Mr. Brown's Science Labs

REGENTS REVIEW PACKET

Glaciers & the Carbon Cycle

NYS Earth & Space Sciences Regents Prep

Student Name:	
Period / Class:	
Date:	

TOPIC 1 Glaciers, Albedo & Ice Sheet Feedbacks	**TOPIC 2** The Fast Carbon Cycle & Climate Change

Tags: NYS Regents, Earth Science, Glaciers, Carbon Cycle, Albedo, Climate Change, Ice Sheets, Greenhouse Gases, ESS, MS-ESS3-1, HS-ESS2-2, HS-ESS2-5, HS-ESS3-1, HS-ESS3-5, NGSS, Mr. Brown's Science Labs

DIRECTIONS & SCORE TRACKER

This review packet contains **30 Regents-style questions** on Glaciers and the Carbon Cycle. Each question is worth **1 point**. Questions that include data tables count as **4 points** when fully completed. You will need the **2024 Edition Earth and Space Sciences Reference Tables (ESRT)** to answer some questions.

Show all work in the spaces provided. Multiple-choice answers should be circled or written on the answer blank. Constructed-response questions require complete sentences. When you are finished, calculate your final grade on the last page of this packet.

Section	# of Q's	Points	Your Score
Section A: June 2025 Regents Q6–10 (Glaciers/Climate)	5	5	
Section B: June 2025 Regents Q11–15 (Carbon Cycle)	5	5	
Cluster 1: Mountain Glaciers of Alaska	5	5	
Cluster 2: Forest Carbon & Wildfires	5	5	
Cluster 3: Greenland Ice Sheet Albedo	5	5	
Cluster 4: Ocean Acidification & Carbon	5	5	
TOTAL	**30**	**30**	

Letter Grade Conversion (Mastery Scale)

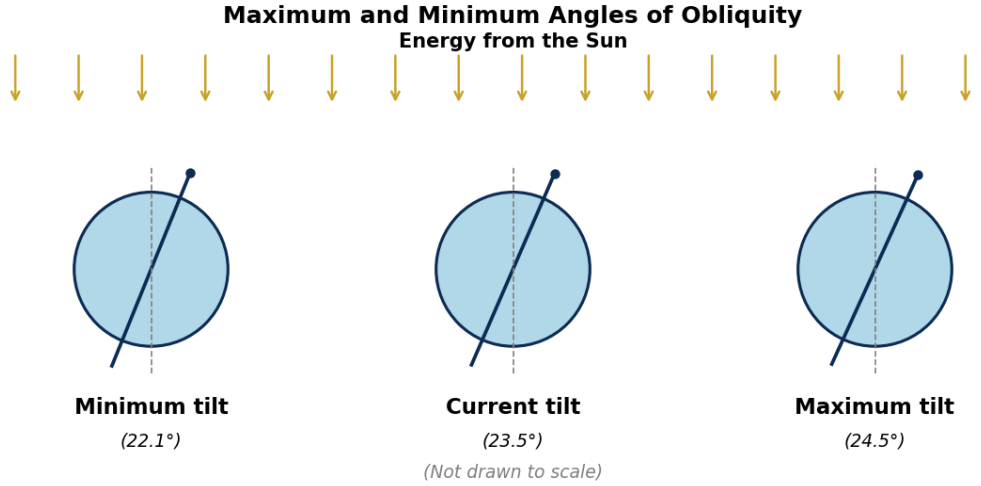
Score / 30	Percent	Letter Grade
27 – 30	90 – 100%	A
24 – 26	80 – 89%	B
21 – 23	70 – 79%	C
18 – 20	60 – 69%	D
0 – 17	0 – 59%	Below Mastery

SECTION A: June 2025 Regents Questions 6–10

Modeling Earth Systems to Understand Global Climate

The geologic record shows a long history of climate fluctuations as a result of many different factors. Climate scientists study models of Earth's motions, ocean currents, plate tectonic movement, and atmospheric composition to better understand energy flow into and out of Earth's systems.

Obliquity, the tilt of Earth's axis relative to the Sun, has a direct impact on Earth's climate. Earth's obliquity changes on a cycle that takes place over a period of 41,000 years. The obliquity is currently decreasing and will reach its minimum value of 22.1° in approximately 9800 years.



1. (June 2025 — Q6) During winter, which statement best describes the amount of energy Earth's northern hemisphere will receive and the impact on global ice formation when the obliquity is 22.1°, compared to Earth's present obliquity?

(1) Earth's northern hemisphere will receive less energy, and less ice will form in polar regions.

(2) Earth's northern hemisphere will receive less energy, and more ice will form in polar regions.

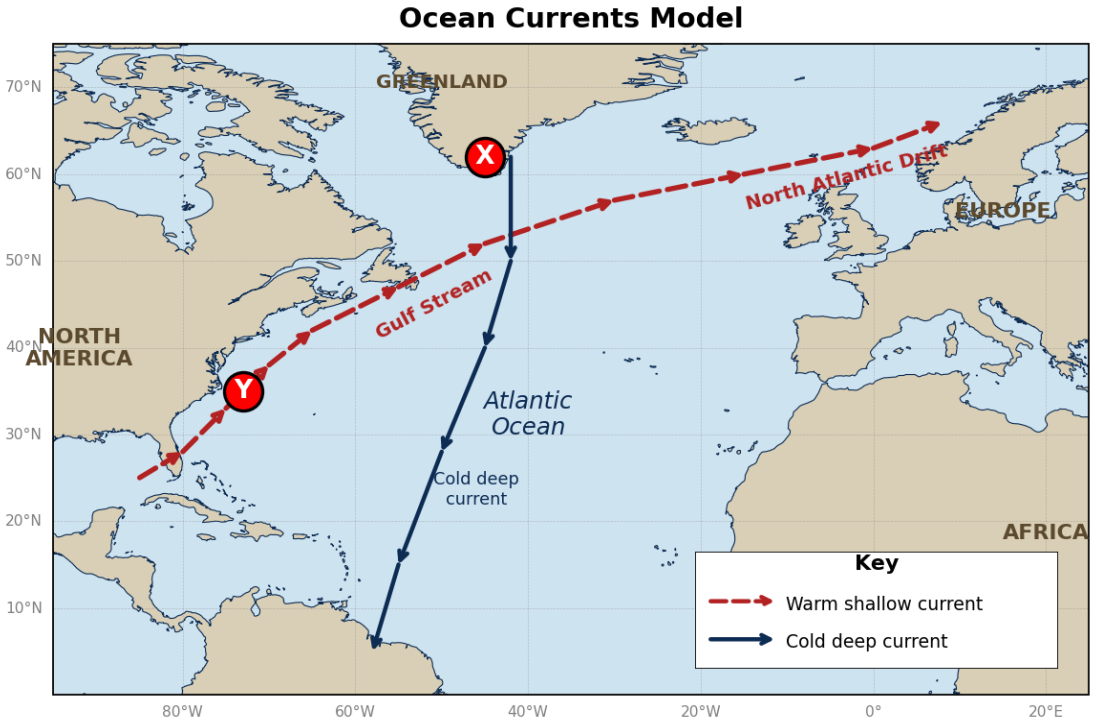
(3) Earth's northern hemisphere will receive more energy, and less ice will form in polar regions.

