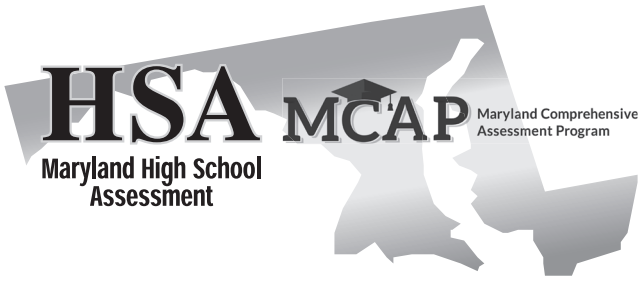


MISA

Maryland Integrated Science Assessment

2018 Released Items

measured progress

Developed and published under contract with the Maryland State Department of Education by Measured Progress.

Read the information. Use the information to answer the questions.

Earthquake Waves

Many students in Maryland felt an earthquake that occurred 1.2 kilometers (km) underground in Virginia. They wondered about the effects of this and other earthquakes around the world.

The students researched earthquake effects. They learned that tension and stress along Earth's crustal plates deep underground sometimes releases suddenly, causing several types of waves to travel through the Earth.

- P-waves travel through both solids and liquids with the greatest speeds.
- S-waves travel only through solids at medium speeds.
- Surface (Love and Rayleigh) waves travel only across the surface of the crust and are the slowest waves.

The students learned that scientists observe earthquakes from seismograph stations located around the world. A seismograph is a tool used to measure seismic waves. The formula for the relationship between velocity (v), frequency (f), and wavelength (λ) is $v = f\lambda$. This formula allows scientists to calculate distances to the epicenter (point of origin) of the earthquake through various crust materials. The students found this table that shows the typical velocity of P-waves traveling through different crust materials.

Typical P-wave Velocities

Crust Material	Approximate Density (kg/m^3)	Approximate Velocity (m/s)
Water	1,000	1,500
Loose sand	1,100	1,500
Dense soil	2,100	2,500
Soft rock	2,600	4,200
Hard rock	3,300	8,500

Locating Earthquakes

The students researched how scientists use wave data to locate earthquake epicenters (points of origin). The students learned that the arrival time of the P-waves and S-waves allows scientists to calculate the time of the earthquake and its distance from the seismograph.

The students found data from three seismograph stations for a 1994 earthquake in California that occurred 4.2 km underground. The students organized the data in this table.

P-wave and S-wave Arrival Times in California

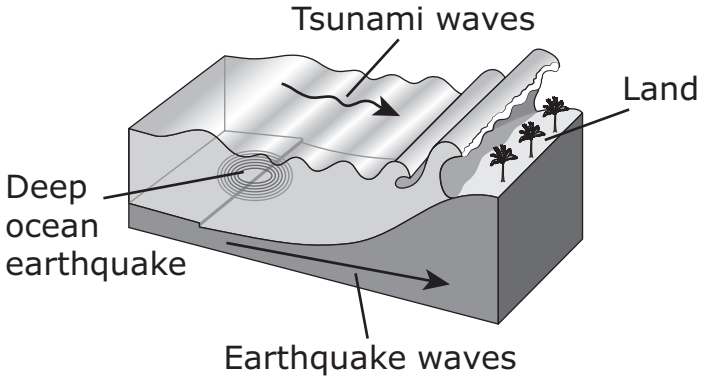
Station	Distance from Earthquake (km)	P-wave Arrival (s)	S-wave Arrival (s)
1	7.8	52	53.5
2	86.0	66	79.0
3	170.0	77	98.0

Effects on Ocean and Land

The students did further research on the effects of earthquakes on other Earth systems. They found that waves created by earthquakes on the ocean floor travel through the ocean floor crust and the ocean water. The waves traveling through the water can cause a seismic sea wave, or tsunami. These powerful waves greatly increase in height as they come ashore. This diagram shows how an earthquake deep under the ocean may cause a tsunami that impacts land.

