GEO 377P/387H Physical Climatology DIAGNOSTIC EXAM Name_____

You may not refer to any other materials during the exam. For each question (except otherwise explicitly stated), select the ***best*** answer for that question. Read all choices carefully before selecting an answer and make sure your choice answers the question asked.

1. The noteable "The Year Without a Summer" came after which volcanic eruption?
   A. Mt. St. Helen's
   B. Mt. Pinatubo
   C. Mt. Pompei
   D. Mt. Tambora
   E. Mt. El Chichon

2. Which of the following is **not** correct about global warming?
   a. Global warming is an increase in Earth's surface temperature brought about by a combination of human activities and natural forces.
   b. The most pervasive, and at the same time controversial, environmental change that is occurring today is global warming.
   c. The global warming issue is extremely complex, because it involves many different parts of the Earth system.
   d. The global warming issue is controversial because it is difficult to separate anthropogenic influences from natural ones and because its causes are deeply rooted in our global industrial infrastructure; hence, these causes would be difficult to eliminate.
   e. Global warming is caused by ozone depletion.

3. Which of the following is **not** correct about the ozone hole?
   a. The past twenty years or so, the size of the Antarctic ozone hole has increased to approximately as large as the area of North America.
   b. The year 1985 was a key one in stratospheric ozone research, because it marked the discovery of the ozone hole above Antarctica.
   c. Scientists are not certain that the ozone hole is caused by chlorine released from the breakdown of anthropogenic CFCs.
   d. So far, nothing as dramatic as the Antarctic ozone hole has been seen elsewhere.
   e. The Antarctic ozone hole is most striking during September and October which are springtime in the Southern Hemisphere.

4. Which of the following is correct about El Niño and/or La Niña?
   a. El Niño is a large-scale oceanic cooling of the eastern tropical Pacific Ocean.
   b. During El Niño, easterly trade winds strengthen.
   c. During La Niña, atmospheric pressure over the eastern tropic Pacific Ocean is weaker than its normal high.
   d. Both El Niño and La Niña are a phenomenon in the Pacific Ocean, so they do not influence weather and climate around the world.
   e. During La Niña, the thermocline in the eastern equatorial Pacific Ocean is shallower than average.

5. Which of the following is **not** true about hurricanes?
   a. Hurricanes derive their energy from the warm tropical water.
   b. Hurricanes derive their energy from the latent heat released as water condenses into clouds.
   c. Hurricanes cannot form within 5° of the equator because Coriolis force is not efficient to establish a vortex.
   d. Hurricanes intensify rapidly when they move over colder water or over a large landmass.
   e. Hurricanes tend to travel from the east to the west in the tropics.

6. Which of the following is **not** true about tropical deforestation?
   a. Tropical deforestation refers to clearing tropical forests and converting the land to other purposes, such as agriculture and grazing.
   b. Tropical deforestation can significantly decrease biodiversity.
   c. Tropical deforestation increases the buildup of atmospheric CO_2.
   d. Tropical deforestation changes the local and regional hydrological cycle.
   e. Tropical deforestation has no effect on surface albedo, so it does not change the amount of solar radiation absorbed at the surface.

7. Consider the study of past climate change and determine which of the following is (are) correct.
   a. The resolution of proxy records is generally greater in the recent past than for the distant geologic past.
   b. The types of proxy records available are generally more diverse in the recent past than they are for the distant geologic past.
   c. Climate proxies allow scientists to directly read the temperature of the past.
   d. Both A and B are correct.
   e. None of the above is correct.

8. Which of the following is **not** correct in describing the Earth's terrestrial biomes?
   a. Tundra typically forms where the ITCZ lies.
   b. For the most part, tropical rainforests are located in the areas of trade-wind convergence associated with the rising branches of the Hadley Cell.
   c. Boreal forests are most common in tropics.
   d. a and b only.
   e. a and c only.

9. By analyzing records taken from proxy sources, scientists can extend our understanding of climate far beyond the 140 year instrumental record. The proxy sources include
   a. science fiction, dreams, and video tapes
   b. historical documents, tree rings, corals, ice cores, and ocean sediments
   c. speleothems
   d. b and c only
   e. a and c only

10. Ice cores are valuable climatic archives because
   a. Annual darker and lighter layers are often resolvable, enabling age determination and correlation
   b. The ice contains geochemical proxies of atmospheric composition and temperature of the past
   c. The geographic distribution of coring sites ranges from the high mountains to both polar regions
   d. All of the above
   e. Both A and B

11. Which of the following statements is **not** true about glacial and interglacial periods?
   a. During the past half million years, ice sheets have peaked about every 100,000 years.
   b. Earth's climate tends to drift slowly into the peak of glacial periods which is rapidly terminated by sudden warming.
   c. During glacial periods, the level of the oceans dropped from their present levels by 100-130 meters.
   d. At the peak of glacial periods, the forest-covered areas increased in size and the tundra biome was smaller in area.
   e. During colder glacial periods, CO_2 levels were lower than during warmer interglacial periods.