(4) Earth's northern hemisphere will receive more energy, and more ice will form in polar regions.

Answer: _____

Section A continued

Another factor climate scientists have identified that contributes to changes in energy flow in Earth systems is ocean current circulation. The model and diagrams below show some information about circulation patterns in ocean currents. Points X and Y are locations on Earth's surface.



Section A continued

Diagram 1: How Currents Work

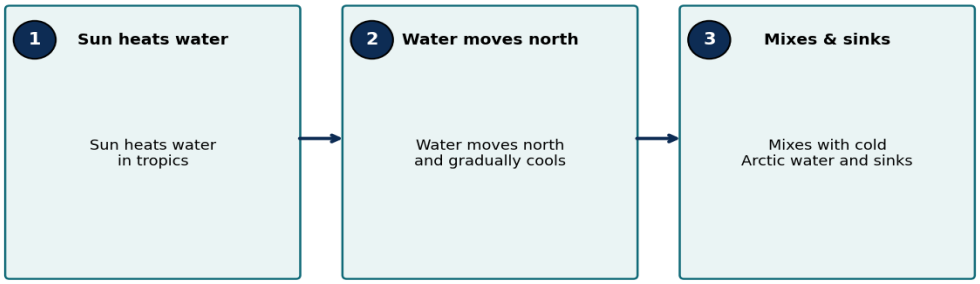
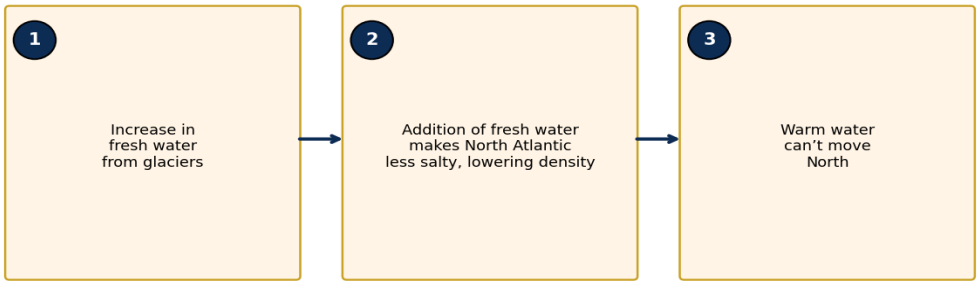


Diagram 2: Influence of Fresh Water



Section A continued

2. (June 2025 — Q7) Which statement most accurately describes the influence of melting glaciers at X on the strength of Earth's ocean currents?

(1) More fresh water is added to the oceans, causing the currents to become deeper.

(2) More fresh water is added to the oceans, causing the currents to weaken.

(3) More fresh water is added to the oceans, causing the water in the currents to become denser.

(4) More fresh water is added to the oceans, causing the water in the currents to become warmer.

Answer: _____

3. (June 2025 — Q8) Which statement most accurately describes the influence of present surface ocean currents on the climate at location Y?

(1) Location Y experiences warmer air temperatures with more precipitation.

(2) Location Y experiences warmer air temperatures with less precipitation.

(3) Location Y experiences cooler air temperatures with more precipitation.

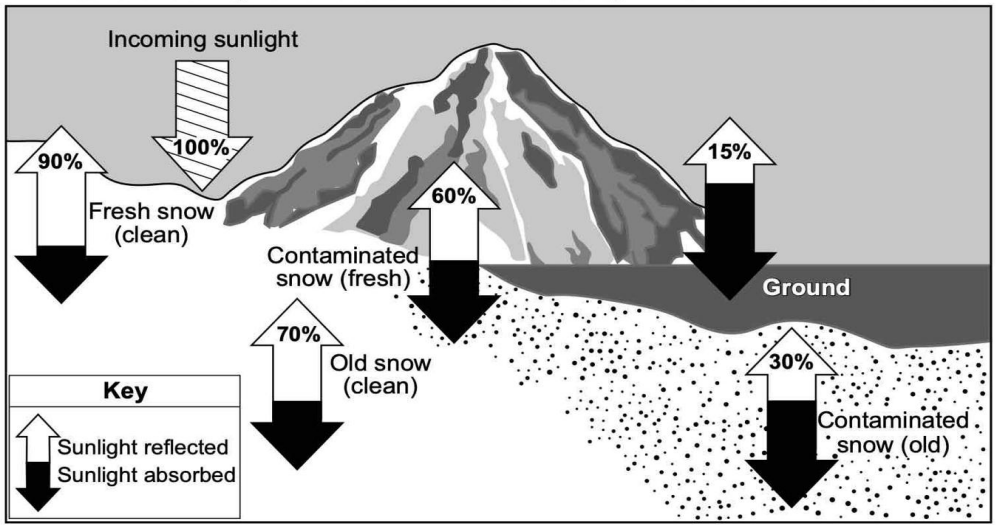
(4) Location Y experiences cooler air temperatures with less precipitation.

Answer: _____

Section A continued

Since the Industrial Revolution, deposition of dark particles such as dust, dirt, and rock in glacial ice (contaminated snow) have caused glaciers to darken. This has led to feedbacks that have caused changes to other Earth systems.

Percent of Sunlight Reflected and Absorbed by Different Glacial Surfaces



Percent of Sunlight Reflected and Absorbed by Different Glacial Surfaces.

4. (June 2025 — Q9) Which model correctly represents the feedbacks that occur when dark surfaces are exposed in glacial areas and cause changes to one or more Earth systems?

(1) Increase in dark surface area on glaciers → Increased absorption of energy from Earth surface → Decreased glacial melting → Increased glacial ice

(2) Increase in dark surface area on glaciers → Increased absorption of energy on Earth surface → Increased glacial melting → Increased glacial ice

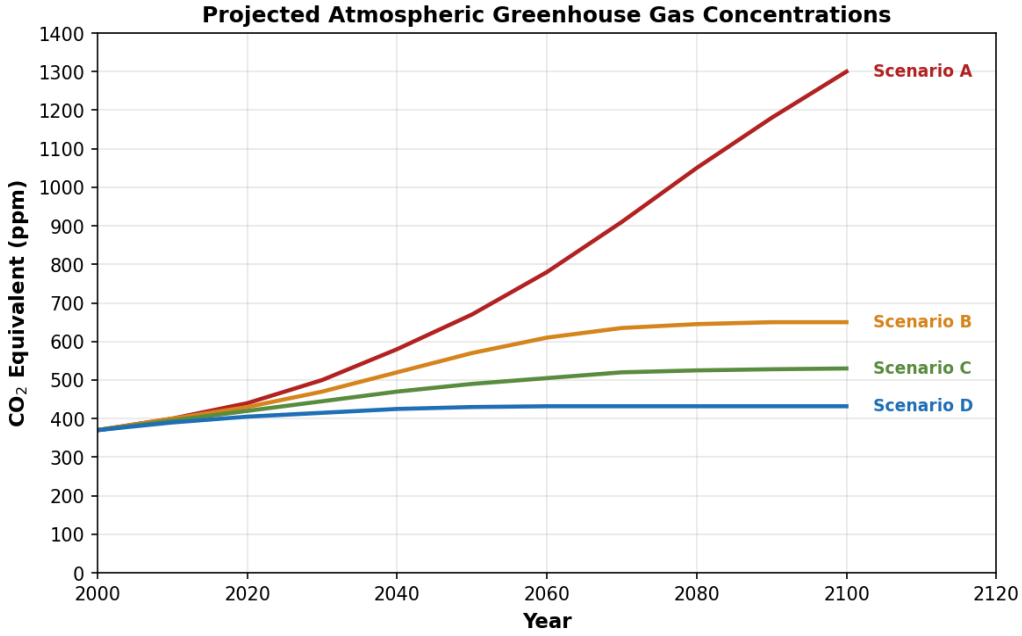
(3) Increase in dark surface area on glaciers → Increased absorption of energy from Earth surface → Decreased glacial melting → Decreased glacial ice

