Unit 2: Systems, models, energy and equilibrium

Teacher(s)	Victoria McKnight	**Subject group and course**	**Sciences: Environmental Systems & Societies**		
Course Part		**DP Year 1 or 2**	DP1	**Dates**	W2 September (4 weeks)

INQUIRY: establishing purpose of the unit

Group/Course Aims (from DP subject guide)	Assessment Objectives (from DP subject guide)
• Acquire the knowledge and understandings of environmental systems at a variety of scales • Appreciate the dynamic interconnectedness between environmental systems and societies • Engage with the controversies that surround a variety of environmental issues	**Demonstrate knowledge and understanding of relevant** • facts and concepts • methodologies and techniques **Apply this knowledge and understanding in the analysis of** • data and models **Evaluate, justify and synthesize, as appropriate** • explanations, theories and models **Engage with investigations of environmental and societal issues at the local and global level through** • selecting and applying the appropriate research and practical skills necessary to carry out investigations

Essential understandings

- A systems approach can help in the study of complex environmental issues.
- The use of systems and models simplifies interactions but may provide a more holistic view without reducing issues to single processes.
- The laws of thermodynamics govern the flow of energy in a system and the ability to do work.
- Systems can exist in alternative stable states or as equilibria between which there are tipping points.
- Destabilizing positive feedback mechanisms will drive systems toward these tipping points, whereas stabilizing negative feedback mechanisms will resist such changes.

Syllabus (from DP subject guide)

Topic 1: Foundations of environmental systems and societies

1.2 Systems and models

Significant ideas:

- A systems approach can help in the study of complex environmental issues.
- The use of systems and models simplifies interactions but may provide a more holistic view without reducing issues to single processes.

Knowledge and understanding:

- A systems approach is a way of visualizing a complex set of interactions which may be ecological or societal.

- These interactions produce the emergent properties of the system.
- The concept of a system can be applied at a range of scales.
- A system is comprised of storages and flows.
- The flows provide inputs and outputs of energy and matter.
- The flows are processes that may be either transfers (a change in location) or transformations (a change in the chemical nature, a change in state or a change in energy).
- In system diagrams, storages are usually represented as rectangular boxes and flows as arrows, with the direction of each arrow indicating the direction of each flow. The size of the boxes and the arrows may be representative of the size/magnitude of the storage or flow.
- An open system exchanges both energy and matter across its boundary while a closed system exchanges only energy across its boundary.
- An isolated system is a hypothetical concept in which neither energy nor matter is exchanged across the boundary.
- Ecosystems are open systems; closed systems only exist experimentally, although the global geochemical cycles approximate to closed systems.
- A model is a simplified version of reality and can be used to understand how a system works and to predict how it will respond to change.
- A model inevitably involves some approximation and therefore loss of accuracy.

Applications and skills:

- Construct a system diagram or a model from a given set of information.
- Evaluate the use of models as a tool in a given situation, for example, climate change predictions.

1.3 Energy and equilibria

Significant ideas:

- The laws of thermodynamics govern the flow of energy in a system and the ability to do work.
- Systems can exist in alternative stable states or as equilibria between which there are tipping points.
- Destabilizing positive feedback mechanisms will drive systems towards these tipping points, whereas stabilizing negative feedback mechanisms will resist such changes.

Knowledge and understanding:

- The first law of thermodynamics is the principle of conservation of energy, which states that energy in an isolated system can be transformed but cannot be created or destroyed.
- The principle of conservation of energy can be modelled by the energy transformations along food chains and energy production systems.
- The second law of thermodynamics states that the entropy of a system increases over time. Entropy is a measure of the amount of disorder in a system. An increase in entropy arising from energy transformations reduces the energy available to do work.
- The second law of thermodynamics explains the inefficiency and decrease in available energy along a food chain and energy generation systems.
- As an open system, an ecosystem will normally exist in a stable equilibrium, either in a steady-state equilibrium or in one developing over time (for example, succession), and maintained by stabilizing negative feedback loops.
- Negative feedback loops (stabilizing) occur when the output of a process inhibits or reverses the operation of the same process in such a way as to reduce change - it counteracts deviation.
- Positive feedback loops (destabilizing) will tend to amplify changes and drive the system toward a tipping point where a new equilibrium is adopted.
- The resilience of a system, ecological or social, refers to its tendency to avoid such tipping points and maintain stability.
- Diversity and the size of storages within systems can contribute to their resilience and affect their speed of response to change (time lags).
- Humans can affect the resilience of systems through reducing these storages and diversity.
- The delays involved in feedback loops make it difficult to predict tipping points and add to the complexity of modelling systems.