12. Which of the following is **not** a greenhouse gas?
   A. Nitrous oxide (N_2O)
   B. Nitrogen dioxide (NO_2)
   C. Methane (CH_4)
   D. Ozone (O_3)
   E. Carbon dioxide (CO_2)

13. Which of the following is **not** true about the Milankovitch Cycles?
   a. They explain glacial and interglacial intervals during the current Icehouse climate period.
   b. One part of the cycle is the change in the tilt of the Earth about every 40,000 years.
   c. One part of the cycle is the change in the shape of Earth's orbit over time scales of 10,000 years.
   d. The cycles have been supported by the trends of atmospheric CO_2, CH_4, and temperature as recorded in the Antarctic ice core.
   e. One part of the cycle is the wobbling of the spin axis about every 20,000 years.

14. Erupting volcanoes can send tons of particles into the atmosphere, along with vast amounts of _____?
   a. Water vapor, carbon dioxide, and sulfur dioxide
   b. Oxygen, ozone, and CFCs
   c. Methane, CFCs, and sulfur dioxide
   d. Ozone, CFCs, and sulfur dioxide
   e. Carbon dioxide, CFCs, and sulfur dioxide

15. The water vapor-temperature rise feedback is a positive feedback because the initial _____ in temperature is _____ by *the addition of more water vapor*.
   a. decrease, unaltered
   b. increase, weakened
   c. decrease, reinforced
   d. increase, reinforced
   e. none of the above

16. Which of the following is true?
   a. when ocean water evaporates, oxygen 16 tends to be left behind
   b. oxygen 18 and oxygen 16 are found in roughly equal amounts in ocean water
   c. the nucleus of oxygen 18 contains two more neutrons than the nucleus of oxygen 16
   d. only oxygen 18 is found in the shells of marine organisms
   e. a lower ratio of oxygen 18 to oxygen 16 in the marine sediment record suggests a colder climate

17. Which of the following is in the correct sequence from long to short term effects on climate?
A. ENSO – mountain building – eccentricity – obliquity – precession – thermohaline circulation
B. mountain building – eccentricity – precession – obliquity – thermohaline circulation – ENSO
C. mountain building – thermohaline circulation – eccentricity – obliquity – precession – ENSO
D. mountain building – eccentricity – obliquity – precession – thermohaline circulation – ENSO
E. mountain building – obliquity – eccentricity – precession – thermohaline circulation – ENSO

18. Solstices are
A. The degree of departure from a perfectly circular orbit
B. The position farthest from the Sun (the "distance pass" position)
C. The tilt of Earth's axis
D. The shift of the positions of the equinoxes with respect to Earth's eccentric orbit
E. The longest or shortest days of the year

19. Which of the following is correct to describe the surface air temperature trend over the past century?
a. Warming greatest in the tropics in the winter
b. Warming greatest in the tropics in the summer
c. Warming greatest in the mid-to-high latitudes in the winter
d. Warming greatest in the mid-to-high latitudes in the summer
e. None of the above because the temperature change will be globally uniform

20. The observed global mean surface air temperature has increased by about 0.75°C since the late 19th century. This warming trend is consistent with
A. a decreasing trend in the Northern Hemisphere snow cover
B. a decreasing trend of global sea level
C. a decreasing trend of atmospheric carbon dioxide
D. all of the above
E. none of the above

21. Water vapor is:
a. a gas
b. a cloud droplet
c. a rain drop
d. a snowflake
e. an ice crystal

22. What factors into estimates of the future increase in carbon emissions?
a. Population change
b. Changes in quality of life
c. Efficiency changes in fossil fuel use
d. All of the above
e. Both A and C

23. What percent of the 0.75ºC 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

24. It appears that, as the number of sunspots increases, the sun's total energy output:
    a. increases slightly
    b. decreases slightly
    c. begins to alternately increase and decrease above average values
    d. does not change

25. What is the today's level of CO_2 in the atmosphere?
    a. 640 ppm
    b. 560 ppm
    c. 380 ppm
    d. 280 ppm
    e. 140 ppm

26. Which of the following is a negative feedback that is taken into account in GCM temperature sensitivity tests of a doubling of CO_2?
    a. Effect of water vapor
    b. Effect of CO_2
    c. Effect of snow and ice albedo
    d. Effect of thick, low clouds
    e. Both A and C

