



# Greenhouse Gases and Climate Warm-Up

LESSON  
Question

How do greenhouse gases influence Earth's climate?

## Goals

Learn how greenhouse gases influence Earth's climate.

**Describe** the how greenhouse gases trap heat.

**Describe** the sources of greenhouse gases and their impacts.

**Analyze** how atmospheric composition and surface conditions may change climate.



# Greenhouse Gases and Climate Warm-Up

## Words to Know

Write the letter of the definition next to the matching word as you work through the lesson. You may use the glossary to help you.

<u>E</u> albedo	A. a type of energy that is invisible but can be felt as heat
<u>D</u> carbon sink	B. the ability to hold in heat energy
<u>F</u> chemical bond	C. the removal of forests or trees from an area
<u>C</u> deforestation	D. anything that absorbs more carbon than it releases
<u>B</u> greenhouse effect	E. the amount of light that a surface reflects
<u>A</u> infrared radiation	F. a force that holds atoms together
<u>G</u> surface composition	G. refers to the types of materials or substances that make up the outermost layer of a planet, moon, or other object



# Greenhouse Gases and Climate Warm-Up

## Climates

There are a variety of climates throughout Earth.

- Each climate differs by the type and amount of:
  - water.
  - sunlight.
  - temperature.
  - geographic features.
  - plants and animals.



# Greenhouse Gases and Climate Instruction

## The Earth's Atmosphere

The Earth's atmosphere is composed of layers.

- The troposphere is:
  - the first layer of the atmosphere.
  - where living things live.
  - naturally composed of different gases.
  - The troposphere is naturally composed of 78% nitrogen, 21% oxygen, and 1% greenhouse gases and other gases.

## The Role of Greenhouse Gases

Greenhouse gases help keep the Earth warm enough to support life.

- Some greenhouse gases include:
  - carbon dioxide.
  - methane.
  - nitrous oxides.
  - fluorinated gases.



# Greenhouse Gases and Climate Instruction

## The Greenhouse Effect

Greenhouse gases create the greenhouse effect.

- A greenhouse traps the sun's energy and turns it into heat.
- Greenhouse gases similarly trap heat in the atmosphere.
- The greenhouse effect is necessary to sustain life on Earth.

## Heating up Earth

The Earth's surface is heated by incoming solar radiation.

- The surface absorbs sunlight.
  - Some infrared escapes into space.
  - Some infrared is trapped by the greenhouse gases in the atmosphere.
- Too many greenhouse gases can lead to excessive warming.

## Heat Trapping and Releasing

The molecular structure of the greenhouse gases allows them to trap heat.

### IR Absorption

- Gas molecules absorb infrared.



# Greenhouse Gases and Climate Instruction

## Bond Movement

- Chemical bonds start to vibrate.
- The molecules stretch and bend.

## More IR Absorption

- More wavelengths of radiations are absorbed.

## IR Release

- Gas molecules release infrared.

## Carbon Dioxide and Nitrous Oxide

The ability of these two molecules to go from symmetrical shape to asymmetrical allows for infrared energy to be absorbed.

- Carbon dioxide vibrates in ways that create an uneven charge distribution.
- Nitrous oxide can absorb energy at unique wavelengths.

## Methane and Fluorinated Gases

Multiple bonds result in various vibrational modes, leading to greater energy absorption.

- Methane gas has four C-H bonds to absorb infrared.
- Many fluorinated gases persist in the atmosphere for decades to millennia.



# Greenhouse Gases and Climate Instruction

## Natural Sources of Greenhouse Gases

Natural sources can release greenhouse gases into the environment.

- **Carbon dioxide**-erupting volcanos and respiration
- **Methane**- ruminating animals and wetlands
- **Nitrous oxide**- ocean currents

## Human-Introduced Sources of Greenhouse Gases

Energy production is necessary for transportation, manufacturing, cooking, and electricity.

- Burning fossil fuels releases carbon dioxide.
- **Deforestation** prevents trees from removing carbon dioxide.

Agriculture, waste management, and industrial processes are crucial activities for humans.

- Agriculture adds nitrous oxide.
- Waste management adds methane.
- Industrial processes add fluorinated gases.
- Agriculture, waste management, and industrial processes are crucial activities for humans.

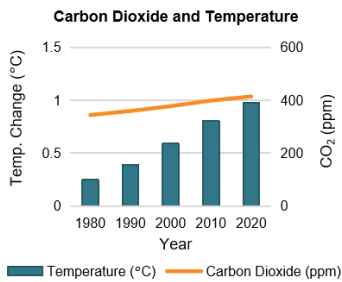


# Greenhouse Gases and Climate Instruction

## Greenhouse Gases and Temperature Change

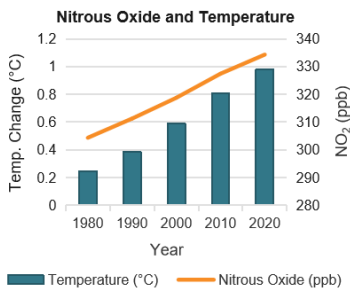
Examine how increased greenhouse gases in the atmosphere have affected global temperatures.

- Higher levels of greenhouse gases are linked to rising global temperatures.
- Over the past 40 years, the average global temperature has increased.
- The bars in the graph represent the average temperature change for each decade, while the line shows the average levels of greenhouse gases in the atmosphere.



