Earth's Energy Ledger

Read energy-flow data to explain climate change.

ES.ESS2.4 "Analyze and interpret data to explore how variations in the flow of energy into and out of Earth's systems cause changes to the atmosphere and climate."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline what brings energy into Earth's system and circle what sends energy out. Number the conditions in the table from greatest initial energy gain to greatest initial energy loss.

When Earth's Energy Flows Change

(1) On a clear afternoon, dark pavement feels hotter than a pale sidewalk because it absorbs more sunlight. Earth also gains energy from sunlight and loses energy by sending infrared radiation into space. When these flows match, the planet's average energy stays roughly steady. A lasting mismatch can change temperatures, winds, rainfall, and other parts of climate.

(2) The table shows four simplified snapshots of Earth's energy budget. Each value is a global average in watts per square meter, a measure of energy flow. These are model examples, not satellite measurements. Compare each changed condition with the starting balance. The outgoing infrared values show the immediate response, before global temperature adjusts.

ILLUSTRATIVE GLOBAL ENERGY FLOWS

Condition	Solar energy absorbed (W/m^2)	Infrared energy sent to space (W/m^2)
Starting balance	240	240
Added greenhouse gases	240	238
Darker surfaces	242	240
Expanded bright ice	238	240

(3) Greenhouse gases absorb infrared radiation and can reduce the amount escaping to space at first. Darker surfaces can absorb more sunlight, while expanding bright ice can reflect more away. If absorbed energy exceeds outgoing energy, Earth stores energy, mainly in the oceans, and tends to warm. Cooling tends to follow an energy deficit.

2 ANSWER WITH EVIDENCE

Use the passage

1. Compare added greenhouse gases with the starting balance. Which energy flow changes, by how much, and what is the initial energy imbalance?

2. Compare darker surfaces with expanded bright ice. Calculate the initial energy imbalance for each condition and explain why their signs differ.

3. Which two changed conditions would initially add energy to the oceans? Use the table to explain how each creates an energy gain.

4. A student claims that expanded bright ice immediately reduces infrared energy sent to space. Does the table support this claim? Explain using both energy flows.

3 YOUR TURN

Your own words

Suppose a volcanic eruption scatters sunlight. Absorbed solar energy falls to 236 W/m^2, while infrared energy sent to space initially stays at 240 W/m^2. In three or four sentences, calculate the initial imbalance, predict the temperature response, and explain how outgoing infrared energy would change if the lower sunlight absorption persisted.

Earth's Energy Ledger

PART 1 · READ AND MARK

Underline what brings energy into Earth's system and circle what sends energy out. Number the conditions in the table from greatest initial energy gain to greatest initial energy loss. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Compare added greenhouse gases with the starting balance. Which energy flow changes, by how much, and what is the initial energy imbalance?	**Infrared energy sent to space falls by 2 W/m^2. Earth initially gains 2 W/m^2 more than it loses.**
2	Compare darker surfaces with expanded bright ice. Calculate the initial energy imbalance for each condition and explain why their signs differ.	**Darker surfaces produce a gain of 2 W/m^2, while expanded bright ice produces a loss of 2 W/m^2. Darker surfaces increase absorbed sunlight; bright ice decreases it.**
3	Which two changed conditions would initially add energy to the oceans? Use the table to explain how each creates an energy gain.	**Added greenhouse gases and darker surfaces. Greenhouse gases reduce infrared energy sent to space to 238 W/m^2; darker surfaces raise absorbed solar energy to 242 W/m^2. Each produces a net gain of 2 W/m^2.**
4	A student claims that expanded bright ice immediately reduces infrared energy sent to space. Does the table support this claim? Explain using both energy flows.	**No. Infrared energy sent to space remains 240 W/m^2, while absorbed solar energy falls from 240 to 238 W/m^2.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Earth initially loses 4 W/m^2 more than it absorbs, giving it a net energy change of negative 4 W/m^2. Earth would tend to cool as it loses stored energy. As it cools, it would send less infrared energy to space, eventually approaching 236 W/m^2 if the lower sunlight absorption persisted.

Accept equivalent calculations stated as gains or losses. For the open task, the new balance is a conditional prediction because volcanic effects may not last long enough for Earth to reach it.