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SNC2DE-02

Climate Change Questions, Condensed

Chapter 8: Earth's Climate System and Natural Change

Climate and Weather

- Weather is the **atmospheric conditions** such as temperature, precipitation, wind, and humidity in a particular location over a **short period of time** (daily or weekly)
- Climate is the **average of the weather** in a region over a **long period of time**.
- Weather stations, weather balloons, aircraft, and satellites are all methods of collecting weather data

What factors can affect climate?

- Presence of large bodies of water
- Distance from the equator
- Presence of ocean or air currents, and of land formations
- Height above sea level

Canadian Climate Zones

Tundra, Subarctic, Cool summer, Semiarid, Highlands, and Marine West Coast.

Ecoregions

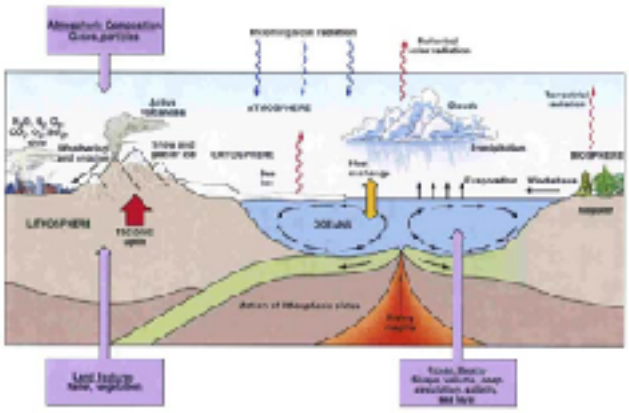
Areas grouped by landforms, soil, plants, animals, climate, and human factors.

Factors Influencing Climate

Distance from the Equator	Proximity to Large Bodies of Water
Dependent on lower and higher latitudes. - The lower the latitude, where the equator is positioned, would cause the sun to directly hit the equator - Results in a concentration of radiation at the equator that spreads out less and causes region to be hotter, and vice versa	Warm ocean currents heat the air above them, and when this air reaches land, it warms the land and produces rain. Cold ocean currents cool the air above them and when this air reaches land, it cools the land and creates desert areas.

The Climate System

Atmosphere: made of layers of gases surrounding Earth
Hydrosphere: includes liquid water in lakes and oceans, water vapour in the atmosphere, and ice in glaciers
Lithosphere: Earth's rock crust, including land surfaces,
Biosphere: All living things on Earth



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Energy Transfer in the Climate System

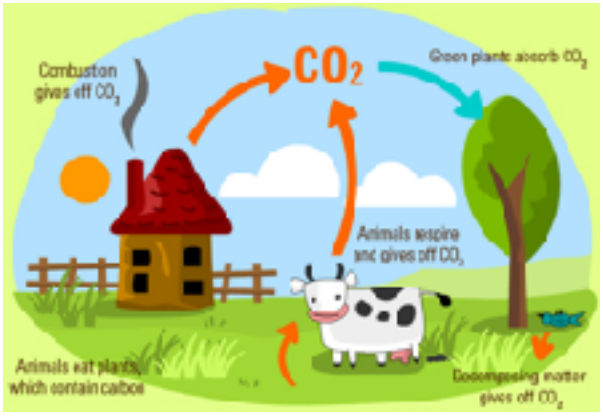
Climate systems transport thermal energy from areas that receive a lot of radiation to areas that receive less, reducing the temperature difference across earth. (see diagram on pg.1)

1) **Atmosphere and hydrosphere act as heat sinks** since they absorb and store thermal energy
2) This **energy is transferred in the atmosphere using convection currents**, a circular current in air and other fluids caused by the rising of warm fluid as cold fluid sinks
3) Air is then **transferred in oceans using thermohaline circulation**, the continuous flow of water around the worlds oceans driven by the differences in water temps and salinity

What happens to the energy from the sun that is absorbed by Earth's surface?
- Plants trap >1%, used to power the process of photosynthesis
- Rocks and water absorb the rest of the Sun's energy, which causes them to heat up

Cycles in the Climate System

What is a *feedback loop*? Process in which the result acts to influence the original process.



The Carbon Cycle

Positive feedback loop
- Trees and other plants are **carbon sinks** as they capture carbon dioxide during photosynthesis and use it to grow
- When trees decompose, the carbon is released back into the atmosphere

The Greenhouse Effect

- Natural process where **gases and clouds absorb infrared radiation emitted from Earth's surface** and radiate it, in turn **heating the atmosphere** and Earth's surface
- This trapped energy keeps Earth's global temperature much higher than it would normally be
- Has been occurring for millions of years.

* **Volcanic Eruptions Altering the Greenhouse Effect**
Spew rocks, dust, and gases into the atmosphere, and particles of sulphur dioxide reflect the Sun's energy back out to space, shading Earth's surface and temporarily cooling down the climate system.

Albedo Effect

The positive feedback loop in which an increase in Earth's temperature causes ice to melt, so more radiation is absorbed by Earth's surface, leading to further increases in temperature.

Application/Thinking

Why can't nitrogen gas and oxygen gas trap infrared radiation? Nitrogen gas and Oxygen gas cannot trap infrared radiation due to the limitations these molecules have. Both of these molecules consist of two identical atoms which can vibrate only back and forth, thus limiting the type of energy that the molecules can absorb.

What information would a scientist gain by studying tree rings? [Proxy Rings] Scientists assemble information from living and dead trees to record climate going back centuries. Warm, wet years will produce thick growth rings while cold, dry years will produce thin growth ring

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Chapter 9: Earth's Climate, Out of Balance

Big Idea: climate change has been accelerated by humans through the anthropogenic greenhouse effect.

What's Happening to Show Climate Change?

