Summary

Topic 6 - Atmospheric systems and societies

Subject	Year	Start date	Duration
Environmental Systems & Societies	IB1, IB2	Week 1, March	3 weeks 10 hours

Course Part

Core

Description

This topic may be particularly appropriate for considering big questions B, E and F

Curriculum

Aims

Acquire the knowledge and understandings of environmental systems at a variety of scales

Apply the knowledge, methodologies and skills to analyse environmental systems and issues at a variety of scales

Appreciate the dynamic interconnectedness between environmental systems and societies

Value the combination of personal, local and global perspectives in making informed decisions and taking responsible actions on environmental issues

Be critically aware that resources are finite, and that these could be inequitably distributed and exploited, and that management of these inequities is the key to sustainability

Develop awareness of the diversity of environmental value systems

Develop critical awareness that environmental problems are caused and solved by decisions made by individuals and societies that are based on different areas of knowledge

Engage with the controversies that surround a variety of environmental issues

Create innovative solutions to environmental issues by engaging actively in local and global contexts

Objectives

Demonstrate knowledge and understanding of relevant

- facts and concepts
- methodologies and techniques
- values and attitudes

Apply this knowledge and understanding in the analysis of

- explanations, concepts and theories

data and models

case studies in unfamiliar contexts

arguments and value systems

Evaluate, justify and synthesise, as appropriate

explanations, theories and models

arguments and proposed solutions

methods of fieldwork and investigation

cultural viewpoints and value systems

Engage with investigations of environmental and societal issues at the local and global level through

evaluating the political, economic and social contexts of issues

selecting and applying the appropriate research and practical skills necessary to carry out investigations

suggesting collaborative and innovative solutions that demonstrate awareness and respect for the cultural differences and value systems of others

Syllabus Content

Topic 6: Atmospheric systems and societies

6.1 Introduction to the atmosphere

Significant ideas:

The atmosphere is a dynamic system that is essential to life on Earth.

The behaviour, structure and composition of the atmosphere influence variations in all ecosystems.

Knowledge and understanding:

The atmosphere is a dynamic system (with inputs, outputs, flows and storages) that has undergone changes throughout geological time.

The atmosphere is a predominantly a mixture of nitrogen and oxygen, with smaller amounts of carbon dioxide, argon, water vapour and other trace gases.

Human activities impact atmospheric composition through altering inputs and outputs of the system. Changes in the concentrations of atmospheric gases—such as ozone, carbon dioxide, and water vapour—have significant effects on ecosystems.

Most reactions connected to living systems occur in the inner layers of the atmosphere, which are the troposphere (0–10 km above sea level) and the stratosphere (10–50 km above sea level).

Most clouds form in the troposphere and play an important role in the albedo effect of the planet.

The greenhouse effect of the atmosphere is a natural and necessary phenomenon maintaining suitable temperatures for living systems.

Applications and skills:

Discuss the role of the albedo effect from clouds in regulating global average temperature.

Outline the role of the greenhouse effect in regulating temperature on Earth.

6.2 Stratospheric ozone

Significant ideas:

Stratospheric ozone is a key component of the atmospheric system because it protects living systems from the negative effects of ultraviolet radiation from the Sun.

Human activities have disturbed the dynamic equilibrium of stratospheric ozone formation.

Pollution management strategies are being employed to conserve stratospheric ozone.

Knowledge and understanding:

Some ultraviolet radiation from the Sun is absorbed by stratospheric ozone causing the ozone molecule to break apart. Under normal conditions the ozone molecule will reform. This ozone destruction and reformation is an example of a dynamic equilibrium.

Ozone depleting substances (including halogenated organic gases such as chlorofluorocarbons—CFCs) are used in aerosols, gas-blown plastics, pesticides, flame retardants and refrigerants. Halogen atoms (such as chlorine) from these pollutants increase destruction of ozone in a repetitive cycle, allowing more ultraviolet radiation to reach the Earth.

Ultraviolet radiation reaching the surface of the Earth damages human living tissues, increasing the incidence of cataracts, mutation during cell division, skin cancer and other subsequent effects on health.

The effects of increased ultraviolet radiation on biological productivity include damage to photosynthetic organisms, especially phytoplankton, which form the basis of aquatic food webs.

Pollution management may be achieved by reducing the manufacture and release of ozone-depleting substances. Methods for this reduction include:

recycling refrigerants

developing alternatives to gas-blown plastics, halogenated pesticides, propellants and aerosols

developing non-propellant alternatives.

UNEP has had a key role in providing information, and creating and evaluating international agreements, for the protection of stratospheric ozone.

An illegal market for ozone-depleting substances persists and requires consistent monitoring.

The Montreal Protocol on Substances that Deplete the Ozone Layer (1987) and subsequent updates is an international agreement for the reduction of use of ozone-depleting substances signed under the direction of UNEP. National governments complying with the agreement made national laws and regulations to decrease the consumption and production of halogenated organic gases such as chlorofluorocarbons (CFCs).

