

Multiple Choice.

1. Heinrich Events
 - a. Show increased abundance of warm-water species of planktic foraminifera
 - b. Show greater intensity since the last deglaciation
 - c. Show increased accumulation of ice-rafted debris in North Atlantic marine sediments
 - d. Occur at a climate shift: at the end of a gradual cooling trend and the beginning of an abrupt warming
 - e. Both C and D

2. If an armada of icebergs were released in the North Atlantic, how might this affect ocean circulation?
 - a. The release of the ice rafted debris would clog up the formation of North Atlantic deep water.
 - b. The fresh water from the iceberg melt could reduce the density of North Atlantic Water and prevent North Atlantic Deep Water formation.
 - c. The icebergs would increase the salinity of the North Atlantic and cause more North Atlantic Deep Water to form.
 - d. Both A and B are correct.
 - e. None of the above is correct.

3. What was the source area for the millennial ice-rafted debris events that are recorded in the North Atlantic?
 - a. Limestone debris was derived from the Hudson Bay of Canada.
 - b. Volcanic debris was derived from Iceland.
 - c. Iron-stained debris was derived from northern Greenland, eastern Canada, and Europe.
 - d. All of the above are correct.
 - e. Both A and B are correct.

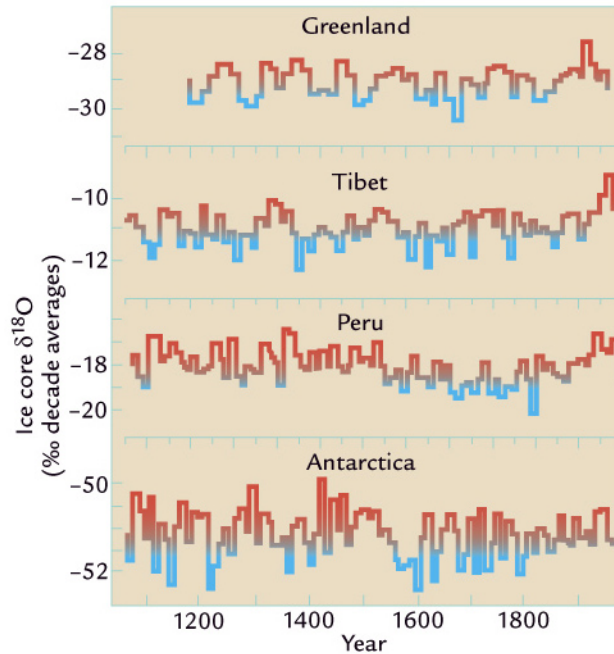
4. Why is correlation of millennial events so challenging?
 - a. Correlations can only be made between geologic archives of the same type.
 - b. Dating uncertainties can be comparable in size to the length of the oscillation itself.
 - c. Unless the oscillation was observed by humans, correlations are not able to be made.
 - d. All of the above are correct.
 - e. None of the above is correct.

5. What could cause the marine margin of an ice sheet to surge?
 - a. Sea level rise could float the ice sheet off a bedrock pinning point.
 - b. A thickening of the ice sheet could result in the base of the ice sheet crossing the pressure-melting threshold, which could trigger basal sliding.
 - c. The slow natural release of small amounts of heat from Earth's interior could melt lower ice layers along the ice margin, which would provide melt water for basal sliding.
 - d. All of the above are correct.
 - e. Both B and C are correct.