Temp. overall increase: 0.73°C

Carbon level increase: 70.3 ppm

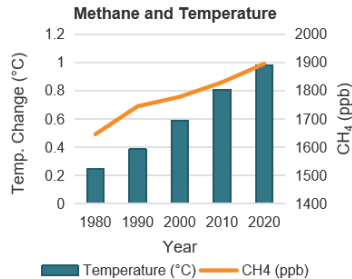


Temp. overall increase: 0.73°C

Nitrous Oxide level increase: 30 ppb

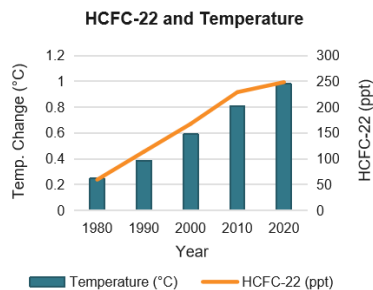


# Greenhouse Gases and Climate Instruction



Temp. overall increase: 0.73°C

Methane level increase: 250 ppb



Temp. overall increase: 0.73°C

HCFC-22 level increase: 189 ppt

## Greenhouse Gases and the Climate

As the concentration of these gases rises, the greenhouse effect intensifies

- Temperature increases result in:
  - the melting of ice caps.
  - the rise of sea levels.
  - extreme weather events.
  - the loss of biodiversity.



# Greenhouse Gases and Climate Instruction

## Melting Artic Ice Caps

Temperature increases have caused the melting of Artic Ice.

- Melting ice exposes darker ocean water.
  - Darker water will absorb more sunlight.
  - The absorption of sunlight will accelerate further warming and further melting.

## Sea Levels Rise

Rising temperatures lead to higher sea levels.

- Warmer temperatures cause thermal expansion of seawater.
- Melting of polar ice caps can also contribute to rising sea levels.
- Rising sea levels result in increased:
  - flooding and coastal erosion.
  - storm damage.



# Greenhouse Gases and Climate Instruction

## Weather Patterns

Increasing temperatures cause weather patterns and atmospheric circulations to change.

- Frequent and severe weather events occur, such as:
  - heatwaves.
  - storms.
  - heavy precipitation.

## Ecosystems and Species

Temperature change disrupts ecosystems.

- Temperatures increasing will affect:
  - habitats.
  - migration patterns.
  - reproductive cycles.

## Greenhouse Gases in the Atmosphere

Greenhouse gases impact the troposphere's heat retention capacity.

- Natural input of the gases creates the right amount in the atmosphere.
- Human activity adds additional greenhouse gases into the atmosphere.



# Greenhouse Gases and Climate Instruction

## Trend of Greenhouse Gases and Temperature

Concentrations of greenhouse gases are influenced by natural and human activity.

- Carbon dioxide, methane, and nitrous oxide have sources that are both natural and man-made.
- In contrast, fluorinated gases are solely the result of human activities.
- Over the past 40 years, the levels of all these greenhouse gases have increased, corresponding with a rise in global temperatures temperature.

Decimal	1980 to 1985	1986 to 1991	1992 to 1997	1998 to 2003	2004 to 2009	2010 to 2015	2016 to 2021	2022 to 2023
Temp Change (°C)	0.26	0.43	0.46	0.63	0.74	0.86	1.12	1.03
CO2 (ppm)	345	356	364	371	383	396	410	420
Methane (ppb)	1630	1650	1689	1760	1775	1790	1830	1885
Nitrous Oxide (ppb)	304	308	311	316	320	324	330	335
Fluorinated Gas (ppt)	175	250	298	313	398	319	322	305



# Greenhouse Gases and Climate Instruction

## The Role of the Earth's Surface

Earth's basic surface composition is 70 % water and 30 % land.

- Earth's surfaces absorb or reflect sunlight.
  - Features of the surface determine absorption or reflection.
  - Sunlight absorbed converts into infrared radiation.
  - Greenhouse gases absorb the infrared radiation.

## Albedo

The increase of greenhouse gases and temperature affect surface albedo.

- Albedo measures how much light a surface reflects, with values from 0–1.
  - 0 means complete absorption.
  - 1 means complete reflection.
- Lower albedo results in an increase in temperatures.

Surfaces	Albedo
Ocean water	0.06
Grass	0.25
Forest	0.12
Snow	0.85
Sea Ice	0.6
Sand	0.4
Asphalt	0.04
Bare Soil	0.17



# Greenhouse Gases and Climate Instruction

## Carbon Sinks

Carbon sinks absorb and store carbon from the atmosphere more than it releases.

- Oceans are the biggest absorbers of carbon.
  - Change in pH, temperature, or currents, decreases its ability to absorb.
- Carbon sinks can also be decreased by:
  - deforestation.
  - wildfires.



# Greenhouse Gases and Climate Summary

## LESSON Question

How do greenhouse gases influence Earth's climate?

## Answer

## Key Concepts

- Greenhouse gases are the only gases in the atmosphere capable of absorbing infrared radiation and adding heat.
- These gases create the greenhouse effect, which traps heat energy and helps maintain Earth's temperature for life to exist.
- Greenhouse gases come from both natural sources and human activities.
- An increase in greenhouse gases is linked to a rise in air temperatures.”
- Increased temperature can alter the current climate.
- Ecosystems, weather patterns, and sea ice have felt the impact of increased temperature.
- Surface composition and deforestation have altered the amount of heat and greenhouse gases in the atmosphere.
- Carbon sinks helps to store more carbon than is released.
- Oceans are the greatest storers of carbon.



# Greenhouse Gases and Climate Summary

*Use this space to write any questions or thoughts about this lesson.*