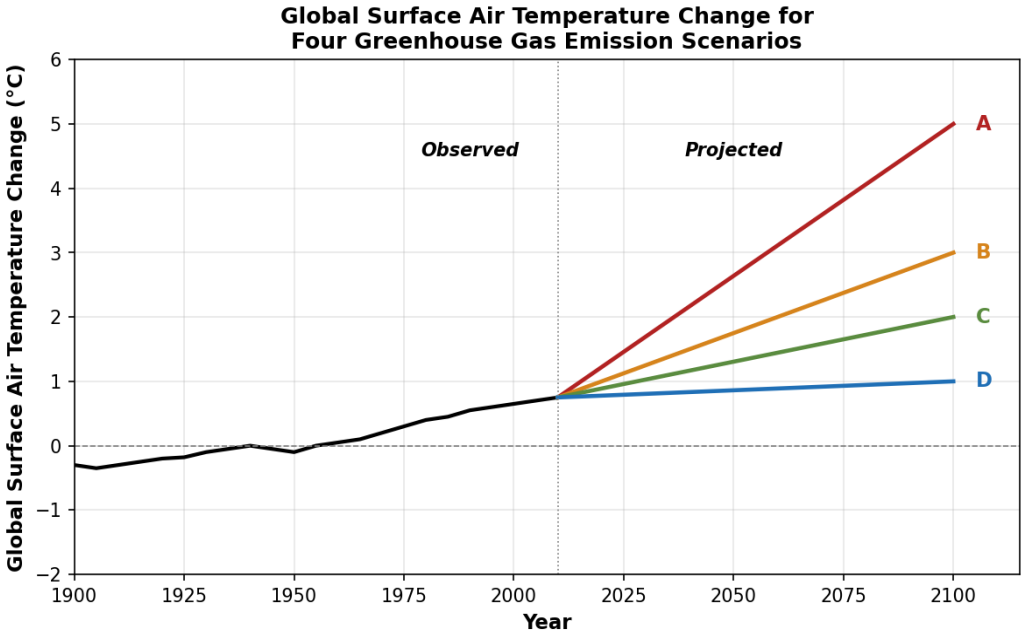
(4) Increase in dark surface area on glaciers → Increased absorption of energy on Earth surface → Increased glacial melting → Decreased glacial ice

Answer: _____

Section A continued

Computer-based global climate models are helpful tools for collecting data on projected future climate conditions. These models use various scenarios, or possibilities, that assume different human-based decisions on how we address greenhouse gas emissions. The graphs below show future greenhouse gas concentrations (in parts per million, ppm) and projected global surface air temperature changes for four different greenhouse-gas emission scenarios.





Section A continued

5. (June 2025 — Q10) Identify the numerical values for the projected concentration of greenhouse gases (CO_2 equivalent) and for the approximate future change to global surface temperature for the year 2100 using scenario B emissions.

Projected CO_2 equivalent in 2100: _____ ppm

Projected global surface temperature change: _____ °C

SECTION B: June 2025 Regents Questions 11–15

The Carbon Cycle

The global carbon cycle refers to the movement of the element carbon through different storage places, or reservoirs, on Earth. Carbon moves through these reservoirs at different rates. Most carbon near Earth's surface cycles fairly quickly. Carbon in the atmosphere recycles in about three to five years, while plants recycle carbon in about 50 years. The carbon found in soil and fossil reservoirs is recycled, on average, in about 3000 to 5000 years.

The carbon cycle has two parts. The “fast cycle” involves the biological processes of photosynthesis and decomposition. The “slow cycle” involves the time it takes for soil (inorganic) carbon to form from the weathering of rocks and soil.

6. (June 2025 — Q11) Explain the process that the trees in a forest use to make energy for food and describe how this process is responsible for a decrease in atmospheric carbon dioxide levels.

_____

_____

_____

_____

Model of Fast Carbon Cycle

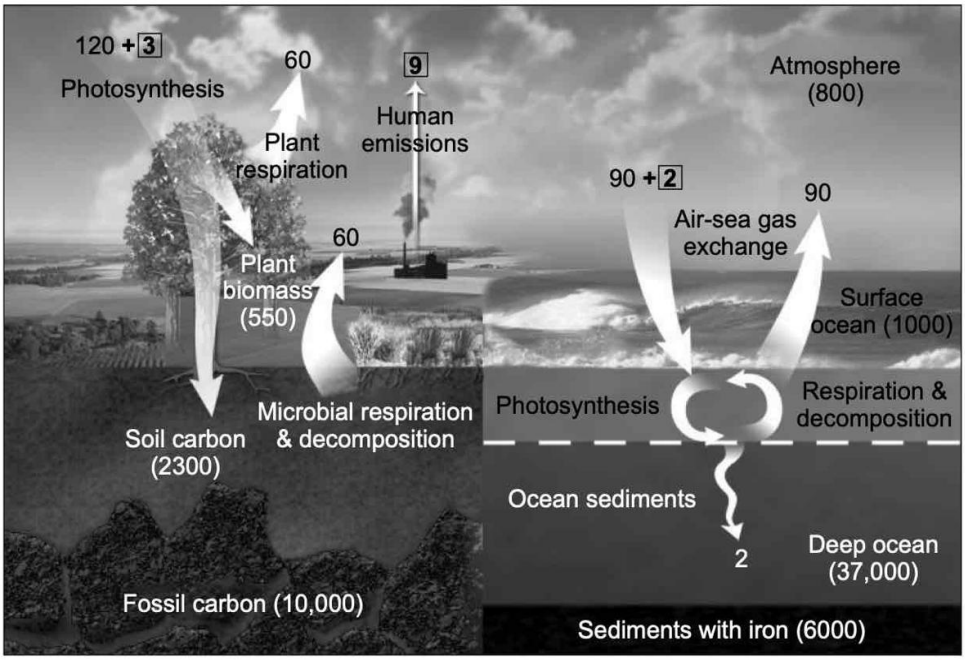


Figure B1. Model of the Fast Carbon Cycle. Numbers in bold = human input. Numbers in parentheses = stored carbon (gigatons, GT).

7. (June 2025 — Q12) Which statement correctly identifies the quantitative cycling of carbon between two of Earth's spheres as a result of natural processes and human activities?

(1) Fossil carbon releases 2300 GT, while microbial respiration and decomposition absorb 60 GT.

(2) The deep ocean stores 36,000 more GT of carbon than is released by air-sea gas exchange.

(3) Human emissions add nine times more carbon to the atmosphere than plant respiration, which is the same amount released to the atmosphere by microbial respiration and decomposition.