- Rising temperatures, e.g. in Canada the average temperature has gotten 1 degree higher
- Rising sea levels
- Rising glacier melting
- Growing seasons changing e.g. spring comes earlier and stays longer
- Ecosystems adapting to new seasons e.g. squirrels come out of hibernation earlier
- Extreme weather, e.g. harsher hurricanes, storms

Why? Anthropogenic Greenhouse Effect

Human enhancement of the natural greenhouse gas effect
- More low-energy infrared radiation is trapped by the atmosphere due to higher levels of greenhouse gases in the atmosphere from human activities
- Leading to an increase in Earth's average temperature.

e.g. carbon dioxide is released when humans cut down trees that were previously carbon sinks, that decompose and release their CO2, causes Earth to heat up more than normally

Anthropogenic Gases

a) **Carbon Dioxide**, CO2: is produced by humans when they burn fossil fuels for energy and cut down trees that are valuable carbon sinks in the atmosphere.
b) **Methane**, CH4: these emissions come from agricultural activities such as rice farming and cattle ranching, as well as from the decay of organic material in landfills and sewage treatment plants.

c) **Nitrous Oxide**, N2O: come from management of livestock feed and waste, and nitrogen fertilizers
d) **Chlorofluorocarbons (CFCs)**: CHC gases leak out of refrigerators and ACs

Impacts? Application of Climate Change?

Increase in Average Temperature of Earth

Earth's average temperature will likely increase by 4 degrees Celsius by the end of the century, which could cause devastating impacts, such as more severe heatwaves, flooding and droughts, and species extinction.

Rising Sea Levels

Melting glaciers, ice sheets, and sea ice, which when melted, run into oceans causing the sea level to rise and thermal expansion, which is when water expands slightly when it warms up.

Migration of Invasive Species

Animal and plant communities are migrating towards the poles and higher altitudes as their original ecosystems warm up. This is bringing undesirable insects into new northern regions, for example the mountain pine beetle that has traveled to areas of British Columbia and attacks pine trees.

Changing Seasons

The amount of snow that remains on the ground during winter is lessening in the Northern Hemisphere. The frequency of very cold days has also decreased and these cold days do not come until later in the year and end earlier in the spring.

Canadian Sources for Anthropogenic Gases

Methane

Agricultural activities such as rice farming and cattle ranching, the decay of organic material in landfills and sewage treatment plants, and coal mining and natural gas extraction

Gases in General

- Transport as in exhaust from cars, trucks, airplanes, and trains, agriculture
- Production of nitrogen fertilizers, farm machinery exhausts
- Industrial processes, mineral and metal production, chemical production

Canadian Sources for Anthropogenic Gases

Why are Canadian forests sometimes sources of carbon?

The combination of insect damage, wildfires, and deforestation cause for Canadian forests to sometimes be sources of carbon. Insect infestations kill trees, which speeds up decomposition therefore increasing carbon dioxide emissions. Forest fires release large quantities of carbon dioxide along with other greenhouse gases into the

atmosphere. When trees are cut down, greenhouse gases such as methane and carbon dioxide are released.

Why do Canadians produce more greenhouse gas than most of the other people in the world? This is largely because Canadians have both long winters, and lots of natural resources. Producing and using energy which accounts for generating heat and electricity for homes in the winter is the source for 324 megatonnes of greenhouse gas emission. Gases released during fossil fuel extraction account for another 67 megatonnes.

How can scientists model the climate? Scientists have developed detailed computer models that represent important components of the climate system. These models are used to create simulations of Earth's climate under different circumstances allowing scientists to identify which factors are affecting the climate.

Chapter 10: Assessing and Responding to Climate Change

Clean Energy sources produce no significant greenhouse gases, and in Ontario, we are successfully using hydroelectric power (through dams, etc.) and nuclear power plants as clean energy.

- eg. **Wind power** is created when wind causes blades of wind turbines to turn, powering generators that produce electricity.
- eg. **Hydroelectricity** is made when the energy of moving water turns turbines to power generators that produce electricity.
- eg. **Nuclear energy** is created by splitting the nuclei of atoms, and although nuclear energy plants do not emit greenhouse gases, they do produce radioactive waste, which creates a different set of problems.

<u>Assessing Climate Change</u>

(IPCC) Intergovernmental Panel on Climate Change
Formed to evaluate the risks of human-caused climate change. Several thousand climate scientists participate voluntarily in sharing and synthesizing their work.

Climate Change Would… Alter Rain Patterns
Dry regions of the world may get even less rainfall, causing crops to potentially be less productive, and millions of people could experience famine. Other areas could experience more rainfall, leading to flooding. This warm, wet weather would likely lead to more damage from insects.

Melt Polar Ice Caps!
Sea level rise – more water will flow into the oceans as Greenland ice sheets and glaciers from Canada, Alaska and Russia melt. Biodiversity – many migratory species

have breeding grounds in the Arctic, and if the Arctic ecosystem changes, species around the world would be affected.

Mitigating Climate Change

Responsible Stewardship is the careful management of the Earth to ensure that future generations will not have to inherit and live on an Earth spoiled by our generation's extravagance.

We Can…

- Walk, bike, take public transport, or carpool instead of using cars alone
- Switch off lights and unplug appliances that use electricity on standby when they are not in use
- Plant trees that are native to your area to aid in the absorption of carbon dioxide
- Use air conditioners and heating only when necessary
- Turn off the water when you brush your teeth or shave and take short showers

Mitigating Climate Change: Industries Can…

- Use more efficient equipment to consume less energy
- Recycle energy (i.e. capturing thermal energy produced by industrial processes and use it to power other processes)
- Capture and store carbon dioxide released by smokestacks
- Impose taxes and limits on fossil fuel use
- Improve energy efficiency through new technologies in the factories