6. What has been the most effective erosive agent in the climate system?
 - a. Water
 - b. Ice
 - c. Wind

- d. Submarine landslides
 - e. Humans and cattle
7. The first evidence of agriculture
- a. Dates to 120,000 years ago
 - b. Coincided with a period of deglaciation.
 - c. Indicates *homo erectus* was the first of the human ancestors to cultivate crops
 - d. All of the above
 - e. Both B and C
8. The Medieval Warm Period
- a. Had a duration of 1000 years
 - b. Occurred after the Little Ice Age
 - c. Was marked by less sea around the Icelandic and Greenland coasts
 - d. Ended abruptly
 - e. All of the above
9. The Little Ice Age
- a. Was global in extent
 - b. Occurred from about A.D. 1400 to 1900
 - c. Was marked by the growth and advance of continental ice sheets in Europe
 - d. All of the above
 - e. Both B and C
10. How do lichen serve as a climate proxy?
- a. Lichen grow at predictable rates.
 - b. Extreme cold kills lichen
 - c. The distribution of lichen halos (dead lichen) indicate where snowfields existed in the past.
 - d. All of the above are correct.
 - e. Both A and C are correct.
11. Dendrochronology studies
- a. Require that scientists cut trees down, examining the ring structures in the stumps of the trees
 - b. Involve the comparison of tree ring width and density to local records of instrumental rainfall and temperature
 - c. Are only effective for reconstructing climate changes occurring over the last few decades
 - d. All of the above
 - e. Both A and B
12. Rising CO₂ levels
- a. Promote greater photosynthesis and thus tree growth
 - b. Could complicate tree ring interpretations
 - c. Would produce the same effect on the tree ring pattern as would a trend toward wetter climates in dry regions
 - d. All of the above
 - e. B and C only

13. Examine the ice core data in the following figure to determine which of the following statements is true.



- The average $\delta^{18}\text{O}$ concentration in Greenland is more positive during the last 50 years than at any other time in the record.
- The average $\delta^{18}\text{O}$ concentration in Tibet is more positive during the last 50 years than at any other time in the record.
- The average $\delta^{18}\text{O}$ concentration in Antarctica is more positive during the last 50 years than at any other time in the record.
- All of the above are correct.
- Both A and B are correct.

14. During an El Niño event

- The tropical eastern equatorial Pacific becomes cooler.
- The winds blowing from east to west over the Pacific weaken.
- The winds blowing from east to west over the Pacific strengthen.
- Drought occurs along coastal South America in Peru and Ecuador.

15. Which types of historical records reflect aspects of climate change?

- Crop reports
- Records of river freeze-up
- Ships' logs of fish catches
- All of the above
- Both A and B

16. Orbital forcing can explain

- About $\frac{1}{2}$ of the cooling between A.D. 1000 and 1800 in the high northern latitudes
- All of the cooling between A.D. 1000 and 1800 in the high northern latitudes
- None of the cooling between A.D. 1000 and 1800 in the high northern latitudes
- All of the warming in the last century

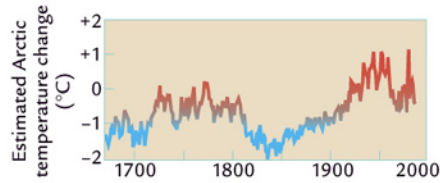
e. Both A and D

17. How could a tide gauge record indicate sea level fall if global sea level is actually rising?
- a. The tide gauge is located in an area where bedrock is rebounding after ice unloading
 - b. The tide gauge is located in an area of active tectonic uplift
 - c. All of the above
 - d. None of the above

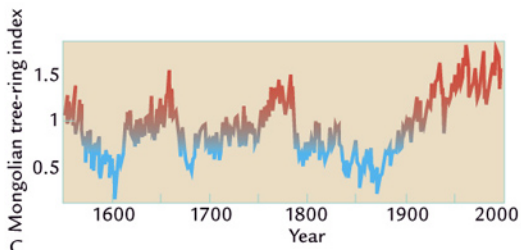
18. Examine the following figures which show integrated signals for temperature change based on tree ring analyses in the circum-Arctic and in Central Asia to determine which of the following statements is correct.



