocean ecosystems
- Use models, diagrams, photographs, and texts, to demonstrate the key processes within the atmosphere such as the formation of winds
- Illustrate how the transmission, reflection, absorption, and scattering of all types of electromagnetic radiation and sound can aid exploration of Earth and Space systems
- Investigate the advantages and disadvantages of manned and unmanned space travel.

Possible assessments
- ESS 3.2 Investigate a socio-scientific issue in an Earth and Space Science context
- ESS 3.3 Demonstrate understanding of techniques investigating geological events
- ESS 3.4 Demonstrate understanding of aspects of interactions between ocean and atmosphere
- ESS 3.6 Investigate an aspect of astronomy
- ESS 3.7 Demonstrate understanding of waves applied to Earth and Space contexts

Geology: Year 12

Key Concept or Big idea
Geological forces shape planet Earth

Learning Contexts
- The importance of plate tectonics to the geology of New Zealand
- Research a geological issue
- The role of heat energy in driving geological cycles and processes
- The relationship between plate tectonics and ocean and atmosphere processes to cause extreme planetary events

Possible Learning Activities
- Carry out an investigation on sedimentation
- Explore an issue such as how the dinosaurs died
- Go on a field trip to an local feature to study the type of rocks of the feature
- Uses models, diagrams, photographs, and texts, to demonstrate the importance of tectonic plate movement.
- Relate plate tectonic and rock cycle processes in New Zealand contexts
- Use models, diagrams, photographs, and texts, to demonstrate the causes of extreme events such as volcanoes, hurricanes, earthquakes and tsunamis
- Understand how the heat energy from the Sun and the centre of the Earth drive important Earth cycles and processes.

Possible assessments

- ESS 2.1 Carry out a practical Earth and Space Science
- ESS 2.2 Evaluate, from an Earth and Space Science perspective, information communicated to the public
- ESS 2.3 Investigate geological processes in a New Zealand locality
- ESS 2.5 Demonstrate understanding of extreme Earth events
- ESS 2.7 Demonstrate understanding of physical principles related to the Earth System.

Geology: Year 13:

Key Concept or Big idea

- Geological forces interact with hydrological and atmospheric processes to cycle matter

Learning Contexts

- Examine evidence for geological events
- Research the overuse of the Earth resources
- Understanding how the earth and oceans interact to form the great ocean currents
- Investigate different forms of waves and how they affect and aid the exploration of the Earth System

Possible Learning Activities

- Investigate a local area to study past evidence for geological events in rock outcrops or road cuttings
- Use techniques such as modelling and satellite images to see geological features obscured by erosion and vegetation
- Understand that human activities are unbalancing the cycles of the Earth system with significant consequences for all parts of the Earth System
- Research the wise and unwise use of the earth's minerals
- Study various techniques such as tree ring dating, and ice core data from glaciers or Antarctica, as indications of climate fluctuations and geological events
- Explain the role of the ocean basins in directing the great ocean currents
- Use models, diagrams, photographs, and texts, to demonstrate the key processes within the atmosphere such as the formation of winds
- Illustrate how the transmission, reflection, absorption, and scattering of all types of electromagnetic radiation and sound can aid exploration of Earth systems

Possible assessments

- ESS 3.1 Conduct a practical Earth and Space Science investigation
- ESS 3.2 Investigate a socio-scientific issue in an Earth and Space Science context

- ESS 3.3 Demonstrate understanding of techniques investigating geological events
- ESS 3.4 Demonstrate understanding of aspects of interactions between ocean and atmosphere
- ESS 3.6 Demonstrate understanding of waves applied to Earth and Space contexts

Marine Science: Year 12

Key Concept or Big idea
Why is the ocean important to all life?

Learning Contexts
- The role of heat energy from the Sun and within the Earth in driving Earth cycles and processes
- The causes of extreme planetary events
- Why the ocean is so important to all life

Possible Learning Activities
- Use techniques such as modelling and satellite images to study temperature differences in the ocean
- Explain the role of the ocean in absorbing excess carbon dioxide and the effect on the ocean's acidity on ocean ecosystems
- Carry out an investigation into the effect of weak acid on seashells
- Uses models, diagrams, photographs, and texts, to demonstrate how tectonic plate movement has formed the ocean basins
- Go on a field trip to a local coastal area and study the relationship between the type of rocks and the shoreline
- Research why the ocean is so important to life on the whole planet
- Explore how life adapts to the deep ocean
- Uses models, diagrams, photographs, and texts, to demonstrate the causes of extreme events such as volcanoes, hurricanes and tsunamis
- Understand how the heat energy from the Sun and the centre of the Earth drive important Earth cycles and processes.
- Recognise how density drives the thermohaline circulation which distributes heat around the world
- Explore the relationship between weather, climate and other natural phenomena to predict events such as the arrival of seasons as developed in Mātaurangi Māori

Possible assessments
- ESS 2.1 Carry out a practical Earth and Space Science
- ESS 2.4 Investigate how organisms survive in an extreme environment
- ESS 2.3 Investigate geological processes in a New Zealand locality

- ESS 2.5 Demonstrate understanding of extreme Earth events
- ESS 2.7 Demonstrate understanding of physical principles related to the Earth System.

