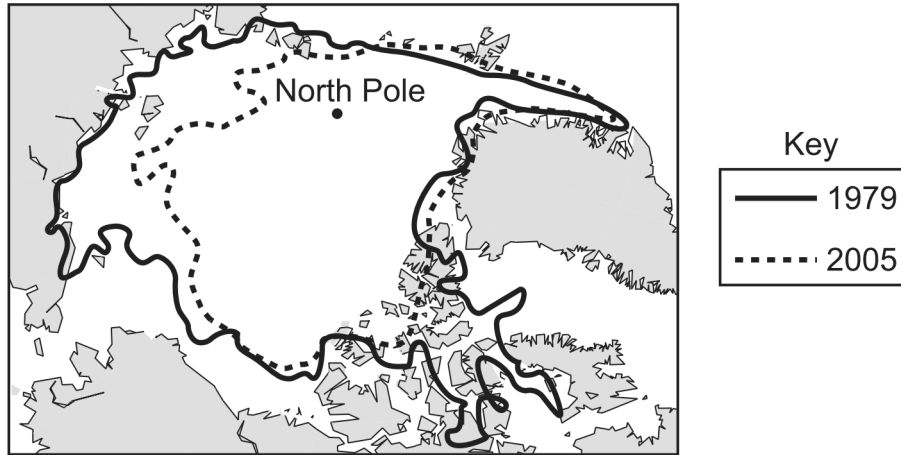


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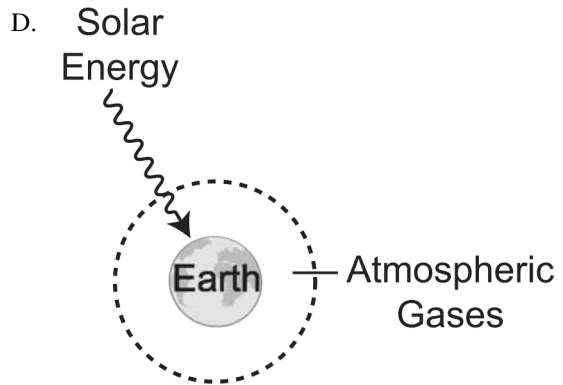
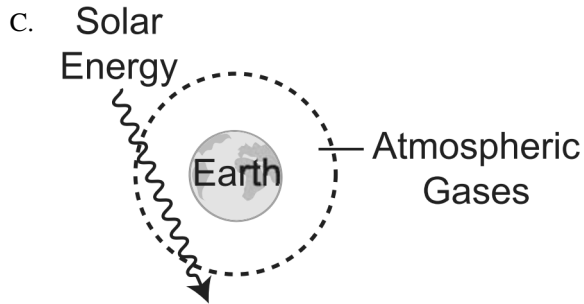
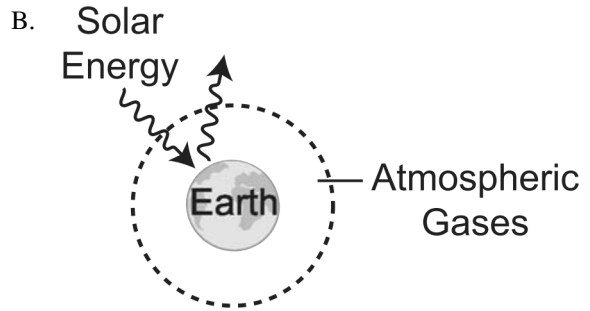
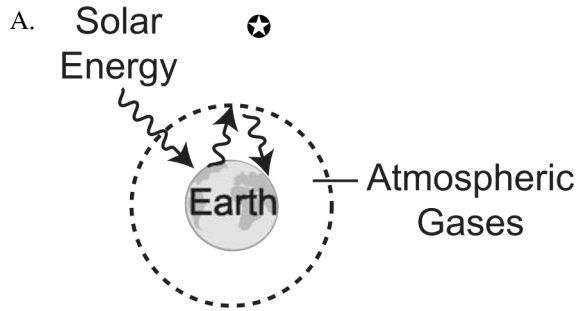
1. The picture below shows the extent of summer Arctic Sea ice in 1979 and 2005.



Which hypothesis is *best* supported by the changes in sea-ice coverage?

- A. Earth's climate is gradually warming.
- B. Arctic Sea ice is migrating away from Earth's poles.
- C. Global warming is caused by human activity, not nature.
- D. Global warming occurs only at Earth's poles during the summer.

2. Which of the following pictures *best* represents the natural greenhouse effect?



3.

The London Smog Disaster of 1952

On December 5, 1952, London, England, experienced temperatures that were much colder than normal. As a result, large amounts of coal were burned in furnaces to keep residences warm. This occurred at the same time as the formation of a heavy fog. Water from the fog condensed around airborne soot particles, and a thick smog quickly developed. Nearly 12,000 human deaths resulted.

In addition to soot, what product of the burning coal contributed *most* to the extreme pollution of London's air?

A. uranium (U)

B. methane (CH₄)

C. sulfur dioxide (SO₂)

D. chlorofluorocarbons (CFCs)

4.

Mount Mitchell Acid Rain

In 1915, Mount Mitchell was designated as North Carolina's first state park and was covered by a dense forest. Today, the forest has thinned considerably as a result of pollution and acid deposition. According to the Division of Parks and Recreation, the forest experiences acid fogs approximately 80% of the year. State officials have determined that much of the air pollution in North Carolina originates in other states and is transported by winds. In 2004, the Environmental Protection Agency began to develop a plan to reduce harmful emissions in states that are "upwind" from North Carolina.

What type of facility is *most* responsible for the pollution that results in acid deposition on Mount Mitchell?

- A. nuclear power plants
- B. coal-fired power plants
- C. toxic waste disposal facilities
- D. wastewater treatment facilities

The following article is adapted from a webpage that Dr. Ben Booth, Senior Climate Scientist, posted on the website of the United Kingdom's National Weather Service, a government office of weather and climate research. Read and study the article, then answer the following question(s)

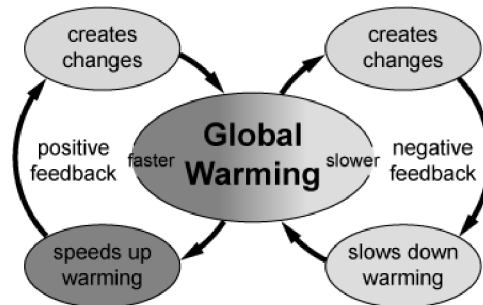
Climate Feedback Loops

Climate feedback loops are an important area of research for scientists.

What is a climate feedback loop?