Tsunami Caused by Earthquake

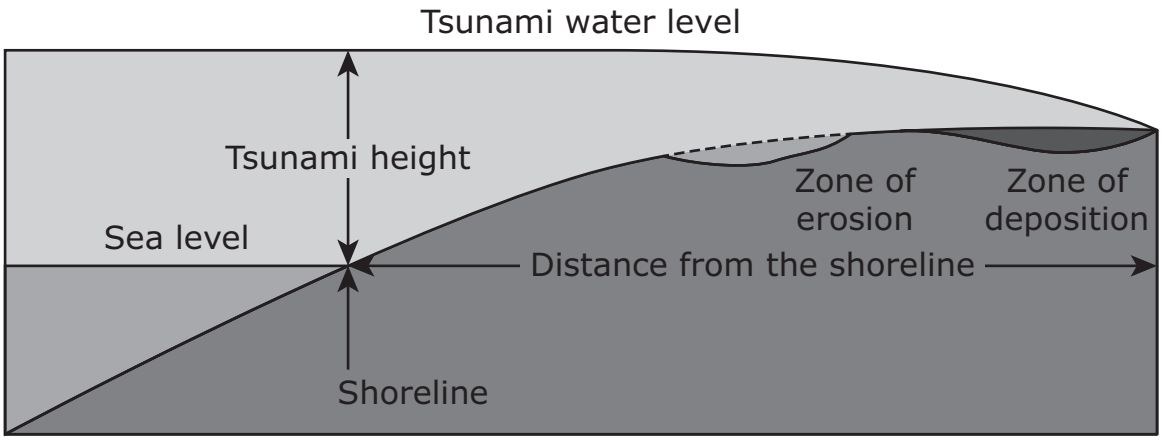
Tsunamis travel more slowly through water than earthquake waves travel through solid crust material



P and S waves in the crust allow forecasting of when a tsunami may arrive

The students found this diagram that shows the water level, coastal erosion, and deposition on the coast of Sri Lanka from a 2004 tsunami caused by an undersea earthquake near Indonesia, 3500 kilometers away.

Coastline Diagram



GO ON

1 What is the approximate frequency of a P-wave traveling at average velocity through soft rock with a wavelength of 2 m?

A 2,100 waves per second

B 2,600 waves per second

C 6,800 waves per second

D 8,400 waves per second

2

Part A

Match each cause to an effect. Not all effects will be used.

Cause	Effect
Media density increases	*f* increases
Wave *v* decreases	λ increases
	f decreases
	λ decreases

Part B

Select the terms that best explain the causes and effects.

Because -Select an Answer- is constant for a P-wave, -Select an Answer- changes in direct proportion to -Select an Answer- .

Because [*f* ,λ] is constant for a P-wave, [v, density] changes in direct proportion to [*f* ,λ].

3 Which description represents a relationship between the frequency, velocity, and wavelength of the P-waves and S-waves observed during the 1994 California earthquake?

A The frequency of the P-wave was greater than the S-wave because the velocity of the P-wave was greater and the wavelength of the P-wave was less.

B The wavelength of the P-wave was greater than the S-wave because the velocity of the P-wave was greater and the frequency of the two waves was the same.

C The velocity of the P-wave was greater than the S-wave because the product of the P-wave frequency and wavelength was greater.

D The velocity of the P-wave was the same as the S-wave because the difference in the frequency and wavelength of both waves increased by the same proportion over distance.

4 Based on the P-wave and S-wave arrival times for the 1994 California earthquake, which station had the most dense crust material located between it and the earthquake epicenter, and what effect did this have on the wavelength recorded at this station compared to the waves recorded at the other two stations?

A Station 1; the wavelength was shortest

B Station 1; the wavelength was longest

C Station 2; the wavelength was shortest

D Station 3; the wavelength was longest

5 Which information illustrates the most direct feedback to the geosphere from an undersea earthquake? Select all that apply.

A Earthquake waves traveled faster through the ocean floor than through seawater.