A



B



C



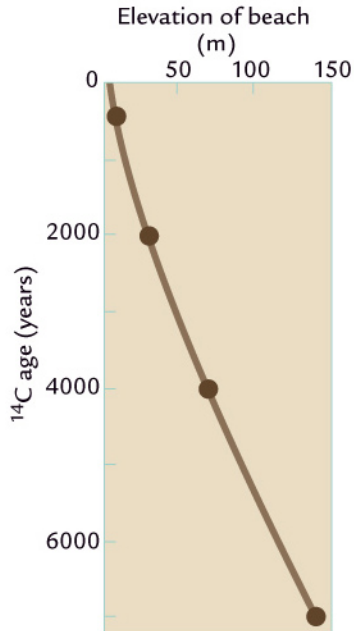
D

- a. The Arctic sustained cool temperatures during the Little Ice Age.
- b. Central Asia sustained cool temperatures during the Little Ice Age.
- c. The climate trends of the circum-Arctic and Central Asia show a similar pattern over the last 320-years.
- d. All of the above are correct.
- e. None of the above is correct.

19. What accounts for the sea level rise of the twentieth century?

- a. Melting of sea ice
- b. Melting of land-based ice
- c. Thermal expansion of sea water
- d. Both A and B
- e. Both B and C

20. Examine the following figure showing data from the Hudson Bay region and determine which of the following statements is correct.



B

- a. Land that was once beneath the ice sheet has been rising for thousands of years.
- b. The rate of beach elevation change is decreasing rapidly.
- c. The beach elevation change results from a sea level drop.
- d. All of the above are correct.

21. Studies of mountain glaciers indicate

- a. About ½ of the studied mountain glaciers are melting
- b. The observed mountain glaciers retreat is largely a result of reduced precipitation
- c. The average retreat of mountain glaciers is 1.5 m since the 1800s
- d. All tropical glaciers are in retreat or have completely melted
- e. All of the above

22. Arctic summer sea ice

- a. Has decreased in area by 25% since the 1970s
- b. Is retreating faster today than in the early twentieth century
- c. Is seasonally at its minimum in July
- d. All of the above
- e. Both A and B

23. Which of the following is evidence for warming of the high northern latitudes?

- a. The last winter snow melting a week earlier in the northern hemisphere
- b. Chlorophyll production beginning two weeks earlier in Alaska

- c. The growing season beginning a week earlier in the northern hemisphere
- d. All of the above
- e. A and C only

24. How do explosive volcanic eruptions affect climate?

- a. They generally result in a cooling.
- b. They affect climate for up to 1000 years after an eruption.
- c. It depends on the latitude of the eruption.
- d. All of the above are correct.
- e. Both A and C are correct.

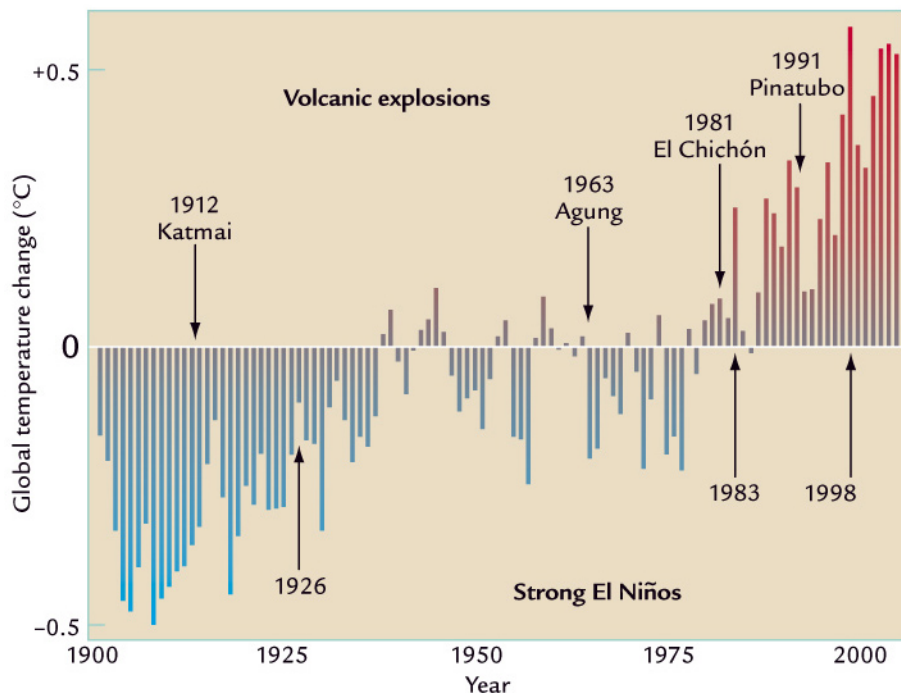
25. What percent of the 0.7°C global warming since the late 1800s can be attributed to long-term tectonic-scale climatic forcing?