A climate feedback loop happens when a change in our climate causes an environmental impact that produces further climate change. Climate feedback loops can be both negative and positive:

- Negative feedback loop: A negative feedback loop occurs when an environmental impact offsets the climate change such that they balance out. Under global warming, the impact would create a cooling effect, offsetting the warming trend.
- Positive feedback loop: A positive feedback loop occurs when an environmental impact increases the climate change such that the first change is amplified. Under global warming, the impact would add to climate warming by creating further heating.



Why are feedback loops so important to climate change?

Feedback loops have the ability to greatly affect climate change. The big question is what overall effect the world's positive and negative feedback loops will have on climate change.

The more we understand about them, the more confidence we have in our climate projections for the future. The better our projections, the better we can understand climate change and prepare for it.

Which climate feedback loops are well understood?

Some types of feedback loops are fairly well understood, such as those involving water vapor and albedo. Scientists use these feedback loops to improve their predictions about climate change through the use of computer models. This means that scientists have taken into consideration the effect these feedback loops will have as the climate warms in the future.

Water Vapor (Positive Feedback)

As air gets warmer, its ability to hold moisture increases. Our atmosphere is getting warmer because of climate change and, as a result, it is holding more water vapor. Water vapor is a powerful greenhouse gas-when in the atmosphere, it helps the Earth hold on to more energy from the Sun. So a warming climate means more water vapor, which in turn warms the climate further.

Albedo (Positive Feedback)

Albedo is the percentage of light reflected by a surface, which is a very important consideration in climate science. A surface with a high albedo, such as snow or sand, will reflect more sunlight back out to space. The lower the albedo, the more energy and heat is absorbed.

Global warming is causing ice and snow to melt, revealing the land or ocean underneath. Ice and snow reflect a lot of sunlight—certainly more than land and the oceans. So as the ice melts, more of the Sun’s energy is absorbed and so the planet gets warmer still—which in turn melts even more snow and ice.

Which climate feedback loops are less well understood?

Other feedbacks, such as the global carbon cycle, are not as easy to understand. They are being included in models, but more research is needed to fully understand these processes. The models are updated as new information becomes available.

Global Carbon Cycle (Currently Negative Feedback)

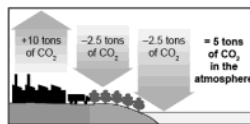
For every ton of carbon dioxide (CO₂) released into the atmosphere, within a year, about half of that will be absorbed by the ocean and land—for example, through trees and plants.

This process helps reduce the effect of CO₂ emissions on global warming. However, if large quantities of carbon dioxide continue to be emitted, it could decrease the benefit of this cycle, which would have a huge impact on the future of the climate.

Global warming could affect the carbon cycle in two areas, the ocean and the land:

1. Ocean changes can result in positive climate change feedback loops, for two reasons:
 - As the ocean absorbs CO₂, it becomes more acidic. Acidic water cannot absorb as much additional CO₂.
 - As the temperature of the ocean increases, its capacity to absorb CO₂ is also reduced.

Simplified Carbon Cycle

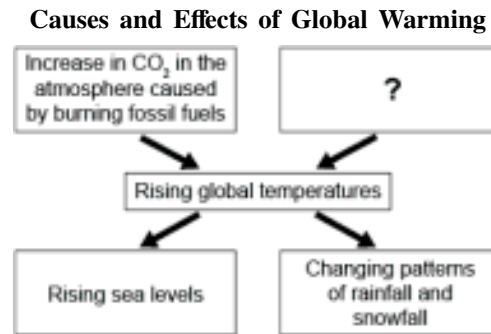


The illustration above is a simplified carbon cycle, showing current CO₂ absorption rates of the land and oceans.

2. Land changes can result in positive or negative climate change feedback loops. Examples include:
 - Negative feedback: As temperatures increase, the areas in which trees can grow will extend north to higher latitudes. New trees will absorb CO₂, taking it out of the atmosphere.
 - Positive feedback: As temperatures increase, soils, plants, and trees in tropical zones will become more heat stressed. This could cause the release of the huge amounts of carbon they store, threatening the future of important ecologies such as the Amazon Rain Forest.

A lot of research continues to go on in this area. Advances in understanding will enable us to improve our confidence in projections resulting from climate models.

5. The flowchart shows some of the causes and effects of global warming.



Which cause *best* completes the flowchart?

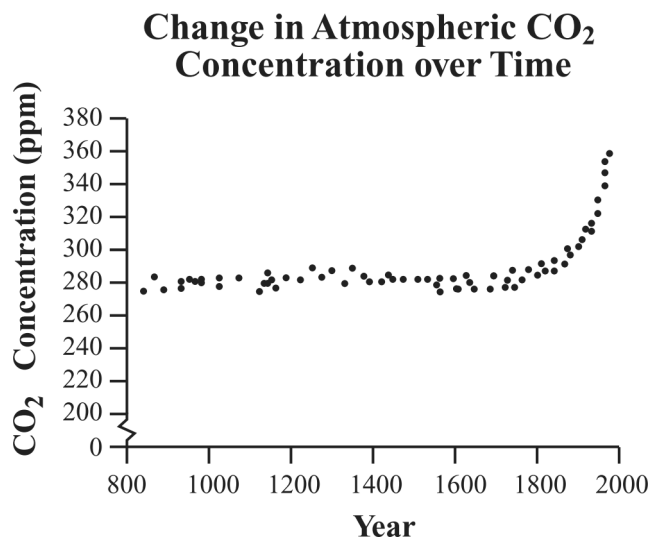
- A. Emissions of chlorofluorocarbons (CFCs) into the atmosphere
 - B. Destruction of forests, especially tropical rain forests
 - C. Increases in particulate pollution, such as soot
 - D. Destruction of ecosystems and loss of biodiversity caused by invasive species
6. One effect of global warming is the retreat of mountain glaciers across the world. This results in less groundwater and water in streams in the summer.

What type of feedback loop would *most likely* be a result of glacial retreat, and why?

- A. A negative feedback loop because reduced evaporation lowers the amount of water vapor in the air near the ground.
- B. A negative feedback loop because the rate of decomposition, which releases CO₂, is slower when the ground is drier.
- C. A positive feedback loop because reduced evaporation reduces the amount of high cloud cover.
- D. A positive feedback loop because a drier landscape is more susceptible to wildfires.

7. One of the effects of global warming is rising sea levels. Analyze the causes and effects of rising sea levels. Your response should:
- Describe a change resulting from global warming that can cause sea levels to rise.
 - Explain why rising sea levels can cause problems for coastal ecosystems and communities, even if they remain above sea level. Provide at least *two* examples in your explanation.
 - Explain at least *two* actions humans can take to help prevent damage caused by rising sea levels.