(4) The amount of carbon that leaves the atmosphere and is absorbed by the ocean is 92 GT, which is the same amount that is released by the oceans back into the atmosphere and absorbed by ocean sediments.

Answer: _____

Section B continued

8. (June 2025 — Q13) Which explanation describes how climate change from increased atmospheric carbon dioxide has influenced human activity?

(1) Humans have increased the replanting of trees in areas burned by wildfires in order to decrease the amount of local atmospheric carbon dioxide.

(2) Humans have increased the burning of fossil fuels in order to decrease the amount of carbon dioxide in the atmosphere.

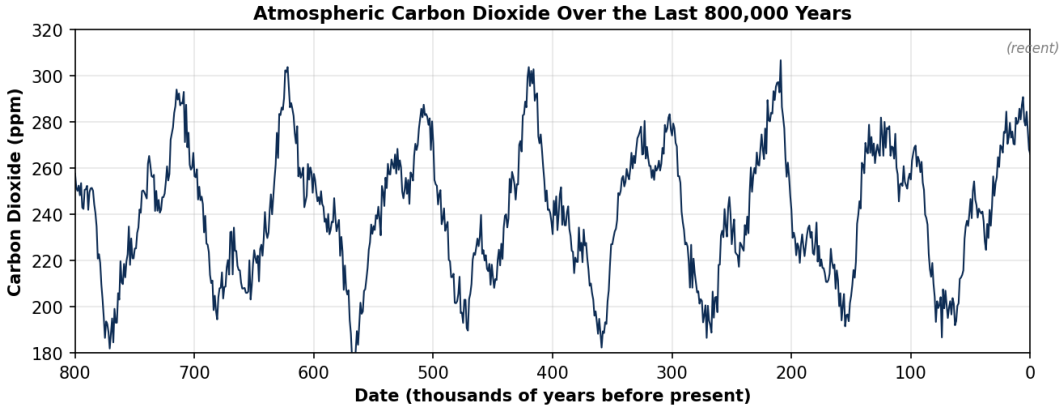
(3) Humans have moved to cooler climate regions to adjust to a warming climate.

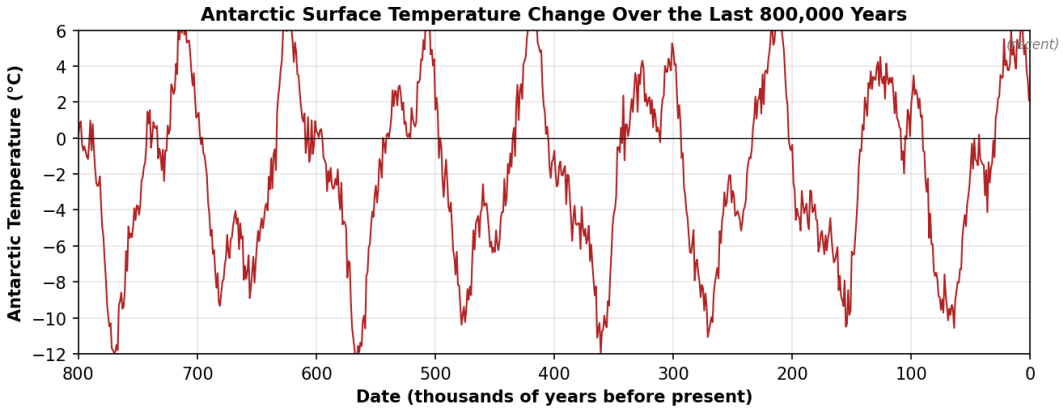
(4) Humans have decreased the number of dead trees in the forest by using them as fuel.

Answer: _____

In Earth's past, the carbon cycle has changed due to changes in climate that resulted from several different factors. Changes in the Sun's energy, the amount of marine organisms that remove carbon dioxide from the atmosphere, and uplift of major mountain chains have all contributed to variations in CO_2.

Ice-core data provides a record of atmospheric carbon dioxide (measured from air trapped in the ice in parts per million, ppm) and of Antarctic surface temperature changes over the last 800,000 years, as shown in the graphs below.





9. (June 2025 — Q14) Which claim correctly summarizes the data in the graphs that a change to one Earth system caused a change to another Earth system?

(1) Increasing atmospheric CO_2 levels caused the Antarctic surface temperature to decrease over the same time period.

(2) Variations in atmospheric CO_2 levels did not affect the surface temperature in Antarctica over the last 800,000 years.

(3) Decreasing atmospheric CO_2 levels caused Antarctic surface temperatures to also decrease over the same time period.

(4) Atmospheric CO_2 levels stayed the same, causing Antarctic surface temperatures to also stay the same over the last 800,000 years.

Answer: _____

10. (June 2025 — Q15) Using the rate of regional climate change in Antarctica for the last 40,000 years, make an evidence-based forecast of how much Antarctic temperatures are predicted to change in the next 40,000 years. Describe a specific associated impact to one Earth system as a result of this temperature change.

Predicted change: _____ °C in next 40,000 years

Associated impact:

_____

_____

_____

CLUSTER 1: Mountain Glaciers of Alaska

Retreat of the Mendenhall Glacier

Mountain glaciers form in cold regions where snowfall accumulates faster than it melts. Over hundreds of years, layers of snow compress into dense glacial ice. Glaciers move slowly downslope under their own weight, eroding bedrock, transporting sediment, and depositing rock material at their leading edge (**terminus**). When melting at the terminus exceeds new ice flowing in from above, a glacier **retreats**—its terminus moves up-valley over time.

The Mendenhall Glacier near Juneau, Alaska, has been monitored for over a century. Geologists have used dated trees, historical photographs, and trim lines on valley walls to reconstruct the position of the glacier's terminus back to the year 1500. The glacier was relatively stable during the cooler climate period known as the **Little Ice Age**. Since the late 1800s, however, the terminus has moved up-valley at an increasing rate. As the ice retreats, freshwater meltwater is added to the Pacific Ocean and bare ground previously buried under ice is exposed.