B Tsunami waves traveled for thousands of kilometers through the ocean.

C Material was removed from the coastal erosion zone.

D Sand was deposited further inland from the shore.

E The water level during the tsunami event was higher than the land elevation.

F The landscape of the coastline changed shape.

6
CR

Using the information provided, describe the sequence of destabilizing effects caused by an undersea earthquake that produces resulting changes to Earth's crust. Include data to support your reasoning.

Write your answer in your Answer Sheet.

Read the information. Use the information to answer the questions.

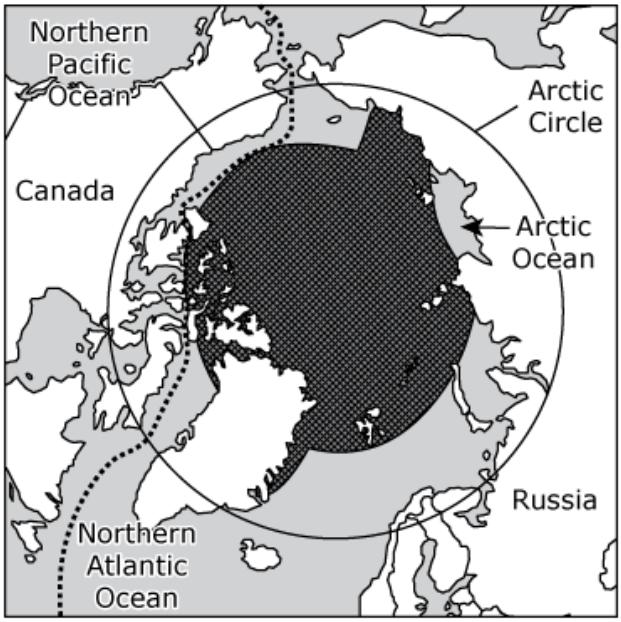
The Northwest Passage

The Northwest Passage is a sea route that connects the northern Atlantic Ocean to the northern Pacific Ocean through the Arctic Circle. In the past, the Northwest Passage was covered year-round by sea ice (frozen ocean water) and was impassable to ships. Due to sea ice melting, ships can now travel through the passage during the summer months.

The Arctic has warmed twice as fast as the rest of the world. Satellite records since 1979 show that Arctic sea ice is disappearing at a rate of 13.4% per decade. Since 1981, the area of ocean covered by sea ice has decreased by 1.02 million square kilometers.

The two maps show the location of part of the Northwest Passage and also show the sea ice boundaries in 1970 and the predicted sea ice boundary for 2100.

Northwest Passage Map
1970



GO ON

Northwest Passage Map (Predicted)
2100

Sea ice is a reflective surface. As the Sun's rays hit Earth, a certain percentage of the energy is reflected back into space. The table shows the percentage of energy reflected by different surfaces.