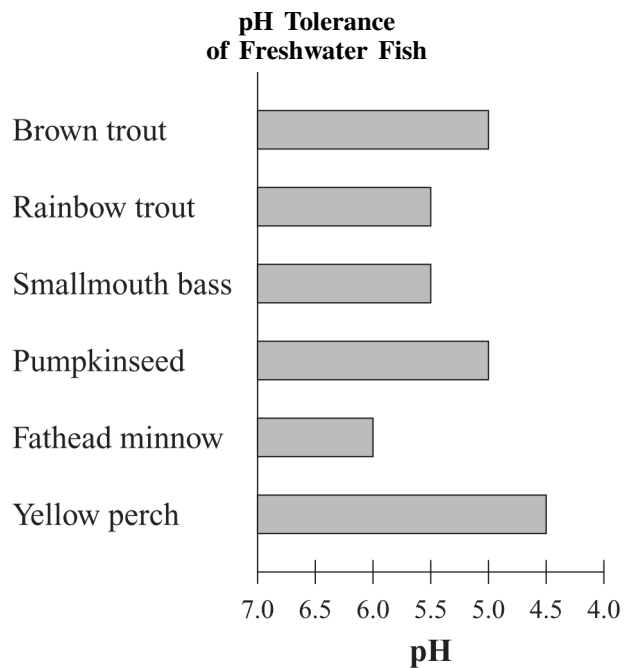
8. A graph of atmospheric carbon dioxide concentration over time is shown below.



Scientists are investigating the cause of the large increase in atmospheric carbon dioxide concentration since about 1800. Which of the following provides the *best* explanation for the increase?

- | | |
|------------------------------------|------------------------------------|
| A. eruptions of large volcanoes | B. use of fossil fuels by humans |
| C. natural fluctuations of climate | D. photosynthesis by phytoplankton |

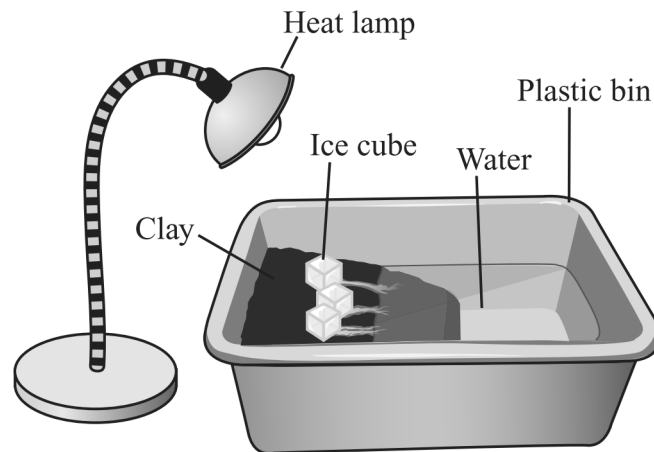
9. The graph below shows the levels of acidity that different kinds of freshwater fish can tolerate. Low pH values mean the water is more acidic.



Based on the data, which of the following fish would *most likely* experience the largest population declines due to acid rain pollution?

- A. brown trout B. smallmouth bass C. fathead minnow D. yellow perch

10. Manuel is building a model to show how water from melting glaciers moves through the ocean. He puts clay, water, and ice cubes into a plastic bin. He places a heat lamp next to the bin. His model is shown in the diagram below.



Which of the following would *most likely* help Manuel show how water from melting glaciers moves in his model?

- A. using colored water to represent the water in the ocean
- B. using colored water to make the ice cubes that represent the glaciers
- C. using different colors of clay to represent dry land and the bottom of the ocean
- D. using different colors of light to represent sunlight shining on the glaciers and dry land

11. The table below lists causes of stream changes in the Mud Creek Watershed in North Carolina.

Changes in the Mud Creek Watershed

Cause	Specific Sources
Sedimentation	<ul style="list-style-type: none"> • Runoff from roads, lawns, fields • Solid surfaces: <ul style="list-style-type: none"> - roads - driveways - parking lots - rooftops - sidewalks • Disturbances from construction sites • Livestock access to creek
Nonpoint source pollutants	<ul style="list-style-type: none"> • Road runoff of salt, metals, oil • Nutrients like pet waste, leaky septic systems, fertilizers • Pesticides from lawns and gardens • Agricultural runoff
Bacteria (fecal coliform)	<ul style="list-style-type: none"> • Runoff of pet waste, leaky septic systems • Livestock access to creek

Which action might help improve the condition of the streams?

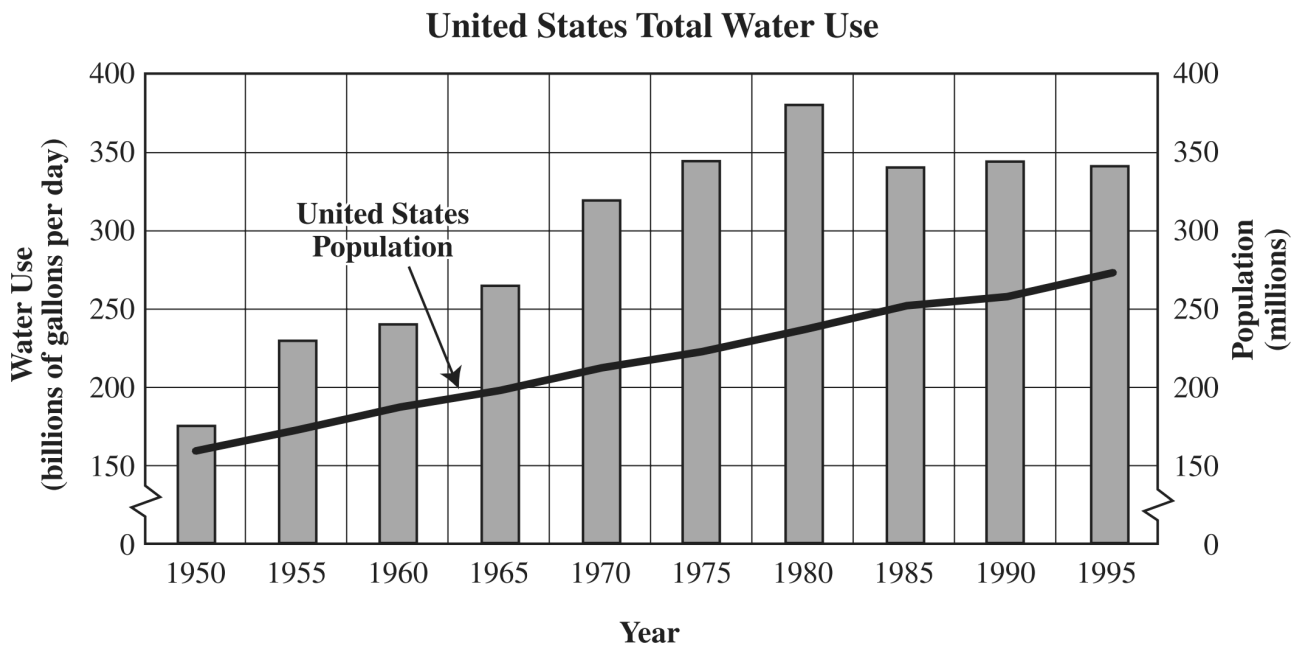
- | | |
|-------------------------------------|-----------------------------------|
| A. restricting fishing | B. clear-cutting the forest |
| C. limiting residential development | D. adding livestock to the region |

12. The pesticide DDT was at one time referred to as a “miracle” pesticide. Its widespread use in the United States peaked in 1959, but then usage steadily declined until its ban in late 1972. Reasons for declining usage included increased insect resistance and public concern over potentially harmful environmental effects.