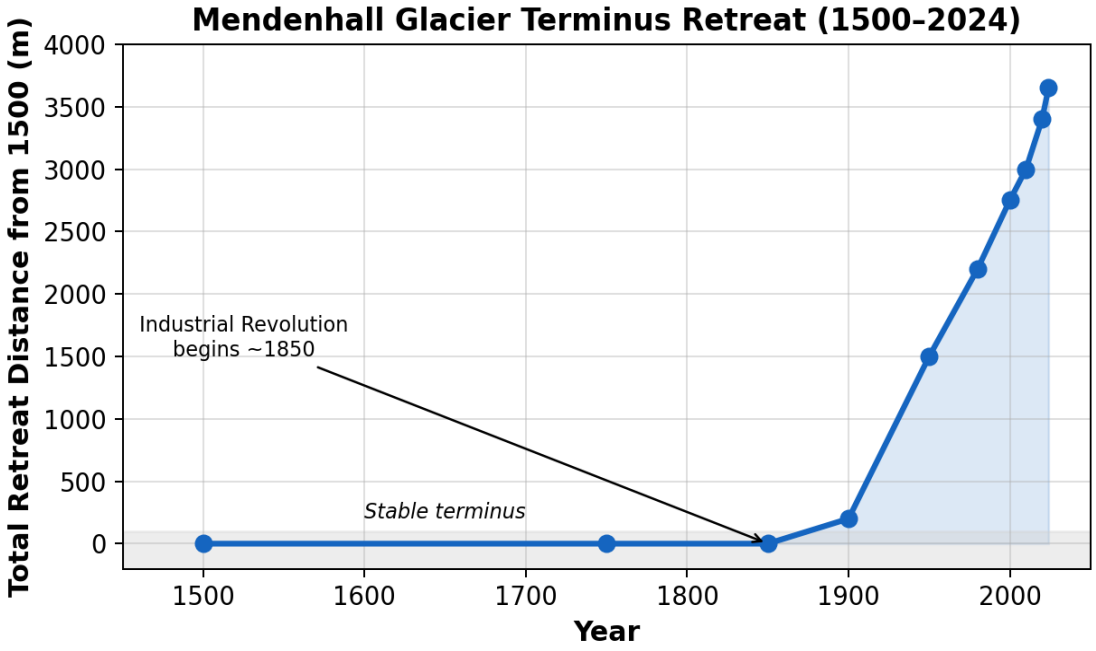


Figure 1.1. Cumulative retreat of the Mendenhall Glacier terminus from 1500 to 2024. Distance shown is the total horizontal distance the terminus has moved up-valley from its 1500 position.

11. Complete each of the three statements below to correctly describe the behavior of the Mendenhall Glacier by placing an X in the box to indicate which phrase correctly completes each statement.

Statement	Place X	Choices
Statement 1: Between 1500 and 1850, the terminus of the Mendenhall Glacier was best described as		stable, because total retreat was approximately zero meters
		rapidly retreating, because of human carbon emissions
Statement 2: The graph shows that the rate of glacial retreat from 1900 to 2024 has		decreased compared to the rate from 1500 to 1850
		increased compared to the rate from 1500 to 1850
Statement 3: Continued retreat of the Mendenhall Glacier most directly adds		salt water to Earth's atmosphere
		fresh meltwater to Earth's hydrosphere

12. A student claims that human activity since 1850 has been the major driver of Mendenhall Glacier retreat. Using all the information in the passage and Figure 1.1, which statement provides the most correct evidence to support this claim?

(1) The terminus moved over 3500 m up-valley between 1500 and 1850, before industrial CO_2 emissions began.

(2) The terminus moved less than 100 m between 1500 and 1850, but moved over 3500 m after 1850 as industrial greenhouse-gas emissions increased.

(3) The terminus has remained at the same position since 1850, showing no measurable change in glacial mass.

(4) The terminus advanced down-valley after 1850, indicating the glacier is gaining mass during the industrial period.

Answer: _____

13. Based on Figure 1.1, what is the approximate average rate of terminus retreat for the Mendenhall Glacier between the years 2000 and 2024?

(1) approximately 4 m/year

(2) approximately 38 m/year

(3) approximately 150 m/year

(4) approximately 3650 m/year

Answer: _____

14. Which model correctly represents the climate feedback that occurs when Mendenhall Glacier retreats and exposes bare ground?

(1) Glacial retreat → more bare ground exposed → less sunlight absorbed → cooler local climate → less melting.

(2) Glacial retreat → more bare ground exposed → more sunlight absorbed → warmer local climate → more melting.

(3) Glacial retreat → more ice exposed → less sunlight reflected → cooler local climate → more freezing.

(4) Glacial retreat → more bare ground exposed → increased ice formation → the glacier advances down-valley.

Answer: _____

15. A geologist makes the following observations near the Mendenhall Glacier terminus:

A. Boulders of mixed rock types lie scattered on the valley floor below the modern terminus.

B. The valley walls are smooth, U-shaped, and contain long parallel scratches in the bedrock.

C. Trees growing on the valley floor are all younger than 100 years old.

D. Stratified beach sand and rounded ocean pebbles are found 2 km up-valley from the terminus.

E. Pollen samples from soil indicate the area was once forested with mature spruce trees 1000 years ago.

F. The bedrock near the terminus is composed of folded marine sedimentary rock.

Which set of observations **best** identifies that the area near the modern terminus was covered by glacial ice within the last few hundred years?

(1) Observations A, B, and C identify recent glacial coverage.

(2) Observations B, D, and F identify recent glacial coverage.

(3) Observations A, D, and E identify recent glacial coverage.

(4) Observations C, E, and F identify recent glacial coverage.

Answer: _____

CLUSTER 2: Forest Carbon and Wildfires

Boreal Forests as Carbon Sinks and Carbon Sources

Boreal forests circle the cold, northern regions of Earth, including parts of Canada, Alaska, Russia, and Scandinavia. They are the largest land biome and store more carbon than any other terrestrial ecosystem. Most of this carbon is not in the trees themselves—it is stored as dead plant material in cold, often frozen soils and **permafrost**. As long as the soils remain cold, decomposition is slow, and the carbon stays trapped underground.

Boreal forests are facing more frequent and severe **wildfires** as the climate warms. Burning forests release CO_2 directly to the atmosphere, and rising soil temperatures cause permafrost to thaw, allowing microbes to decompose carbon that has been frozen for thousands of years. In 2023, fires in the Canadian boreal forest released roughly 2 billion metric tons of CO_2—more than three times Canada's annual fossil fuel emissions. After a fire, regrowing forests can pull carbon back out of the atmosphere, but full recovery of the carbon stored in soil and trees takes more than 100 years.

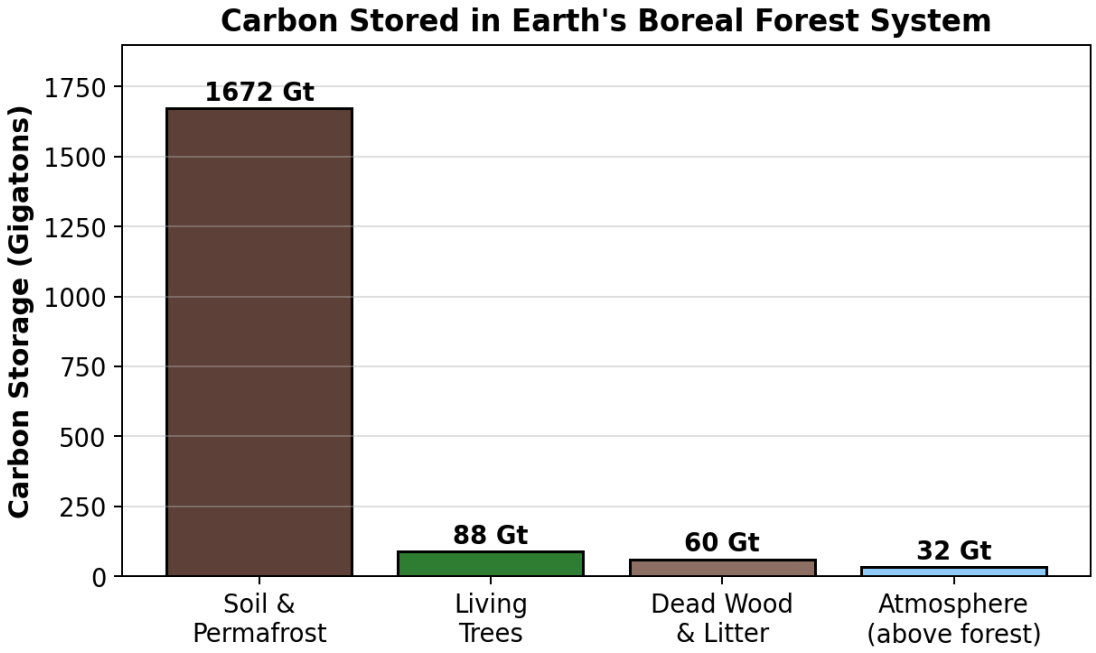


Figure 2.1. Carbon storage (in gigatons of carbon) within four reservoirs of the global boreal forest system.