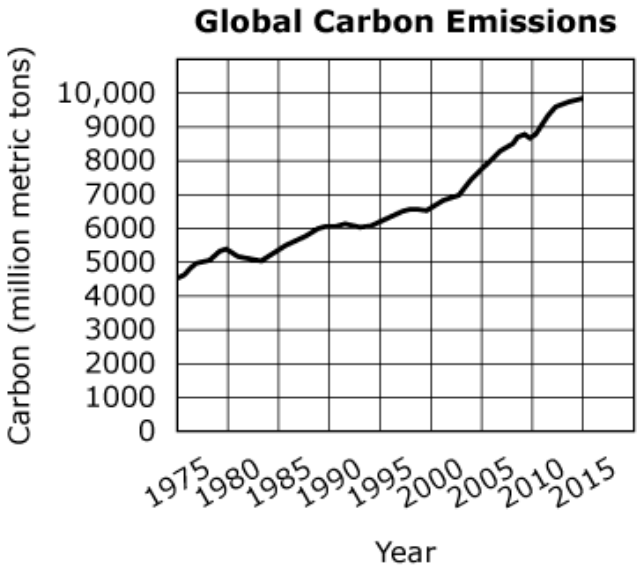
Reflectivity

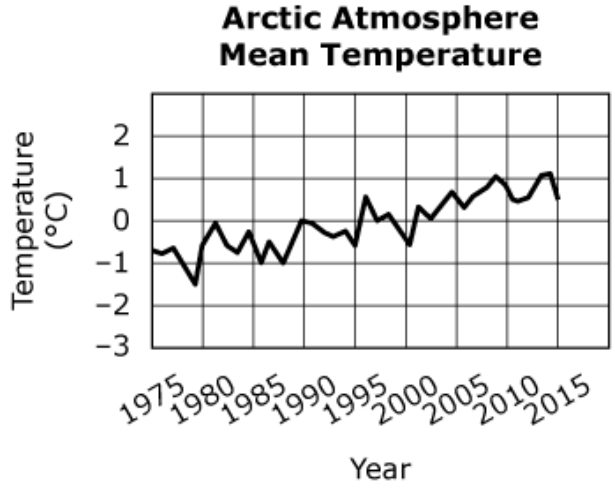
Surface	Solar Energy Reflected (%)
Desert	30
Forest	8–15
Ocean water	6
Sea ice	50–70
Average for Earth	31

GO ON

Atmosphere Observations

Scientists studied changes to the atmosphere in order to understand the changes to the Northwest Passage. Since the start of the industrial era, the atmospheric concentrations of greenhouse gases have been rising. In the United States, the burning of fossil fuels for industry, electricity production, and transportation account for 77% of greenhouse gas emissions. Approximately 82% of the greenhouse gases are carbon dioxide. Global carbon emissions and Arctic atmosphere temperature data are shown in the graphs.

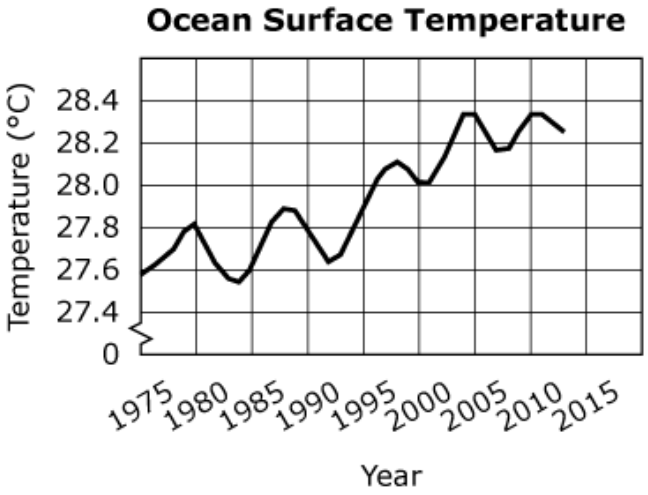




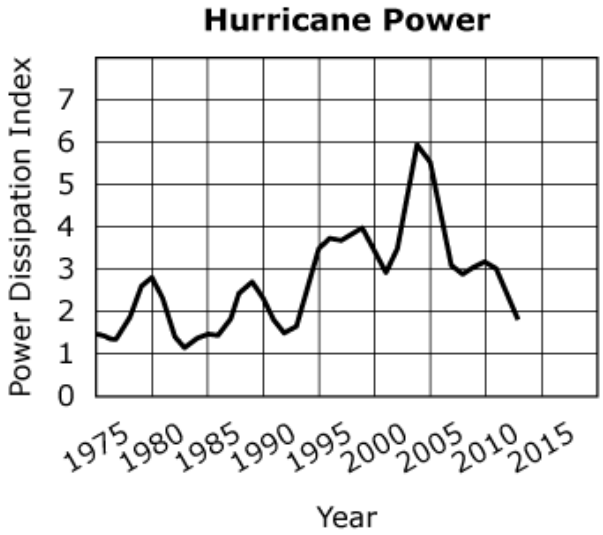
GO ON

Environmental Changes

Sea ice melt from the Arctic may impact the environment in other parts of the world. Scientists collect data from other areas to determine if there are relationships between sea ice melting and environmental changes throughout the world. They collected data on the changes in water surface temperature in the North Atlantic Ocean. This graph shows the data they collected.

