Science Grade 10

Science

Curriculum Map

Topic D: Energy Flow in Global Systems

Resources Included: Academic One File, *Science in Context Canada in Context, Global Issues in Context*

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User Guide

Curricular Topic

(taken from Alberta Education's Program of Studies)

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Topic D: Energy Flow in Global Systems

Overview

Solar energy sustains life and drives the global climate systems on Earth. Without solar energy there would be no heat or precipitation and, therefore, no life on Earth. Students will gain an understanding that the absorption and transfer of thermal energy at and near Earth's surface results in a variety of climate zones with characteristic weather patterns and biomes. Climatic factors largely determine the flora and fauna found in each of the world's major biomes. The *United Nations Intergovernmental Panel on Climate Change* has stated that the balance of evidence suggests a human influence on global climate. Scientists from various fields are studying this relationship to determine the potential impact on biomes.

Focusing Questions

Are there relationships between solar energy, global energy transfer processes, climate and biomes? What evidence suggests our climate may be changing more rapidly than living species can adapt? Is human activity causing climate change? How can we reduce our impact on the biosphere and on global climate, while still meeting human needs?

Outcomes for Science, Technology & Society (STS) & Knowledge

Students will:

1. **Describe how the relationships among input solar energy, output terrestrial energy and energy flow within the biosphere affect the lives of humans and other species**
    - Explain how climate affects the lives of people and other species, and explain the need to investigate climate change *(e.g., describe the responses of human and other species to extreme climatic conditions; describe housing designs, animal habitats, clothing and fur in conditions of extreme heat, cold, dryness or humidity, wind)*
    - Identify the Sun as the source of all energy on Earth
    - Analyze, in general terms, the net radiation budget, using per cent; i.e., solar energy input, terrestrial energy output, net radiant energy

- Describe the major characteristics of the atmosphere, the hydrosphere and the lithosphere, and explain their relationship to Earth's biosphere
- Describe and explain the greenhouse effect, and the role of various gases—including methane, carbon dioxide and water vapour—in determining the scope of the greenhouse effect

2. Analyze the relationships among net solar energy, global energy transfer processes—primarily radiation, convection and hydrologic cycle—and climate.

- Describe, in general terms, how thermal energy is transferred through the atmosphere (i.e., global wind patterns, jet stream, Coriolis effect, weather systems) and through the hydrosphere (i.e., ocean currents, large bodies of water) from latitudes of net radiation surplus to latitudes of net radiation deficit, resulting in a variety of climatic zones (e.g., analyze static and animated satellite images)
- Investigate and describe, in general terms, the relationships among solar energy reaching Earth's surface and time of year, angle of inclination, length of daylight, cloud cover, albedo effect and aerosol or particulate distribution
- Explain how thermal energy transfer through the atmosphere and hydrosphere affects climate
- Investigate and interpret how variations in thermal properties of materials can lead to uneven heating and cooling
- Investigate and explain how evaporation, condensation, freezing and melting transfer thermal energy; i.e., use simple calculations of heat of fusion and vaporization and to convey amounts of thermal energy involved, and link these processes to the hydrologic cycle

3. Relate climate to the characteristics of the world's major biomes, and compare biomes in different regions of the world

- Describe a biome as an open system in terms of input and output of energy and matter and exchanges at its boundaries (*e.g., compare and contrast cells and biomes as open systems*)
- Relate the characteristics of two major biomes (i.e., grassland, desert, tundra, taiga, deciduous and rain forest) to net radiant energy, climatic factors (temperature, moisture, sunlight and wind) and topography (mountain ranges, large bodies of water)

- Analyze the climatographs of two major biomes (i.e., grasslands, desert, tundra, taiga, deciduous and rain forest) and explain why biomes with similar characteristics can exist in different geographical locations, latitudes and altitudes
- Identify the potential effects of climate change on environmentally sensitive biomes *(e.g., impact of a reduction in the Arctic ice pack on local species and on Aboriginal societies that rely on traditional lifestyles)*

4. Investigate and interpret the role of environmental factors on global energy transfer and climate change

- Investigate and identify human actions affecting biomes that have a potential to change climate *(e.g., emission of greenhouse gases, draining of wetlands, forest fires, deforestation)* and critically examine the evidence that these factors play a role in climate change *(e.g., global warming, rising sea level(s))*
- Identify evidence to investigate past changes in Earth's climate *(e.g., ice core samples, tree ring analysis)*
- Describe and evaluate the role of science in furthering the understanding of climate and climate change through international programs *(e.g., World Meteorological Organization, World Weather Watch, Global Atmosphere Watch, Surface Heat Budget of the Arctic Ocean (SHEBA) project, The Intergovernmental Panel on Climate Change (IPCC); the study of paleoclimates and models of future climate scenarios)*
- Describe the role of technology in measuring, modelling and interpreting climate and climate change *(e.g., computer models, devices to take measurements of greenhouse gases, satellite imaging technology)*
- Describe the limitations of scientific knowledge and technology in making predictions related to climate and weather *(e.g., predicting the direct and indirect impacts on Canada's agriculture, forestry and oceans of climate change, or from changes in energy transfer systems, such as ocean currents and global wind patterns)*
- Assess, from a variety of perspectives, the risks and benefits of human activity, and its impact on the biosphere and the climate *(e.g., compare the Gaia hypothesis with traditional Aboriginal perspectives on the natural world; identify and analyze various perspectives on reducing the impact of human activity on the global climate)*