16. Write the correct letter from the choices below on the line at the end of each sentence to complete each statement about boreal forests and the carbon cycle.

Choices for Statement 1:
A – photosynthesis, which removes CO_2 from the atmosphere
B – combustion, which adds CO_2 to the atmosphere

Choices for Statement 2:
C – a carbon source, because it releases more carbon than it stores
D – a carbon sink, because it stores more carbon than it releases

Choices for Statement 3:
E – decrease, because thawing permafrost will refreeze and lock carbon underground

F – increase, because thawing permafrost allows microbes to decompose stored organic carbon

Statement 1: Living trees in a healthy boreal forest take in atmospheric carbon dioxide through _____.

Statement 2: Based on Figure 2.1, the boreal forest soil and permafrost system is best described as _____.

Statement 3: If global temperatures continue to rise, atmospheric CO_2 levels are expected to _____.

Cluster 2 continued

17. Use Figure B1 (Model of the Fast Carbon Cycle) to answer this question. Which statement correctly identifies how a wildfire that destroys a portion of Earth's plant biomass would change the cycling of carbon between Earth's spheres?

(1) Carbon stored in plant biomass (550 GT) would move directly into the deep ocean reservoir (37,000 GT).

(2) Carbon stored in plant biomass (550 GT) would move into the atmosphere reservoir (800 GT) as CO_2.

(3) Carbon stored in fossil carbon (10,000 GT) would move into plant biomass via photosynthesis.

(4) Carbon stored in soil (2300 GT) would move into the atmosphere through air-sea gas exchange.

Answer: _____

18. Several statements about boreal forest carbon are listed below.

Statement 1: The boreal forest stores more carbon in soil and permafrost than in living trees.

Statement 2: Wildfires move carbon from the biosphere to the atmosphere as CO_2.

Statement 3: Photosynthesis is the only process that releases carbon from a forest into the atmosphere.

Statement 4: Carbon stored in permafrost cannot enter the atmosphere under any conditions.

Statement 5: Increasing atmospheric CO_2 traps more outgoing infrared energy, contributing to warming.

Statement 6: Boreal forest fires have no effect on global atmospheric CO_2 concentrations.

Which three statements correctly describe how boreal forest fires and carbon storage affect Earth's systems?

(1) Statements 1, 3, 4

(2) Statements 1, 2, 5

(3) Statements 2, 4, 6

(4) Statements 3, 5, 6

Answer: _____

19. A boreal forest is destroyed by a wildfire. Which statement best describes how the carbon balance of the forest changes immediately after the fire and over the next 100 years as the forest regrows?

(1) Immediately after: net carbon source. Over 100 years: net carbon sink as plants regrow and absorb CO_2.

(2) Immediately after: net carbon sink. Over 100 years: net carbon source as decomposition continues.

(3) Immediately after: no change in carbon. Over 100 years: no change in carbon.

(4) Immediately after: net carbon sink. Over 100 years: net carbon sink at all times.

Answer: _____

20. A student makes the claim: *"Replanting forests after wildfires is an effective short-term solution for offsetting human CO_2 emissions in the next decade."* Using the information in the passage and Figure 2.1, which statement provides the most correct evidence to refute this claim?

(1) Replanted forests immediately store more carbon in soil and trees than the forest had before burning.

(2) Replanting forests removes the need to reduce fossil fuel use.

(3) Recovery of carbon stored in trees and soil takes more than 100 years, so replanting cannot offset current decade emissions.

(4) Replanted forests release more CO_2 than they absorb because young trees only respire and never photosynthesize.

Answer: _____

CLUSTER 3: Greenland Ice Sheet Albedo

Black Carbon and Ice Sheet Reflectivity

Albedo is a measure of how much sunlight a surface reflects back to space. Surfaces with high albedo (close to 1.0) reflect most incoming solar energy; surfaces with low albedo absorb it. Clean fresh snow has one of the highest albedos of any natural surface on Earth, near 0.90. As snow ages, becomes denser, and accumulates dark particles, its albedo drops.

Wildfires, dust storms, and the burning of fossil fuels release tiny dark particles called **black carbon** into the atmosphere. Wind currents carry this material thousands of kilometers and deposit it on glaciers and ice sheets, including Greenland. As black carbon accumulates in surface snow, it reduces albedo and increases the amount of solar energy absorbed by the ice. The ice warms, melts faster, and exposes older, dirtier ice and bare ground beneath—further lowering albedo. This is an example of a positive (amplifying) feedback in the climate system.

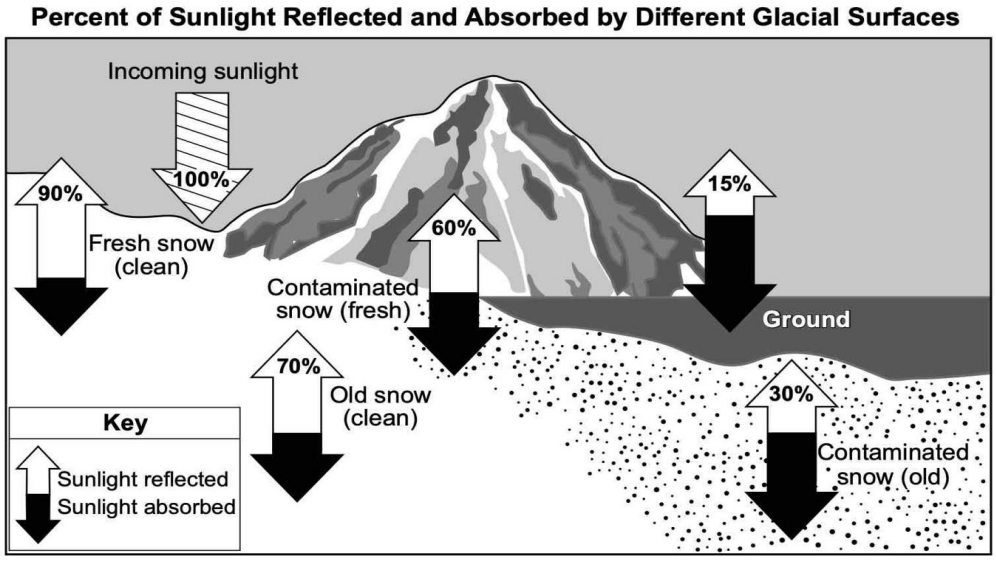


Figure 3.1. Percent of sunlight reflected and absorbed by different glacial surfaces.

