Earth's Energy Ledger

Trace energy-flow changes across climate timescales.

HS-ESS2-4 "Use a model to describe how variations in the flow of energy into and out of Earth systems result in changes in climate. Clarification Statement: Examples of the causes of climate change differ by timescale..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each change to an energy flow. Circle each timescale, then number the climate results linked to an energy imbalance.

Following the Energy Arrows

1. Climate can be modeled as an energy budget. Sunlight enters Earth's system. Some energy is reflected by clouds, ice, and bright surfaces, while land and ocean absorb the rest. Earth releases energy to space as infrared radiation. Climate changes when the amount entering, reflected, absorbed, or leaving shifts for long enough. The model uses arrows to track these flows and links the imbalance to surface temperature, precipitation, ice, sea level, and where organisms can live.

2. Over one to ten years, a large volcanic eruption can place sulfur-rich particles high in the atmosphere. These particles reflect more incoming sunlight, so less energy is absorbed and surface temperatures can temporarily fall. Ocean circulation can also shift heat between ocean regions and the atmosphere over years to centuries. A circulation change does not create energy, but it changes where stored ocean heat is released, affecting regional temperatures and precipitation patterns.

3. Over decades to centuries, human activities can raise greenhouse gas concentrations. More outgoing infrared energy is absorbed and re-emitted within the atmosphere, reducing the rate at which energy leaves to space and warming the surface. Over tens to hundreds of thousands of years, changes in Earth's orbit and axis orientation alter the distribution of sunlight. Over millions of years, long-term atmospheric composition changes can alter the energy budget, influencing ice volume, sea level, and biosphere distribution.

2 ANSWER WITH EVIDENCE

Use the passage

1. For a large volcanic eruption, which energy-flow arrow changes, and what temperature change can follow?

2. Why can an ocean circulation change affect regional climate without creating energy?

3. Compare a human-caused greenhouse gas increase with an orbit or axis change. State each timescale and energy-flow change.

4. A model shows energy leaving to space more slowly while incoming sunlight stays the same. Which cause from the passage fits this model, and what happens to surface temperature?

3 YOUR TURN

Your own words

Draw a four-arrow energy-budget model for a centuries-long increase in solar output. Label incoming, reflected, absorbed, and outgoing energy, then write two sentences explaining the imbalance and predicting one climate result.

ANSWER KEY

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PART 1 · READ AND MARK

Underline each change to an energy flow. Circle each timescale, then number the climate results linked to an energy imbalance. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	For a large volcanic eruption, which energy-flow arrow changes, and what temperature change can follow?	**The reflected-sunlight arrow increases, so less energy is absorbed and surface temperatures can temporarily fall.**
2	Why can an ocean circulation change affect regional climate without creating energy?	**It changes where stored ocean heat is released, affecting regional temperatures and precipitation.**
3	Compare a human-caused greenhouse gas increase with an orbit or axis change. State each timescale and energy-flow change.	**Greenhouse gas increases act over decades to centuries and reduce the rate of infrared energy leaving space. Orbit or axis changes act over tens to hundreds of thousands of years and alter the distribution of sunlight.**
4	A model shows energy leaving to space more slowly while incoming sunlight stays the same. Which cause from the passage fits this model, and what happens to surface temperature?	**A human-caused increase in greenhouse gases fits the model, and the surface warms.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Model: incoming sunlight ↑; reflected sunlight ↑; absorbed energy ↑; outgoing infrared initially unchanged, then ↑ as the surface warms More incoming sunlight makes absorbed energy exceed outgoing infrared energy at first. Surface temperatures would rise until additional outgoing infrared energy helps rebalance the budget.

Accept models that show increased solar input leading to greater absorbed energy and an initial positive energy imbalance. Accept a supported prediction involving surface temperature, precipitation, ice volume, sea level, or biosphere distribution.