Applications and skills:

Evaluate the role of national and international organizations in reducing the emissions of ozone-depleting substances.

6.3 Photochemical smog

Significant ideas:

The combustion of fossil fuels produces primary pollutants that may generate secondary pollutants and lead to photochemical smog, the levels of which can vary by topography, population density and climate.

Photochemical smog has significant impacts on societies and living systems.

Photochemical smog can be reduced by decreasing human reliance on fossil fuels.

Knowledge and understanding:

Primary pollutants from the combustion of fossil fuels include carbon monoxide, carbon dioxide, black carbon or soot, unburned hydrocarbons, oxides of nitrogen, and oxides of sulfur.

In the presence of sunlight, secondary pollutants are formed when primary pollutants undergo a variety of reactions with other chemicals already present in the atmosphere.

Tropospheric ozone is an example of a secondary pollutant, formed when oxygen molecules react with oxygen atoms that are released from nitrogen dioxide in the presence of sunlight.

Tropospheric ozone is highly reactive and damages plants (crops and forests), irritates eyes, creates respiratory illnesses and damages fabrics and rubber materials. Smog is a complex mixture of primary and secondary pollutants, of which tropospheric ozone is the main pollutant.

The frequency and severity of smog in an area depends on local topography, climate, population density, and fossil fuel use.

Thermal inversions occur due to a lack of air movement when a layer of dense, cool air is trapped beneath a layer of less dense, warm air. This causes concentrations of air pollutants to build up near the ground instead of being dissipated by “normal” air movements.

Deforestation and burning, may also contribute to smog.

Economic losses caused by urban air pollution can be significant.

Pollution management strategies include:

altering human activity to consume less fossil fuels—example activities include the purchase of energy-efficient technologies, the use of public or shared transit, and walking or cycling

regulating and reducing pollutants at the point of emission through government regulation or taxation

using catalytic converters to clean the exhaust of primary pollutants from car exhaust

regulating fuel quality by governments

adopting clean-up measures such as reforestation, regreening, and conservation of areas to sequester carbon dioxide.

Applications and skills:

Evaluate pollution management strategies for reducing photochemical smog.

6.4 Acid deposition

Significant ideas:

Acid deposition can impact living systems and the built environment.

The pollution management of acid deposition often involves cross-border issues.

Knowledge and understanding:

The combustion of fossil fuels produces sulfur dioxide and oxides of nitrogen as primary pollutants. These gases may be converted into secondary pollutants of dry deposition (such as ash and dry particles) or wet deposition (such as rain and snow).

The possible effects of acid deposition on soil, water and living organisms include:

direct effect—for example, acid on aquatic organisms and coniferous forests

indirect toxic effect—for example, increased solubility of metal (such as aluminium ions) on fish

indirect nutrient effect—for example, leaching of plant nutrients.

The impacts of acid deposition may be limited to areas downwind of major industrial regions but these areas may not be in the same country as the source of emissions.

Pollution management strategies for acid deposition could include:

altering human activity—for example, through reducing use, or using alternatives to, fossil fuels; international agreements and national governments may work to reduce pollutant production through lobbying

regulating and monitoring the release of pollutants—for example, through the use of scrubbers or catalytic converters that may remove sulfur dioxide and oxides of nitrogen from coal-burning powerplants and cars.

Clean-up and restoration measures may include spreading ground limestone in acidified lakes or recolonization of damaged systems—but the scope of these measures is limited.

Applications and skills:

Evaluate pollution management strategies for acid deposition.

ATL Skills

Approaches to Learning

Thinking

- In this unit, we will

  ask students to formulate a reasoned argument to support their opinion or conclusion

  give students time to think through their answers before asking them for a response

  reward a new personal understanding, solution or approach to an issue

  ask open questions

  set students a task which required higher-order thinking skills (such as analysis or evaluation)

  build on a specific prior task

  help students to make their thinking more visible (for example, by using a strategy such as a thinking routine)

  require students to take an unfamiliar viewpoint into account when formulating arguments

  ask questions that required the use of knowledge from a different subject from the one you are teaching

  include a reflection activity

  make a link to TOK

Social

- In this unit, we will

  have students work in small groups

  allocate, or ask students to allocate among themselves, different roles in a classroom discussion or activity

  have students peer assess their group performance or process

  support students in resolving a conflict in a team

  give a group assessment task

  give students feedback on how they worked as a group

  have students discuss their understanding of a text or idea among themselves and come up with a shared understanding

  provide an opportunity for students to analyse the impact of their behaviour on the class or on a group performance

  encourage students to consider alternative points of view or to take the perspective of others

  provide opportunities for students to make decisions

Developing IB Learners

Learner Profile

- Inquirers
- Knowledgeable
- Thinkers
- Communicators
- Reflective