Applications and skills:

- Explain the implications of the laws of thermodynamics to ecological systems.
- Discuss resilience in a variety of systems.
- Evaluate the possible consequences of tipping points.

Inquiry questions

Skills-based How can the Daisy World hypothesis be simply modelled?

Content-based 1. How does is it possible to understand one component of a system better by understanding its interactions with other parts of the system?

Debatable 2. Could it be possible for humans to live in a closed system?

Approaches to learning (ATL)

Thinking

Communication

ATL coverage details and notes:

Linking the daiyworld lab to albedo and global warming conceptually. Communication of the findings from the investigation should be clearly conveyed in the conclusion statment in the lab.

Language and learning

- Scaffolding learning

Details:

Using the MYP framework for inquiry students will now apply this to DP investigations and understand the value of repetition in gathering scientific data.

ToK Connections

- Areas of knowledge
- The knowledge framework

Details:

- Models are simplified constructions of reality—in the construction of a model, how can we know which aspects of the world to include and which to ignore?
- The laws of thermodynamics are examples of scientific laws—in which ways do scientific laws differ from the laws of human science subjects, such as economics?

CAS Connections

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Learner Profile

Knowledgeable

Being able to decribe the effect albedo has on the global temperature.

International Mindedness

Describe how this unit will enable students to engage with an issue of global importance and/or analyse an issue from different cultural perspectives.

- The use of models facilitates international collaboration in science by removing language barriers that may exist.

	• The use of energy in one part of the globe may lead to a tipping point or time lag that influences the entire planet's ecological equilibrium

Assessments	
Internal Assessment **Individual investigation** • C: Results, analysis and conclusion **External Assessment** **Paper 2** • A: Short-answer and data-based questions	**What summative assessment will be used in this unit?** Daisy world lab focussing on collecting, processing and presenting data to draw a conclusion. Unit 2 test **What formative assessment will be used in this unit?** Assigment on Bioshere 2 Homework assignment to construct an open ocean systems diagram after reading the paragraph written by David Attenborough. **How will students show understanding? And what will constitute acceptable evidence of understanding?** Use of Kognity section review questions but gauge the students understanding and enable clarifications and reteaching where necessary. **Describe the process for standardization of marking and moderation?** Use of IB standard question and markschemes ensure the vaidity of the questions used. Single teacher so at this point moderation not completed until semester exam.

ACTION: teaching and learning through inquiry

Content	Learning process
Students will know: • A systems approach is a way of visualizing a complex set of interactions which may be ecological or societal. • These interactions produce the emergent properties of the system. • The concept of a system can be applied at a range of scales. • A system is comprised of storages and flows. • The flows provide inputs and outputs of energy and matter. • The flows are processes that may be either transfers (a change in location) or transformations (a change in the chemical nature, a change in state or a change in energy).	Learning experiences and strategies/planning for self-supporting learning: • Lecture • Socratic seminar • PowerPoint lecture/notes • Group presentations • Student lecture/leading • Interdisciplinary Learning