How did this concern affect the field of agricultural science?

- A. It led to the development of equally harmful herbicides.
- B. It encouraged farmers to violate the ban and increase the use of DDT.
- C. It led to the development of more effective, alternative pesticides.
- D. It encouraged farmers to reduce the number of crops grown in their fields.

13. The graph below shows the United States population and the total water consumption in the United States from 1950 to 1995.



Based on the graph, which statement is a fact?

- A. People used too much water between 1970 and 1985.
- B. People have been finding better uses for water since 1985.
- C. The average number of people who used water decreased after 1985.
- D. The average amount of water each person used was lower in 1995 than in 1985.

14. Read the information about a photosynthesis experiment then answer the following question(s)

Mrs. Ryland placed a water plant in a test tube, filled the test tube with water, and then inverted the tube in a beaker half filled with water. She placed a lamp next to the beaker and turned on the light (see Figure 1). The next day the class saw that the level of water in the test tube had gone down (see Figure 2).

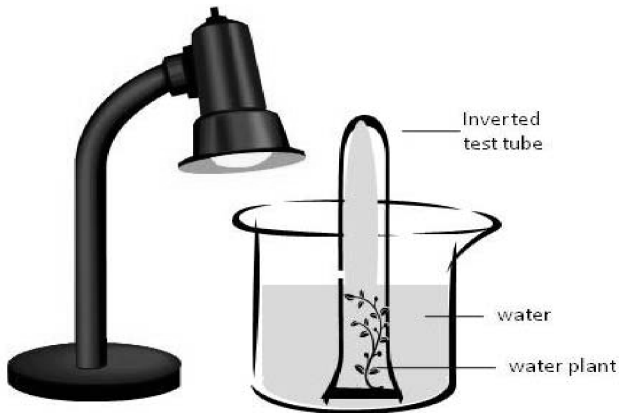


Figure 1



Figure 2

After seeing these results, Ella wrote four questions in her lab notebook.

- Question 1: Why did the water level in the test tube go down?
- Question 2: Is light needed to change the water level in the test tube?
- Question 3: Did light cause the water level in the test tube to go down?
- Question 4: Would a different type of plant change the water level in the test tube?

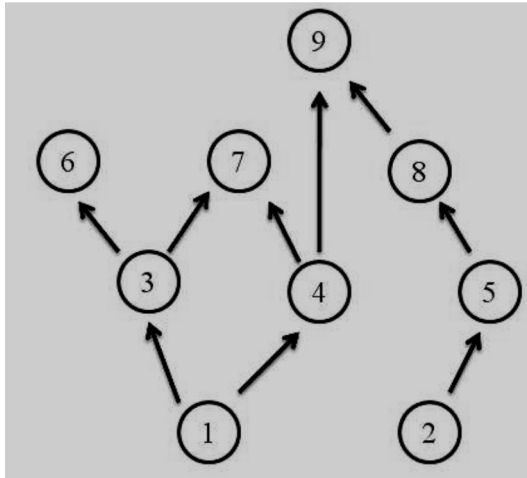
Ella set up an experiment to investigate one of her questions. She set up one test tube to look like Figure 1. She set up another test tube similar to Figure 1 but without a lamp, and placed it in a dark closet. A day later, Ella checked the water level in each test tube.

What is the main substance found in the top part of the test tube labeled X in Figure 2?

- A. oxygen
- B. nothing
- C. water vapor
- D. carbon dioxide

15. Read the information about the food web below then answer the following question(s).

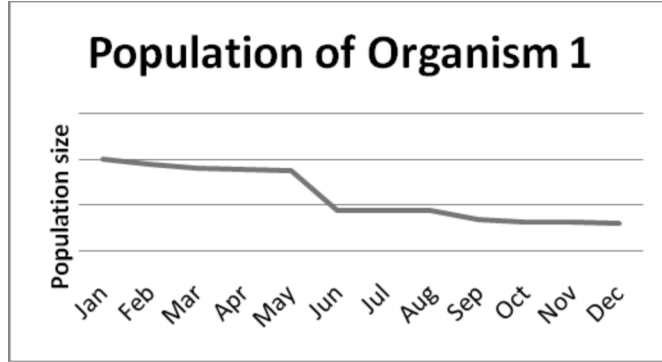
Each number represents an organism in the food web.



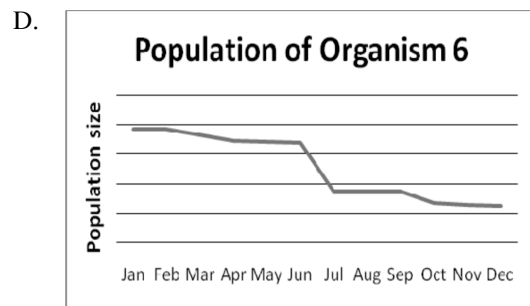
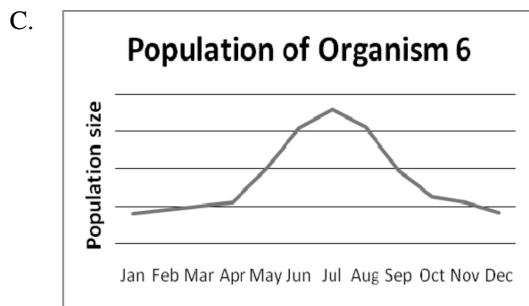
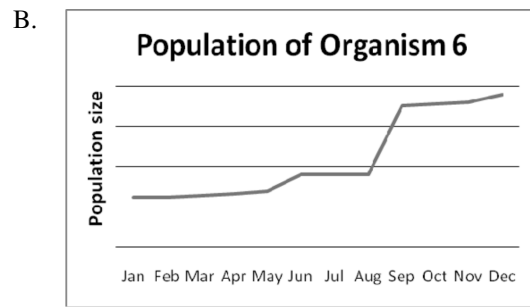
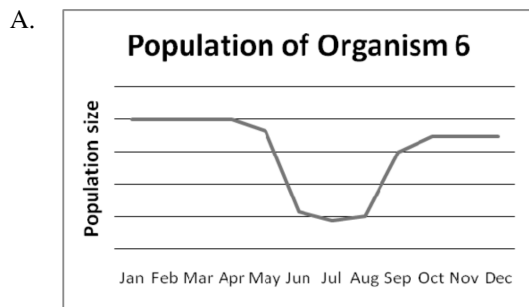
Which of the following organisms can transform light energy into chemical energy?