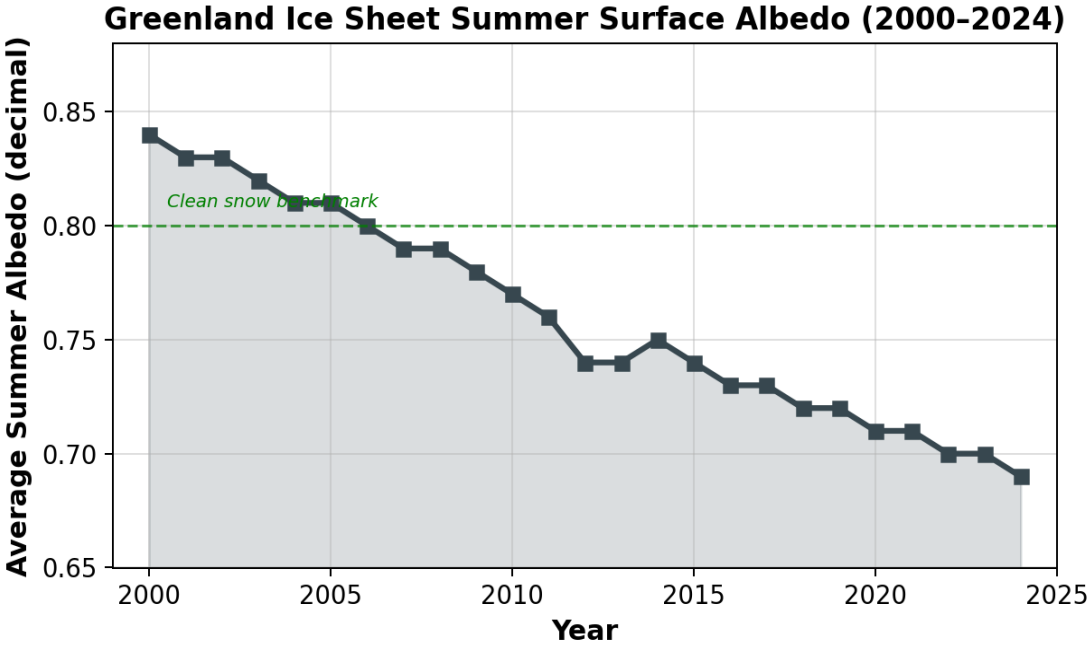


Figure 3.2. Average summer surface albedo on the Greenland Ice Sheet, 2000–2024.

Cluster 3 continued

21. Complete each of the three statements below by placing an X in the box that correctly describes how albedo and feedbacks affect the Greenland Ice Sheet. Use Figures 3.1 and 3.2.

Statement	Place X	Choices
Statement 1: According to Figure 3.1, the surface that absorbs the most sunlight is		fresh clean snow, which absorbs about 10%
		old contaminated snow, which absorbs about 70%
Statement 2: The most likely cause of the change in Greenland's summer albedo from 2000 to 2024 is		increasing accumulation of black carbon and dust on the ice sheet
		increasing accumulation of fresh, clean snow on the ice sheet
Statement 3: The change shown in Figure 3.2 is best described as a		positive (amplifying) feedback that increases ice melt
		negative (stabilizing) feedback that slows ice melt

22. Based on Figure 3.2, what is the approximate change in average summer surface albedo on the Greenland Ice Sheet from 2000 to 2024?

(1) An increase of about 0.15

(2) A decrease of about 0.15

(3) An increase of about 0.05

(4) No measurable change

Answer: _____

23. Which statement best describes how the trend shown in Figure 3.2 is expected to affect global sea level?

(1) Sea level will fall, because lower albedo causes the ice sheet to grow.

(2) Sea level will fall, because lower albedo cools the surrounding ocean.

(3) Sea level will rise, because lower albedo causes increased melting and freshwater runoff.

(4) Sea level will not change, because albedo does not affect ice mass.

Answer: _____

Cluster 3 continued

24. Use Figure 3.1 to rank the four glacial surfaces below in order of increasing solar energy absorbed (from least to most). Then justify your ranking using one piece of evidence from Figure 3.1.

Surfaces: • Fresh clean snow • Contaminated old snow • Old clean snow • Contaminated fresh snow

Least energy absorbed

1. _____
2. _____
3. _____

Most energy absorbed

4. _____

Justification:

_____

_____

_____

25. Which row in the table below correctly describes how the trend in Figure 3.2 will most likely influence Greenland's energy balance and global climate?

Row	Energy Absorbed by Ice Sheet	Effect on Melting	Effect on Global Climate
(1)	Decreases	Decreases	Cooling
(2)	Increases	Decreases	Cooling
(3)	Increases	Increases	Warming
(4)	Decreases	Increases	Warming

Answer: _____

CLUSTER 4: Ocean Acidification & the Carbon Cycle

How Rising CO_2 Changes the Ocean

The world's oceans absorb roughly one-quarter of the carbon dioxide that humans release each year. When CO_2 dissolves in seawater, it reacts with water to form **carbonic acid** (H_2CO_3). This reaction releases hydrogen ions (H^+), which lowers the pH of seawater. Although the ocean still has a basic pH, the average value has been falling steadily since 1850. This process is called **ocean acidification**.

Lower seawater pH makes it harder for organisms such as corals, oysters, sea urchins, and certain plankton to build their calcium carbonate ($CaCO_3$) shells and skeletons. As atmospheric CO_2 continues to rise, scientists project that the rate of acidification will accelerate, putting additional stress on marine ecosystems and the human communities that depend on them.

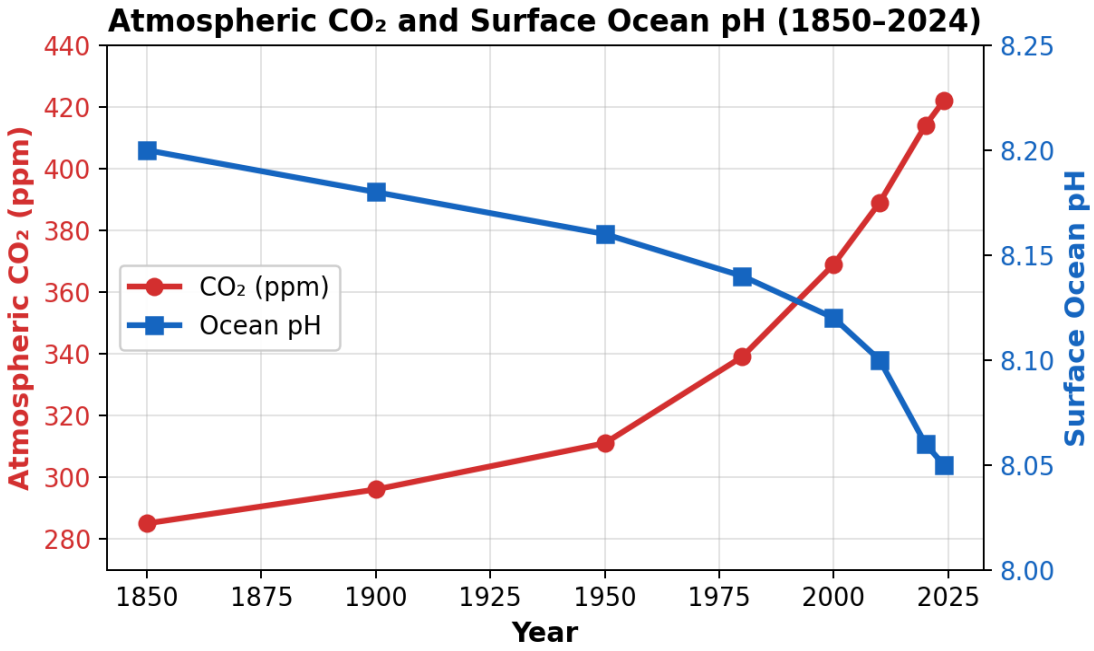


Figure 4.1. Atmospheric CO_2 (ppm, red) and surface ocean pH (blue) from 1850 to 2024.