Skill Outcomes

(focus on the use of research and inquiry skills to inform the decision-making process)

Initiating and Planning

Students will:

Ask questions about observed relationships, and plan investigations of questions, ideas, problems and issues

- Identify questions to investigate that arise from practical problems and issues *(e.g., develop questions related to climate change, such as "How will global warming affect Canada's northern biomes?"; "How will a species be affected by an increase or decrease in average temperature?"*
- Design an experiment, and identify specific variables *(e.g., investigate the heating effect of solar energy, using variables, such as temperature, efficiency and materials used)*
- Formulate operational definitions of major variables *(e.g., define heat of fusion or vaporization as the quantity of energy to change the state of one mole of matter at its melting or boiling point in the absence of temperature change)*

Performing and Recording

Students will:

Conduct investigations into relationships between and among observable variables, and use a broad range of tools and techniques to gather and record data and information

- Carry out procedures, controlling the major variables and adapting or extending procedures where required *(e.g., perform an experiment to determine the ability of various materials to absorb or reflect solar energy)*
- Use instruments, effectively and accurately, to collect data *(e.g., use a barometer, rain gauge, thermometer, anemometer)*
- Compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data *(e.g., organize data to prepare climatographs for comparing biomes)*
- Use library and electronic research tools to collect information on a given topic *(e.g., research sources of*

greenhouse gases; research protocols to control human sources of greenhouse gases)

- Select and integrate information from various print and electronic sources or from several parts of the same source *(e.g., collect weather and climate data, both historic and current, from the Internet)*

Analyzing and Interpreting

Students will:

Analyze data and apply mathematical and conceptual models to develop and assess possible solutions

- Compile and display, by hand or computer, evidence and information in a variety of formats, including diagrams, flow charts, tables, graphs and scatterplots *(e.g., construct climate graphs to compare any two of the following biomes: grassland, desert, tundra, taiga, deciduous forest, rain forest)*
- Identify and apply criteria for evaluating evidence and sources of information, including identifying bias *(e.g., investigate the issue of global climate change)*
- Interpret patterns and trends in data, and infer or calculate linear and nonlinear relationships among variables *(e.g., analyze a graph of mean monthly temperatures for cities that are at similar latitudes but have different climates)*
- Identify limitations of data, evidence or measurement *(e.g., list the limitations of data and evidence of past climate changes, evaluate the validity of interpolations and extrapolations, use significant digits appropriately)*
- State a conclusion based on experimental data, and explain how evidence gathered supports or refutes the initial hypothesis *(e.g., summarize an analysis of the relationship between human activity and changing biomes)*
- Explain how data support or refute a hypothesis or a prediction *(e.g., provide evidence for or against the hypothesis that human activity is responsible for climate change)*
- Propose alternative solutions to a given practical problem, identify the potential strengths and weaknesses of each, and select one as the basis for a plan *(e.g., design a home for a specific climate; analyze traditional Aboriginal home designs for their suitability in particular climates)*

Communication and Teamwork

Students will:

Work as members of a team in addressing problems, and apply the skills and conventions of science in communicating information and ideas and in assessing results

- Represent large and small numbers using appropriate scientific notation
- Select and use appropriate numeric, symbolic, graphical and linguistic modes of representation to communicate ideas, plans and results *(e.g., use appropriate Système international (SI) units, fundamental and derived units, significant digits)*
- Synthesize information from multiple sources or from complex and lengthy texts, and make inferences based on this information *(e.g., use integrated software effectively and efficiently to produce work that incorporates data, graphics and text)*
- Identify multiple perspectives that influence a science-related decision or issue *(e.g., consult a wide variety of electronic sources that reflect varied viewpoints and economic, social, scientific and other perspectives on global warming and climate change)*
- Develop, present and defend a position or course of action, based on findings *(e.g., a strategy to reduce greenhouse gas emissions caused by the transportation of people and goods)*

Attitude Outcomes

Interest in Science

Students will be encouraged to:

Show interest in science-related questions and issues, and confidently pursue personal interests and career possibilities within science-related fields *(e.g., expand their inquiries beyond the classroom and into their everyday lives; show interest in careers related to climate and the environment)*

Mutual Respect

Students will be encouraged to:

Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds *(e.g.,*

appreciate Aboriginal clothing and home designs of the past and present that use locally-available materials to adapt to climate; recognize that science and technology develop in response to global concerns, as well as to local needs; consider more than one factor or perspective when making decisions on Science, Technology and Society [STS] issues)

Scientific Inquiry

Students will be encouraged to:

Seek and apply evidence when evaluating alternative approaches to investigations, problems and issues *(e.g., view a situation from different perspectives, propose options and compare them when making decisions or taking action; evaluate inferences and conclusions with a critical mind and without bias, being cognizant of the many factors involved in experimentation)*

Collaboration

Students will be encouraged to:

Work collaboratively in carrying out investigations and in generating and evaluating ideas *(e.g., choose a variety of strategies, such as active listening, paraphrasing and questioning, in order to understand other points of view; consider a variety of perspectives and seek consensus before making decisions)*

Stewardship

Students will be encouraged to:

Demonstrate sensitivity and responsibility in pursuing a balance between the needs of humans and a sustainable environment *(e.g., recognize that human actions today may affect the sustainability of biomes for future generations; identify, without bias, potential conflicts between responding to human wants and needs and protecting the environment)*

Safety

Students will be encouraged to:

Show concern for safety in planning, carrying out and reviewing activities *(e.g., demonstrate concern for self and others in planning and carrying out experimental activities involving the heating of materials; select safe methods for collecting evidence and solving problems)*

Section 1: General Topical References

Atmospheric Chemistry: *Science in Context:* Topic Overview, featured content, reference articles, images, experiments, statistics, news and magazine articles, etc.

Atmospheric Circulation and Wind: *Science in Context:* Topic Overview, featured content, reference articles, images, experiments, statistics, news and magazine articles, etc.

Biomes: *Canada in Context*: Topic Overview, reference, news, magazines, biographies, academic journals, images, videos, websites, etc.

Biomes: *Science in Context:* Topic Overview, featured content, reference articles, images, experiments, statistics, news and magazine articles, etc.

Carbon Dioxide: *Science in Context:* Topic Overview, featured content, reference articles, images, experiments, statistics, news and magazine articles, etc.

Climate and Weather: *Science in Context:* Topic Overview, featured content, reference articles, images, experiments, statistics, news and magazine articles, etc.

Climate Change: *Canada in Context*: Topic Overview, reference, news, magazines, biographies, academic journals, images, videos, websites, etc.

Climate Change: *Global Issues in Context:* Topic/Definition page with links to articles, podcasts, primary source documents, reference, news and academic journal articles, statistics, and websites.

Earth's Atmosphere: *Science in Context:* Topic Overview, featured content, reference articles, images, experiments, statistics, news and magazine articles, etc.

Environment and Climate Change: List of Issues and Topics related to Environment and Climate Change. *Global Issues in Context*.

Extreme Weather: *Global Issues in Context:* Topic/Definition page with links to articles, podcasts, primary source documents, reference, news and academic journal articles, statistics, and websites.

Global Warming: *Canada in Context:* Topic Overview, reference, news, magazines, biographies, academic journals, images, videos, websites, etc.

Global Warming: *Global Issues in Context:* Topic/Definition page with links to articles, podcasts, primary source documents, reference, news and academic journal articles, statistics, and websites.

Global Warming and Climate Change: *Science in Context:* Topic Overview, featured content, reference articles, images, experiments, statistics, news and magazine articles, etc.

"Greenhouse Effect/Greenhouse Gases." *Science in Context:* Topic Overview, featured content, reference articles, images, experiments, statistics, news and magazine articles, etc.

Hydrologic Cycle: *Science in Context:* Topic Overview, featured content, reference articles, images, experiments, statistics, news and magazine articles, etc.

Oceans: *Science in Context:* Topic Overview, featured content, reference articles, images, experiments, statistics, news and magazine articles, etc.

Solar Cycle: *Science in Context:* Topic Overview, featured content, reference articles, images, experiments, statistics, news and magazine articles, etc.

Solar Flares: *Science in Context:* Topic Overview, featured content, reference articles, images, experiments, statistics, news and magazine articles, etc.

Sun: *Science in Context:* Topic Overview, featured content, reference articles, images, experiments, statistics, news and magazine articles, etc.

Weather Modeling. *Science in Context:* Topic Overview, featured content, reference articles, images, experiments, statistics, news and magazine articles, etc.

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Section 5: Videos

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- What is Climate? Climate Change, Lines of Evidence: Chapter 1
- Is Earth Warming? Climate Change, Lines of Evidence: Chapter 2
- Greenhouse Gases: Climate Change, Lines of Evidence: Chapter 3
- Increased Emissions: Climate Change, Lines of Evidence: Chapter 4
- How Much Warming? Climate Change, Lines of Evidence: Chapter 5
- Solar Influence: Climate Change, Lines of Evidence: Chapter 6
- Natural Cycles: Climate Change, Lines of Evidence: Chapter 7

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