- A. organism 1 B. organism 4 C. organism 7 D. organism 9

16. A scientist monitored the population sizes of organisms 1 and 6 over a one year period. Below is a graph showing how the population of organism 1 changed.



Which of the following graphs would *best* represent the population size of organism 6 over the same time period?



17. **Read the information about fish hatcheries then answer the following question(s).**

Fish hatcheries are an enclosed environment used to farm a large number of fish. A fish biologist wondered if fish raised in hatcheries would be able to survive in a wild environment. The biologist thought that fish raised in hatcheries lost their fear of predators.

To test the idea, he placed 15 young hatchery trout and 15 wild trout of the same age and species into two separate but identical tanks. He divided each tank in half by inserting a clear divider made out of plexiglass. The biologist placed the trout on one side of the plexiglass divider and a large predatory fish—the northern pike—on the other side of the plexiglass. He then recorded the amount of time it took the young trout to move to the back of the tank away from the northern pike. The biologist found that the hatchery fish moved away much slower than the wild fish.

Which of the following statements is the basis for the hypothesis that was tested?

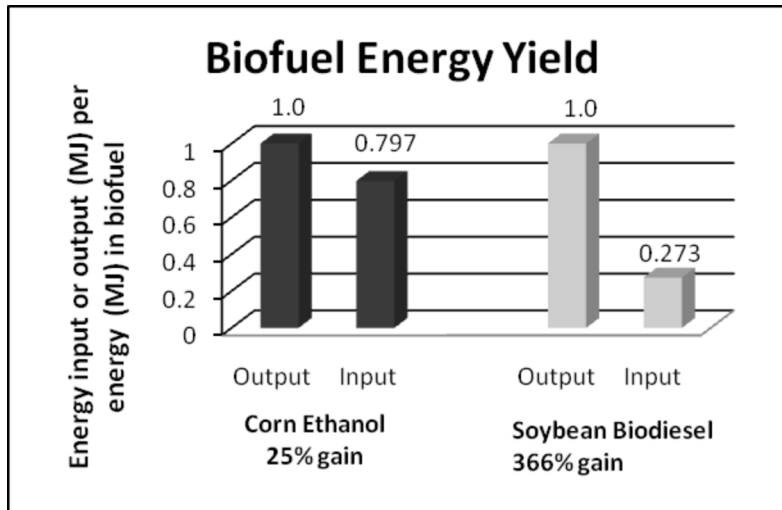
- A. “A fish biologist wondered if fish raised in hatcheries would be able to survive in a wild environment.”
- B. “The biologist thought that fish raised in hatcheries lost their fear of predators.”
- C. “To test the idea, he placed 15 young hatchery trout and 15 wild trout of the same age and species into two separate but identical tanks.”
- D. “The biologist found that the hatchery fish moved away much slower than the wild fish.”

Read the information about biofuels then answer the following question(s).

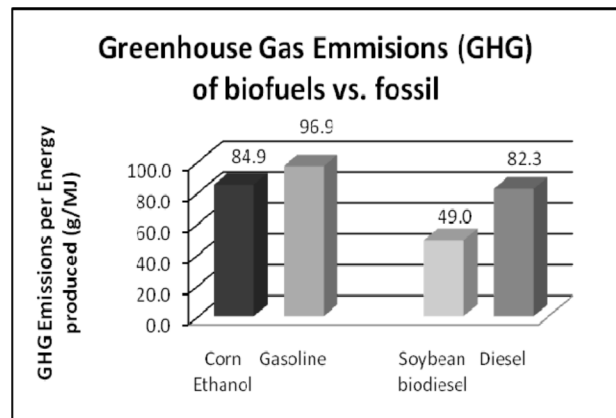
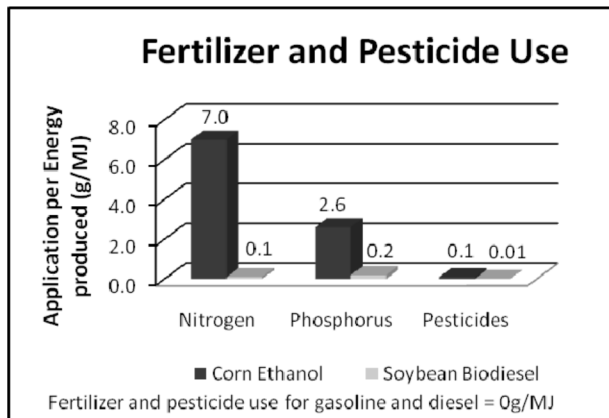
Negative environmental consequences of fossil fuels and concerns about petroleum supplies have led to the search for renewable biofuels. To be a viable alternative, a biofuel should provide a net energy gain, have environmental benefits, be economically competitive, and be producible in large quantities without reducing food supplies.

An energy consultant wanted to determine whether two biofuels, corn ethanol and soybean biodiesel, met the criteria for a viable alternative fuel. Corn ethanol is a biofuel that could be used to replace gasoline. Soybean biodiesel is a biofuel that could be used to replace diesel fuel.

The consultant collected data for these two fuels and summarized them in the following graphs.



Energy input is the amount of energy needed to grow and harvest the crop and convert it to biofuels. Energy output is the amount of energy yielded from the biofuel.