Marine Science: Y 13

Key Concept or Big idea
The oceans rule the world!

Learning Contexts
- How does the ocean control climate?
- How do the ocean and atmosphere interact to cycle carbon?
- Investigate the effect of energy transfer via different types of waves in the oceans

Possible Learning Activities
- Explore how the oceans distribute heat around the world
- Learn how gases such as carbon dioxide are exchanged between atmosphere and ocean
- Understand how the oceans help cycle carbon by chemical and biological means
- Learn about the importance of phytoplankton in the production of oxygen and the cycling of carbon
- Investigate the effects on marine life of the oceans becoming less alkaline (more acidic)
- Carry out an experiment of the effect of weak acid on marine shells
- Understand how sediment cores can be used to discover past climate changes
- Experiment on how well sound travels through water and relate this to how marine animals such as whales echolocate and communicate over vast distances
- Investigate how ocean waves transfer energy by using a wave tank

Possible assessments
- ESS 3.1 Conduct a practical Earth and Space Science investigation
- ESS 3.2 Investigate a socio-scientific issue in an Earth and Space Science context
- ESS 3.3 Demonstrate understanding of techniques investigating geological events
- ESS 3.4 Demonstrate understanding of aspects of interactions between ocean and atmosphere
- ESS 3.6 Demonstrate understanding of waves applied to Earth and Space contexts

Astronomy: Y 12

Key Concept or Big idea

- How humans relate to outer space

Learning Contexts

- How the sun affects the temperature on earth at different times of the day and year
- The role of heat in the universe
- Stars and planets and how they were formed
- Space probes and their discoveries
- Could humans survive in space for very long?

Possible Learning Activities

- Carry out an investigation showing the relative energy from the sun at different times of the day or over two or three seasons
- Explore the problems humans would have to overcome to undertake long space flights
- Have an astronomy evening to look at nebulae, stars of different colour, planets, and open and closed clusters
- Use models, diagrams, photographs, and texts to represent the stages in the birth, life and death of stars, and the energy transfers and transformations involved
- Find out the characteristics of different stars and planetary systems
- Observe the movement of selected planets over a period of time
- Track the movement of planets across the sky over a few months
- Use models, diagrams, photographs, and texts to represent the characteristics of planetary systems and their formation from protoplanetary disks around young stars
- Research the problem of space debris
- Explore how heat moves and travels outwards in planet Earth, the Sun and stars by convection and radiation
- Study the different parts of the electromagnetic spectrum and how they are used to find out information about the solar system

Possible assessments

- ESS 2.1 Carry out a practical Earth and Space Science
- ESS 2.2 Evaluate, from an Earth and Space Science perspective, information communicated to the public
- ESS 2.4 Investigate how organisms survive in an extreme environment.
- ESS 2.6 Demonstrate understanding of stars and planetary systems
- ESS 2.7 Demonstrate understanding of physical principles related to the Earth System.

Astronomy: Y 13

Key Concept or Big idea

- How would humans found out if life existed on other planets or moons?

Learning Contexts

- Could there be life out there?
- Could a planet with earth-like conditions ever be found?
- How do we gain information about outer space?
- How do we measure distance in space?

Possible Learning Activities

- Investigate the conditions on other planets and moons that may mean primitive life could exist on them
- Explore the forms such life may take
- Find out how exoplanets are found around stars
- Learn how electromagnetic waves and sound assist exploration of the solar system and universe
- Research the benefits and drawbacks of space exploration to humans using both manned and unmanned probes
- Explore how vast distance is measured in space

Possible assessments

- ESS 3.1 Conduct a practical Earth and Space Science investigation
- ESS 3.2 Investigate a socio-scientific issue in an Earth and Space Science context
- ESS 3.5 Investigate an aspect of astronomy
- ESS 3.6 Demonstrate understanding of waves applied to Earth and Space contexts
- PHY 3.2 Demonstrate understanding of the application of physics to a selected context.