- a. 50%
- b. 25%
- c. 5%
- d. 1%
- e. Effectively none

26. The recent 0.7°C global warming is

- a. Consistent with insolation changes due to orbital forcings of tilt and precession
- b. Consistent with eccentricity as a dominant forcing, although the mechanics are poorly understood
- c. 10 times faster than the rate that should result from orbital forcing
- d. In the opposite direction of orbital forcing
- e. All but D

27. Examine the following figure and determine which of the following statements is correct.

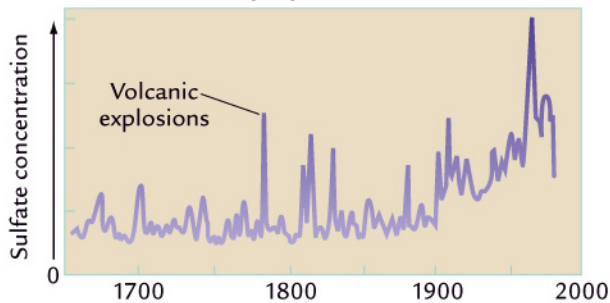


- a. The effect of large volcanic explosions is not detected by instrumental temperature records.
- b. The effect of large volcanic explosions contributed to the long-term baseline-warming trend.
- c. Large volcanic explosions caused short-term cool, but had no effect on the long-term warming trend.
- d. Strong El Niños contribute to the long-term baseline-warming trend.
- e. Both B and D are correct.

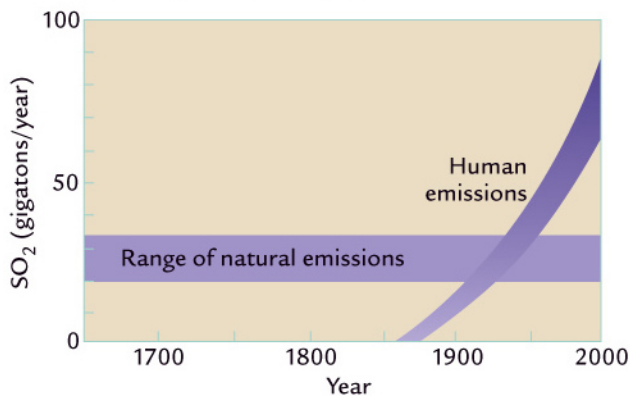
28. What is the modern level of CO₂ in the atmosphere?

- a. 640 ppm
- b. 560 ppm
- c. 380 ppm
- d. 280 ppm
- e. 140 ppm

29. Examine the following figure and determine which of the following statements is correct.



A Sulfate concentration in ice cores



B Estimated global SO₂ emissions

- a. An increase in sulfate concentration causes volcanoes to explode.
- b. There have been more volcanic explosions on average since 1900 than during the previous two centuries.
- c. Sulfate concentrations were lower in 1990 than in 1980.
- d. The baseline sulfate concentration increased because volcanic eruptions increased.
- e. Both B and D

30. Global dimming

- a. Is irreversible
- b. Is caused by rising CO₂ levels

- c. Will produce a solar eclipse
- d. Masks the effects of global warming
- e. Is more prominent in polar regions

31. Methane

- a. Occurs in higher abundances in the atmosphere than CO₂ does
- b. Is a more effective greenhouse gas than CO₂ on a molecule-by-molecule basis
- c. Rise for the last 150 years is equivalent to a CO₂ rise of 60%
- d. All of the above
- e. Both A and C