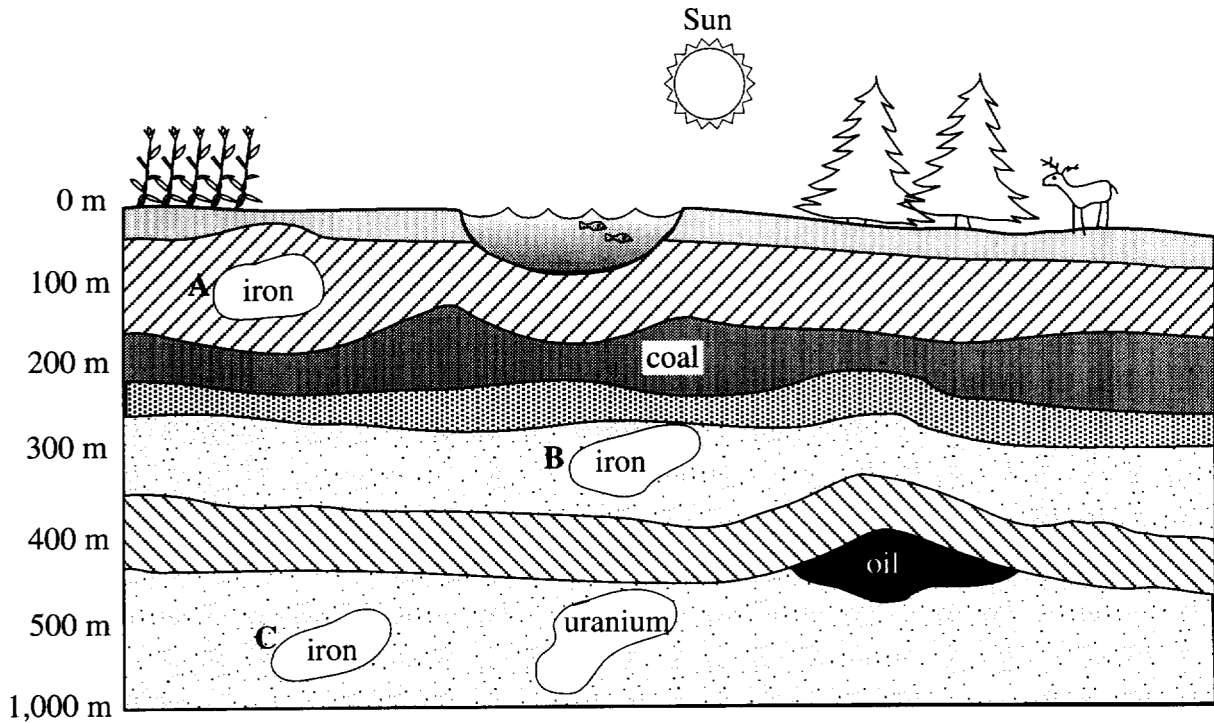
(Data from <http://www.pnas.org/content/103/30/11206.full.pdf+html>)

18. Why is it important to know the energy input and output when comparing possible biofuels?
- A. Low energy input leads to low energy output of the biofuel.
 - B. High energy input leads to high energy output of the biofuel.
 - C. Biofuels should have a high energy input and a lower energy output.
 - D. Biofuels should have a low energy input and a higher energy output.
19. The consultant concluded that soybean biodiesel was a viable alternative to diesel fuel. Which of the following statements has data to support this conclusion?
- A. Soybean biodiesel requires more energy to make than it produces.
 - B. Soybean biodiesel releases less greenhouse gas pollution than diesel fuel.
 - C. Growing soybeans for biodiesel adds needed nitrogen into the environment.
 - D. Growing soybeans for biodiesel increases the amount of pesticides in the environment.
20. During heavy rains, water runoff from crop fields can contaminate nearby lakes or rivers with fertilizers, leading to eutrophication. Which fuel source has the greatest potential to cause eutrophication?
- A. diesel
 - B. gasoline
 - C. corn ethanol
 - D. soybean biodiesel

21. The following question(s) are based on the passage and diagrams below.

A resource is anything found in nature that can be collected and turned into a useful product. Some resources, called *renewable resources*, can be reused or replaced by nature relatively quickly. Other resources, called *nonrenewable resources*, occur in limited amounts and are used faster than nature can replace them. Whether a resource is renewable or nonrenewable affects the way we manage the resource.

Students were provided the following cross-section of a natural setting which had been thoroughly explored by a mining company (see the figure below). The students were then asked to come up with some conclusions about the resources in the setting.



Fish are usually considered a renewable resource. However, the fish in the figure above might be considered a nonrenewable resource if the fish

- A. overpopulated the pond.
- B. were not harvested.
- C. were taken from the pond faster than they could reproduce.
- D. reproduced faster than they could be harvested.

22. A mining company decided that any iron deposit deeper than 400 meters would cost more to collect than the iron was worth. Which iron deposit(s) in the figure above is/are possible resources for the mining company?
- A. C only B. A and B only C. B and C only D. A, B, and C

23. Corn can be processed into ethanol that can be used as fuel for cars. Accordingly, corn could be considered a renewable replacement for which of the resources shown in the figure above?
- A. iron B. water C. oil D. uranium

24. Any light or color that your eye detects is made up of visible light waves. In the last two centuries, scientists have learned that there are many kinds of light waves that humans cannot see. As shown in the table below, different types of light waves differ in their *wavelength* and energy content. The sun emits many different types of light waves. Earth's atmosphere acts to filter the light waves emitted by the sun. The atmosphere blocks the majority of certain types of light waves. This is important because some light waves, like ultraviolet and x-rays, are potentially harmful to humans in large doses. The table below lists how close some types of light waves get to Earth's surface before they are blocked by the atmosphere.