26. Based on Figure 4.1, which statement correctly identifies the relationship between atmospheric CO_2 and surface ocean pH from 1850 to 2024?

(1) As atmospheric CO_2 increased, ocean pH increased.

(2) As atmospheric CO_2 increased, ocean pH decreased.

(3) As atmospheric CO_2 decreased, ocean pH decreased.

(4) Atmospheric CO_2 and ocean pH stayed constant.

Answer: _____

Cluster 4 continued

27. A marine biologist makes the following observations about a coral reef ecosystem over a 50-year period:

A. The thickness of newly grown coral skeletons has decreased.

B. Local sea surface temperature has risen by 1.2°C.

C. Atmospheric CO_2 above the reef has risen from 320 ppm to 420 ppm.

D. The number of coral species in the reef has remained constant.

E. The water clarity (light penetration) of the surrounding ocean has not changed.

F. The average surface ocean pH near the reef has fallen from 8.15 to 8.05.

Based on the biologist's observations, which set of observations correctly identifies evidence that the coral reef is being affected by ocean acidification?

(1) Observations A, C, and F identify ocean acidification effects.

(2) Observations B, D, and E identify ocean acidification effects.

(3) Observations C, D, and E identify ocean acidification effects.

(4) Observations A, B, and D identify ocean acidification effects.

Answer: _____

28. Use Figure B1 (Model of the Fast Carbon Cycle) on an earlier page. Which statement correctly describes how human emissions are affecting the air-sea exchange of carbon between Earth's atmosphere and surface ocean?

(1) Humans add 9 GT/yr to the atmosphere; this extra CO_2 cannot dissolve in the ocean and stays in the atmosphere only.

(2) Humans add 9 GT/yr to the atmosphere; some of this carbon dissolves into the surface ocean (shown as +2 GT/yr air-sea uptake), increasing dissolved CO_2 in seawater.

(3) Humans remove 9 GT/yr from the atmosphere; the surface ocean releases 90 GT/yr to replace it.

(4) Humans add 9 GT/yr directly to the deep ocean (37,000 GT) without entering the atmosphere first.

Answer: _____

29. A student makes the following claim:

"The ocean is a perfect, unlimited buffer for human CO_2 emissions, so increased fossil fuel burning will not have any negative effect on marine ecosystems."

Place a check mark (✓) in either the **Support** or **Refute** box below to indicate whether the information in the passage and Figure 4.1 supports or refutes the student's claim. Justify your response using evidence from the passage **and** Figure 4.1.

☐	**SUPPORT**	☐	**REFUTE**

Justification:

Cluster 4 continued

30. Based on the passage and Figure 4.1, which statement best describes how continued increases in atmospheric CO_2 will most likely affect human communities that depend on shellfish harvests?

(1) Shellfish populations will increase because warmer water grows shells faster, increasing harvest sizes.

(2) Shellfish populations will increase because lower pH makes calcium carbonate easier to form.

(3) Shellfish populations will decrease because lower pH makes it harder for organisms to build calcium carbonate shells, reducing harvest sizes.

(4) Shellfish populations will not be affected, because ocean pH does not influence shell formation.

Answer: _____

FINAL GRADE CALCULATION

Use the answer key (last page) to grade your responses, then complete the table below to calculate your final grade.

Section	Questions	Possible Pts	Pts Earned
Section A: June 2025 Q6–10	Q1–5	5	
Section B: June 2025 Q11–15	Q6–10	5	
Cluster 1: Mountain Glaciers of Alaska	Q11–15	5	
Cluster 2: Forest Carbon & Wildfires	Q16–20	5	
Cluster 3: Greenland Ice Sheet Albedo	Q21–25	5	
Cluster 4: Ocean Acidification & Carbon	Q26–30	5	
TOTAL POINTS EARNED		**30**	
FINAL PERCENTAGE (Points / 30 × 100)			_____ %
LETTER GRADE			

Reflection: What topic or question type was most challenging?

_____

_____

_____

What is your plan for review before the Regents exam?

ANSWER KEY (Teacher Edition)

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Q#	Topic	Type	Answer
1	Obliquity / NH winter energy	MC	(2) less energy, more ice
2	Glacier melt → ocean currents	MC	(2) currents weaken
3	Gulf Stream effect on climate Y	MC	(1) warmer, more precipitation
4	Albedo feedback loop	MC	(4) dark surface → absorption → melting → less ice
5	Scenario B 2100 values	CR	~650 ppm CO_2 equiv.; ~+3.0 °C
6	Photosynthesis decreases atm CO_2	CR	Photosynthesis: light + $6CO_2$ + $6H_2O$ → glucose + $6O_2$; trees take in atmospheric CO_2, lowering levels.
7	Quantitative carbon cycling	MC	(4) 92 GT cycles between atm and ocean
8	Climate change → human activity	MC	(1) replanting trees after wildfires
9	CO_2 / Antarctic temp ice cores	MC	(3) decreasing CO_2 → decreasing temp
10	Antarctic temp forecast	CR	~+5–6 °C; impact e.g., ice sheet melt → sea level rise
11	X-box: Mendenhall behavior	X-box	1: stable; 2: increased; 3: fresh meltwater to hydrosphere
12	Claim/evidence: human role since 1850	MC	(2)
13	Rate calc 2000–2024	MC	(2) ~38 m/yr
14	Albedo feedback diagram	MC	(2)
15	Set of observations: glacial coverage	MC	(1) A, B, C
16	A/B letter completion	Letter	Statement 1: A; Statement 2: D; Statement 3: F
17	Wildfire → spheres	MC	(2)
18	Select 3 statements	MC	(2) Statements 1, 2, 5
19	Wildfire short vs long term	MC	(1)
20	Refute replanting claim	MC	(3) recovery > 100 yrs
21	X-box: albedo / Greenland	X-box	1: old contaminated, 70%; 2: black carbon/dust; 3: positive feedback
22	Albedo change 2000–24	MC	(2) decrease ~0.15
23	Sea level effect	MC	(3) rise

24	Rank surfaces, justify	CR	Order: fresh clean (10%) → old clean (30%) → contaminated fresh (40%) → contaminated old (70%). Justify with absorption % from Figure 3.1.
25	Energy balance row	MC	(4) absorbed up, melt up, warming
26	CO_2 / pH relationship	MC	(2) inverse
27	Set of observations: acidification	MC	(1) A, C, F
28	Air-sea CO_2 uptake	MC	(2)
29	Refute ocean buffer claim	CR	REFUTE. pH dropped 0.15 since 1850, so CO_2 IS changing ocean chemistry; lower pH stresses calcifying organisms (corals, shellfish).
30	Shellfish & human communities	MC	(3) decrease