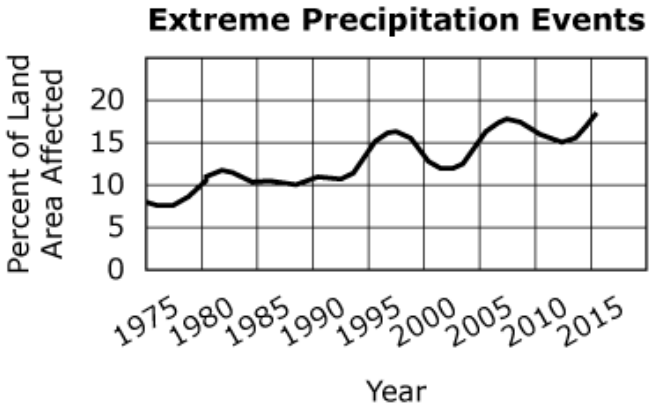


Additional data was collected on the Power Dissipation Index for hurricanes in the North Atlantic. The Power Dissipation Index is higher for more powerful hurricanes. This graph shows changes in hurricane power.



GO ON

Data was also collected on the percent of land area affected by one-day extreme precipitation events for the United States. An extreme one-day precipitation event is when the rain or snowfall in a single day exceeds the normal amount. The graph shows the data collected.



GO ON

7 Scientists claim that one reason Earth is warming is because it is absorbing more radiation from the Sun.

Which data **best** support this claim?

A By 2100, only 50% of the solar energy will be reflected from the sea ice.

B As the sea ice melts, it reflects about 10 times less of the solar energy.

C The Arctic Circle includes a large section of land, which reflects 31% of the solar energy.

D The desert and Earth reflect approximately the same amount of the solar energy.

8 Which of these long-term changes to the sea ice in the Arctic Circle is **best** supported by the Northwest Passage Maps and Reflectivity table?

A The sea ice area will decrease when the solar energy is absorbed over a wider area.

B The sea ice area will increase more quickly as solar radiation is reflected away from the area.

C The sea ice area will increase and extend farther into the Northern Atlantic Ocean as solar energy is reflected.

D The sea ice area will decrease more quickly as solar radiation is absorbed by open water.

9 Which statement **best** describes whether the impact of humans on the predicted sea ice melt is reversible or irreversible?

A All impacts are irreversible; temperatures will continue to rise and severe weather events will continue.

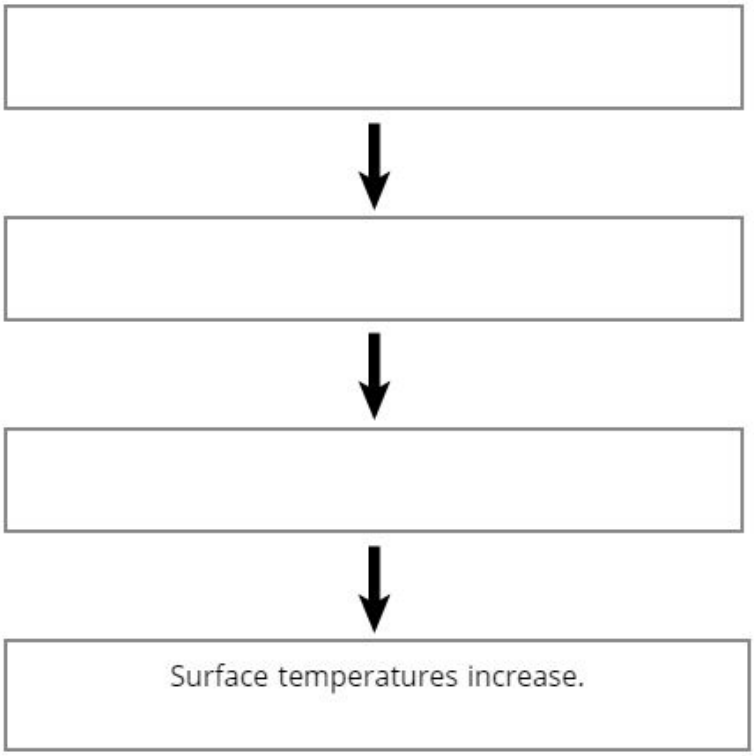
B Some impacts are irreversible; carbon emissions will continue to increase, but hurricane power may decrease.