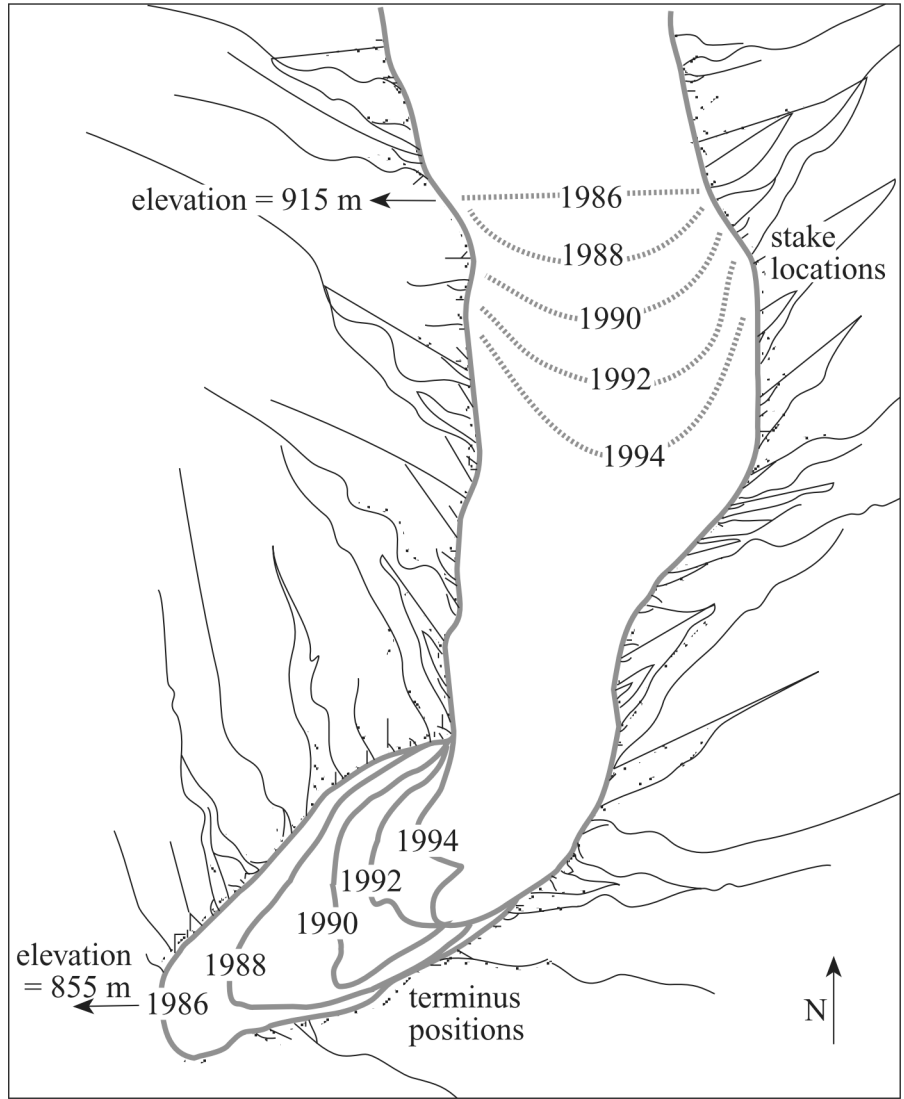
Type of light wave	Typical height blocked	Wavelength	Relative energy
X-rays	70 km	0.000000001	10,000,000
Ultraviolet	50 km	0.00000001	1,000,000
Visible	0 km	0.000001	10,000
Infrared	4 km	0.00001	1,000
Radio	0 km	0.01	1

Ozone is an atmospheric gas that blocks most of the ultraviolet light that reaches Earth. Many scientists believe that certain gases produced by human activity are destroying ozone. Which of the following events would be most likely to happen if this were true?

- A. Humans would be exposed to more potentially harmful rays.
- B. The sun would appear redder in the sky.
- C. Temperatures on Earth would decrease.
- D. The number of thunderstorms would increase.

Glaciers are large masses of ice that form in cold climates or at high elevations. Changes in climate can cause changes in the amount of glacial ice, causing glaciers to advance or retreat. Therefore, scientists study changes in glacial movement and position as an indication of climatic change.

A group of scientists studied the movement of a glacier occupying a mountain valley. The scientists drove a row of stakes into the surface of the glacier in 1986. They also noted the position of the glacier's *terminus* (the downhill edge of the glacier). Between 1986 and 1994, the scientists returned every two years to note the positions of the stakes and the terminus. The figure below is an aerial view of the glacier, showing the positions of the stakes (dotted lines with years) and the terminus (solid lines with years) during the course of the study.



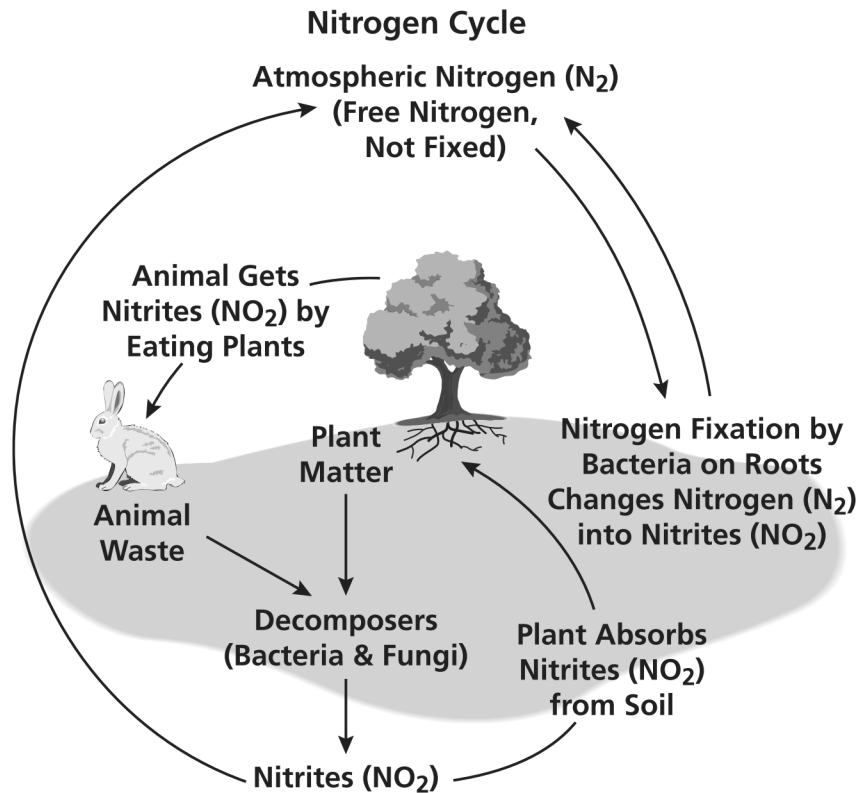
25. The speed of glacial movement is the distance a glacier moves during a given period of time. Which of the following units would be most appropriate for measuring the speed of glacial movement?

- A. meters per year B. seconds per meter C. liters per second D. millimeters \times years

26. Assume that the terminus of the glacier did not move during the study. Accordingly, you could hypothesize that glacial ice was

- A. melting faster than it was being formed. B. melting as fast as it was being formed.
C. melting more slowly than it was being formed. D. melting, but it was not being formed.