• In system diagrams, storages are usually represented as rectangular boxes and flows as arrows, with the direction of each arrow indicating the direction of each flow. The size of the boxes and the arrows may be representative of the size/ magnitude of the storage or flow. • An open system exchanges both energy and matter across its boundary while a closed system exchanges only energy across its boundary. • An isolated system is a hypothetical concept in which neither energy nor matter is exchanged across the boundary. • Ecosystems are open systems; closed systems only exist experimentally, although the global geochemical cycles approximate to closed systems. • A model is a simplified version of reality and can be used to understand how a system works and to predict how it will respond to change. • A model inevitably involves some approximation and therefore loss of accuracy. • The first law of thermodynamics is the principle of conservation of energy, which states that energy in an isolated system can be transformed but cannot be created or destroyed. • The principle of conservation of energy can be modelled by the energy transformations along food chains and energy production systems. • The second law of thermodynamics states that the entropy of a system increases over time. Entropy is a measure of the amount of disorder in a system. An increase in entropy arising from energy transformations reduces the energy available to do work. • The second law of thermodynamics explains the inefficiency and decrease in available energy along a food chain and energy generation systems. • As an open system, an ecosystem will normally exist in a stable equilibrium, either in a steady-state equilibrium or in one developing over time (for example, succession), and maintained by stabilizing negative feedback loops. • Negative feedback loops (stabilizing) occur when the output of a process inhibits or reverses the operation of the same process in such a way as to reduce change—it counteracts deviation. • Positive feedback loops (destabilizing) will tend to amplify changes and drive the system toward a tipping point where a new equilibrium is adopted. • The resilience of a system, ecological or social, refers to its tendency to avoid such tipping points and maintain stability. • Diversity and the size of storages within systems can contribute to their resilience and affect their speed of response to change (time lags). • Humans can affect the resilience of systems through reducing these storages and diversity. • The delays involved in feedback loops make it difficult to predict tipping points and add to the complexity of modelling systems. **Students will be able to:**	

• **Construct** a system diagram or a model from a given set of information. • **Evaluate** the use of models as a tool in a given situation, for example, climate change predictions. • **Explain** the implications of the laws of thermodynamics to ecological systems. • **Discuss** resilience in a variety of systems. • **Evaluate** the possible consequences of tipping points.	
Learning Experiences	**Teaching Strategies**
Do the students have enough prior knowledge? How will we know? No prior knowledge is assumed about systems and models although students have routinely investigated them during MYP science, Students have a good base knowledge on how to design and carry out open investigations. **Through what activities will students acquire the knowledge and practice the skills required?** • Daisyworld modelling lab • Practice building systems diagrams • Feeback confusion worksheet	**What different teaching methodologies will be used to support different learning styles?** A wide variety of methodologies will be used from socratic seminar lectures, groupwork, practical work, animations and multimedia, and classroom discussion. **How will formative assessment be used to give students feedback during the unit?** Assignments will be set using Kognity and grades immediatey fed back to the students. During the lab, the collecting and processing of the raw data will be considered and feedback given before the processing of data is started. Students get to practise the new skill of drawing systems diagrams in homework activities that are discussed togetehr with the answers next lesson. **How will information literacy and the use of ICT be developed?** Use of Kognitgy, online assignments, animations, jeopardy ppt and quizlet all expose the students to the use of ITC. In the daisyworld lab instead of using thermometers they will use dataloggers and temperataure probes. **How will the idea of academic honesty be reinforced?**

Differentiation
Differentiation items in this unit • Value prior knowledge • Scaffold learning • Extend learning **Details** Build on MYP lab skills and learn how to omit outlier from sets of data.

Resources
File: 7._Watercycle_systems_diagrams.pptx **Website:** http://www.npr.org/templates/story/story.php?storyId=6929010 **Website:** http://www.biospheres.com/ **Youtube:** https://youtu.be/VjLC3GjFMv0 **Youtube:** https://youtu.be/8kj__V8ehDU **File:** 5._Systems_Diagrams.pptx **File:** 2._Systems_and_Models.pptx **Website:** https://quizlet.com/_1rcfgq

REFLECTION: considering the planning, process and impact of the inquiry

Prior to studying the unit	During the unit	After the unit
Reflections & Evaluation	Reflections & Evaluation	Reflections & Evaluation