C All impacts are reversible; climates fluctuate naturally and over time Earth's systems will be restored to their usual conditions.

D Some impacts may be reversible; if carbon emissions are reduced, temperatures may decrease and some Arctic sea ice could be restored.

10

Put the processes into the correct order to show the feedback effects from an increase in greenhouse gas emissions resulting in an increase in surface temperatures.



Ice melts.

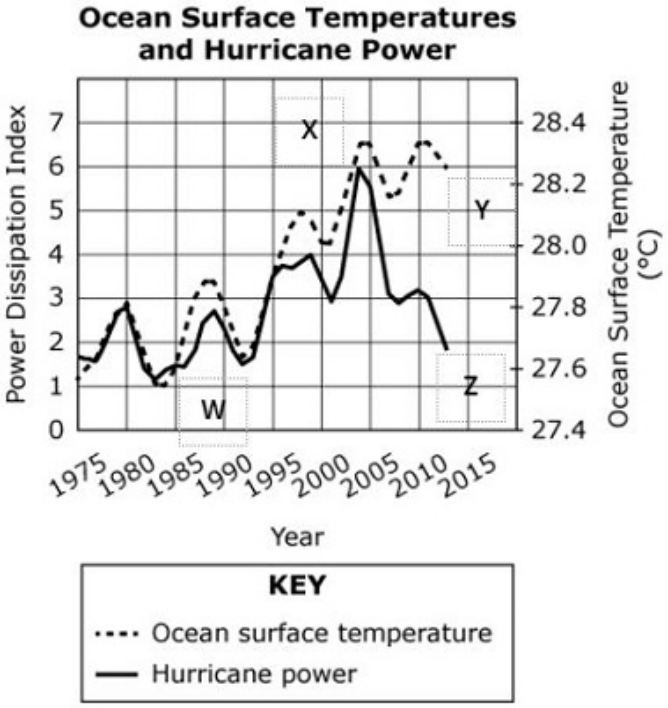
Atmospheric temperatures increase.

Less sunlight is reflected from the surface.

GO ON

11

A scientist merged two graphs to compare ocean surface temperatures with hurricane power. The scientist claimed that an increase in ocean surface temperatures causes more powerful hurricanes to occur. Select the location(s) on the graph that support the scientist's claim.



GO ON

12
CR

Use the data and models to predict the future effect of global carbon emissions on Earth's systems.

Write your answer in your Answer Sheet.