27. The following diagram shows the nitrogen cycle.

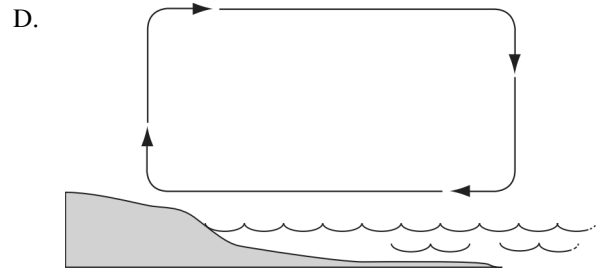
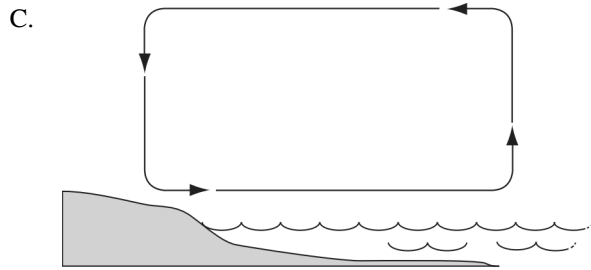
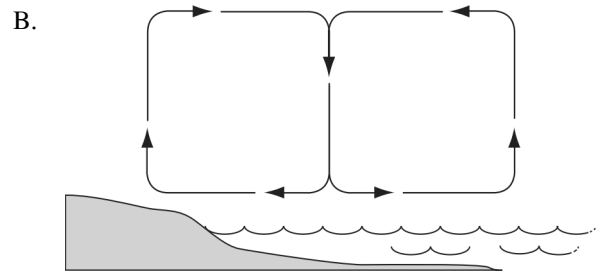
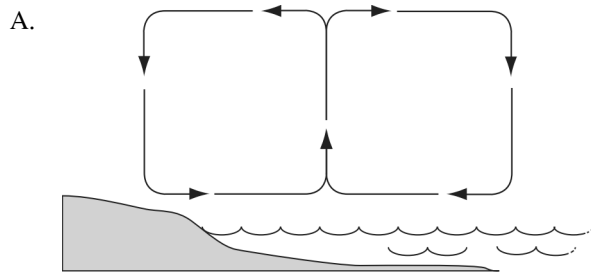


Animals need nitrite (NO_2) to make proteins. Nitrogen (N_2) is found in the air but is not in a form that animals can use. Through the nitrogen cycle, nitrogen from the atmosphere becomes nitrite.

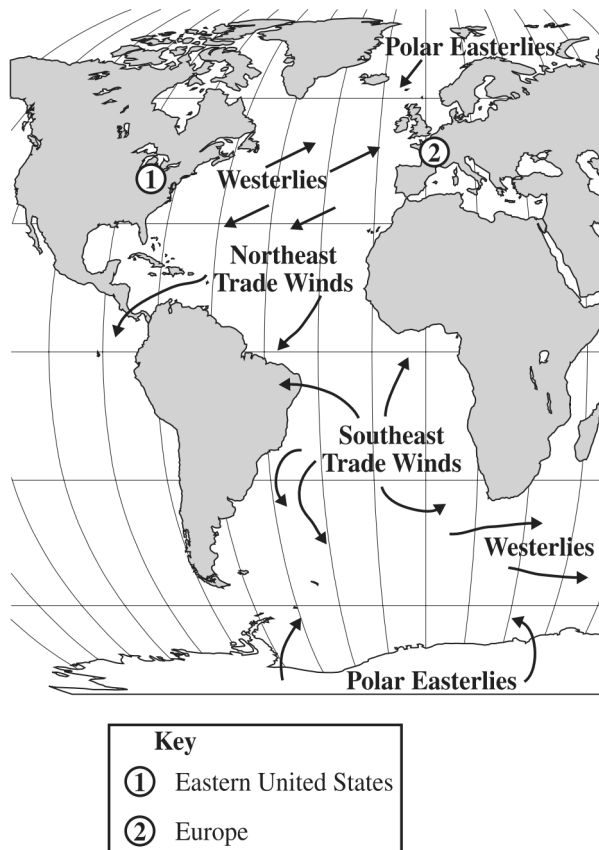
Which of these can be concluded about the importance of bacteria in the nitrogen cycle?

- A. Bacteria are important because they make nitrites that animals need.
- B. Bacteria are important because they change nitrogen into nitrites that animals need.
- C. Bacteria are important because they allow plant roots to absorb nitrites from the air.
- D. Bacteria are important because they decompose plant matter that compete with living plants for nitrites.

28. Which diagram *best* models the movement of coastal air during the afternoon?



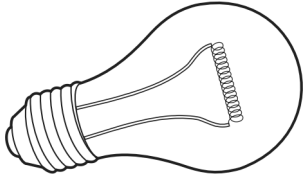
29. The diagram below illustrates the motion of prevailing winds over oceans on Earth.



If a sailboat sailed from the eastern United States to Europe and then back, which of the following winds would *most* directly power the sailboat?

- A. Polar Easterlies going and Westerlies returning
- B. Northeast Trade Winds going and Westerlies returning
- C. Westerlies going and Northeast Trade Winds returning
- D. Southeast Trade Winds going and Northeast Trade Winds returning

30. An incandescent light bulb is shown below.



A typical incandescent light bulb has an energy efficiency of about ten percent. What is the meaning of this statement?

- A. Ten percent of the bulb's light energy becomes heat energy.
- B. Ten percent of the energy used by the bulb becomes light energy.
- C. The bulb uses ten percent less electrical energy than other bulbs.
- D. The bulb will save ten percent on electrical energy costs per year.

1.
Answer: A
2.
Answer: A
3.
Answer: C
4.
Answer: B
5.
Answer: B
6.
Answer: D

7.
Answer: – When global average temperatures rise, snow and ice melt, especially in Greenland and the Antarctic. Glacial melting sends new water into the oceans and causes sea levels to rise even further. Unfortunately, melting snow and ice also exposes more dark land, which absorbs heat and causes even more snow and ice to melt, making the warming and melting trend worse, and causing sea levels to rise even more.
- Rising sea levels are very challenging for coastal ecosystems and communities. Some coastal ecosystems or human communities may actually be completely drowned under the new, higher ocean. This is already happening to the Maldives Islands, for example. It is also happening to parts of the coast of Louisiana. Even when land is not actually underwater, there can be many problems caused by rising sea levels. Tides and storm surges can increase the frequency and severity of flooding. Sea level rise made Hurricane Sandy more damaging to New York and New Jersey than it otherwise might have been. Salt water intrusion can cause land and groundwater to become salty, which harms or kills many plants. When plants are hurt by salt water, the animals that depend on them may also decline or die out. Also, sources of drinking water can be contaminated. For example, in St. Tammany Parish, wells were contaminated by salt water after Hurricane Katrina.
- There are many ways humans can reduce damage from rising sea levels. In Louisiana, restoring coastal marshlands helps to reduce salt water intrusion and storm surges. Other areas may benefit from building seawalls to prevent flooding. Finally, humans should work to reduce their carbon dioxide emissions so that global warming is reduced, which would help prevent additional sea level rise.

8.
Answer: B
9.
Answer: C
10.
Answer: B

11.
Answer: C

12.
Answer: C

13.
Answer: D

14.
Answer: A

15.
Answer: A

16.
Answer: D

17.
Answer: B

18.
Answer: D

19.
Answer: B

20.
Answer: C

21.
Answer:

22.
Answer:

23.
Answer:

24.
Answer: A

25.
Answer: A

26.
Answer: B

27.
Answer: B

28.
Answer: D

29.
Answer: C

30.
Answer: B