STOP

2018 Released Items ANSWER KEY
MISA

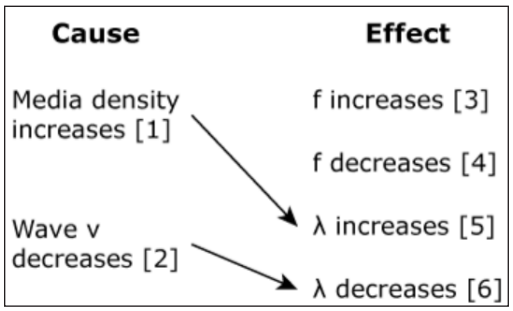
Item Number	Key	Evidence Statements
1	A	**HS-PS4-1/3.a** Using the mathematical relationship v=fλ, students assess claims about any of the three quantities when the other two quantities are known for waves travelling in various specified media.
2	TEI*	**HS-PS4-1/2.c** Students predict the relative change in the wavelength of a wave when it moves from one medium to another (thus different wave speeds using the mathematical relationship v=fλ). Students express the relative change in terms of cause (different media) and effect (different wavelengths but same frequency).
3	C	**HS-PS4-1/2.a** Students show that the product of the frequency and the wavelength of a particular type of wave in a given medium is constant, and identify this relationship as the wave speed according to the mathematical relationship v=fλ.
4	D	**HS-PS4-1/2.c** Students predict the relative change in the wavelength of a wave when it moves from one medium to another (thus different wave speeds using the mathematical relationship v=fλ). Students express the relative change in terms of cause (different media) and effect (different wavelengths but same frequency).
5	C, D, F	**HS-ESS2-2/2.a.ii** Students use tools, technologies, and/or models to analyze the data and identify and describe relationships in the datasets, including: possible feedbacks, including one example of feedback to the climate.
6	CR-2	**HS-ESS2-2/3.a** Students use the analyzed data to describe a mechanism for the feedbacks between two of Earth's systems and whether the feedback is positive or negative, increasing (destabilizing) or decreasing (stabilizing) the original changes.
7	B	**HS-ESS2-2/1.b** Students describe what each data set represents.
8	D	**HS-ESS2-2/2.a.i** Students use tools, technologies, and/or models to analyze the data and identify and describe relationships in the datasets, including: the relationships between the changes in one system and changes in another (or within the same) Earth system.
9	D	**HS-ESS3-5/3.c** Students describe whether the predicted effect on the system is reversible or irreversible.
10	TEI*	**HS-ESS2-2/2.a.ii** Students use tools, technologies, and/or models to analyze the data and identify and describe relationships in the datasets, including: possible feedbacks, including one example of feedback to the climate.
11	TEI*	**HS-ESS3-5/2.a.ii** Students analyze the data and identify and describe relationships within the datasets, including: relationships between quantities in the given data.
12	CR-4	**HS-ESS3-5/3.b** Students use their analysis of the data to predict the future effect of a selected aspect of climate change on the physical parameters (e.g., temperature, precipitation, sea level) or chemical composition (e.g., ocean pH) of the atmosphere, geosphere, hydrosphere, or cryosphere.

☐ = Written response.

* Technology Enhanced Item – Correct responses shown on the following pages.

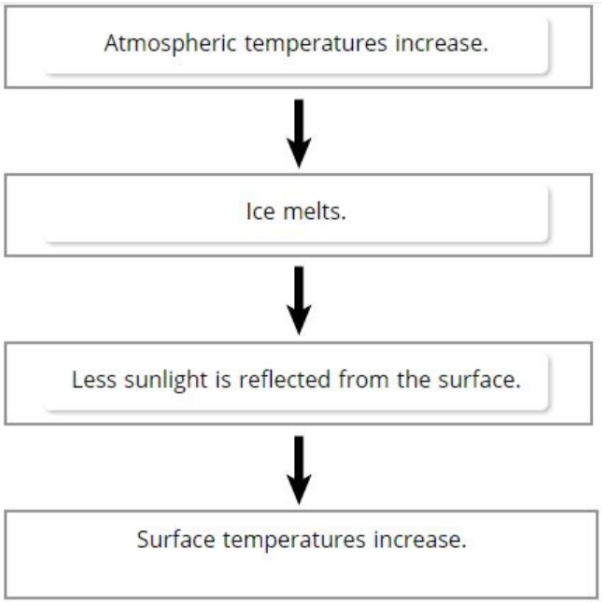
Item 2. TEI correct response:

Part A



Part B
(Responses in bold are the correct selections.)
Because [**f**, λ] is constant for a P-wave, [**v**, density] changes in direct proportion to [f, λ].

Item 10. TEI correct response:



Item 11. TEI correct response:

A scientist merged two graphs to compare ocean surface temperatures with hurricane power. The scientist claimed that an increase in ocean surface temperatures causes more powerful hurricanes to occur. Select the location(s) on the graph that support the scientist's claim.