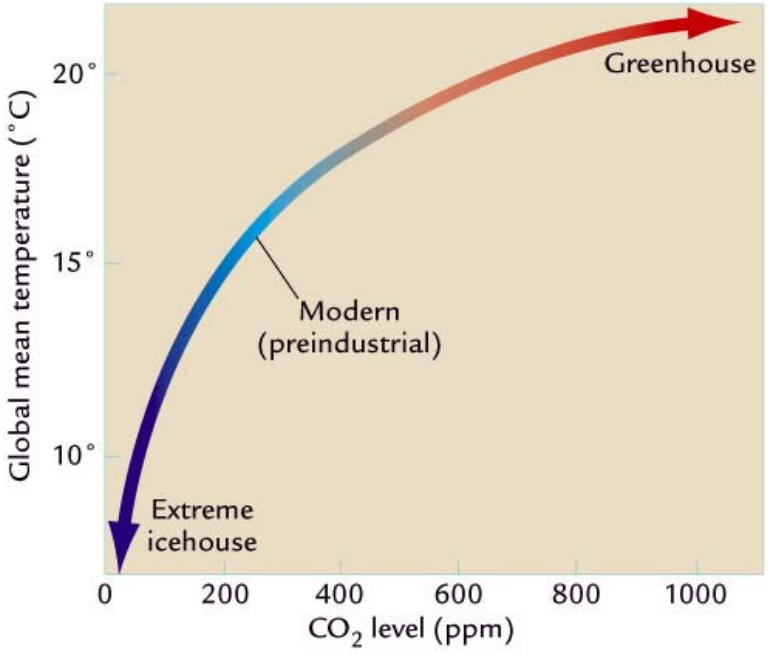
27. The temperature of the stratosphere rises with height because of the
    a. greenhouse effect of carbon dioxide
    b. absorption of incoming ultraviolet radiation
    c. radiant energy from surface of the earth
    d. greenhouse effect of water vapor
    e. the latent heat released as water condenses into clouds

28. If the earth's gravitational force were to increase, atmospheric pressure at the ground would:
    a. remain the same
    b. decrease
    c. increase
    d. cause the atmosphere to expand vertically
    e. be proportional to temperature.

29. Which of the following causes relative global sea level to rise?
    a. Slower rates of seafloor spreading
    b. Global cooling
    c. Ice sheet formation
    d. Thermal expansion of water molecules
    e. Both B and C

30. The gas that shows the most variation from place to place and from time to time in the lower atmosphere is:
    a. oxygen (O_2)
    b. carbon dioxide (CO_2)
    c. water vapor (H_2O)
    d. methane (CH_4)
    e. nitrogen (N_2)

31. What do the GCM sensitivity test results summarized in the following figure show?



a. Greater warmth for higher CO_2 concentrations
b. A linear (i.e. straight line) relationship between CO_2 and global mean temperature
c. That a doubling of pre-industrial CO_2 levels would increase global mean temperature by about 1ºC
d. All of the above
e. Both A and B

32. The greenhouse effect
    a. Keeps Earth's average temperature such that liquid water can exist at Earth's surface
    b. Describes the process by which incoming solar radiation is trapped in the atmosphere
    c. Is a synonym for global warming
    d. All of the above
    e. None of the above

33. The most abundant greenhouse gas in the earth's atmosphere:
    a. carbon dioxide (CO_2)
    b. nitrous oxide (N_2O)
    c. water vapor (H_2O)
    d. methane (CH_4)
    e. chlorofluorocarbons (CFCs)

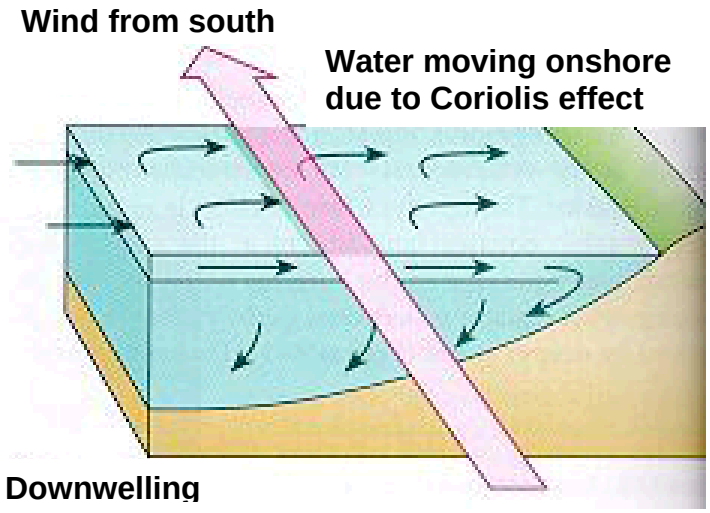
34. The Laurentide ice sheet was
    A. The boundary between the upper area of positive ice mass balance and the lower area of net loss of ice mass
    B. The ice sheet in northern Europe
    C. The deep frozen ground caused by the harsh winter cold and sparse snow cover
    D. The ice sheet centered on east-central Canada
    E. The ice sheet over the Rockies in the American West

35. The greenhouse gas that has been increasing in concentration, at least partly due to deforestation, is:
    a. carbon dioxide (CO_2)
    b. chlorofluorocarbons (CFCs)
    c. water vapor (H_2O)
    d. ozone (O_3)
    e. none of the above

36. What is the force that initially sets the air in motion?
    a. Coriolis force.
    b. Frictional force.
    c. Pressure gradient force.
    d. Earth's rotation.
    e. None of the above.

37. In the Earth's climate system, the term longwave radiation refers to
    a. The incoming solar radiation received by Earth
    b. The outgoing radiation emitted by Earth
    c. The albedo of Earth
    d. Solar radiation reflected by Earth's clouds
    e. Both A and D

38. The figure below refers to the relationship between wind and ocean currents occurring in
    A. Northern Hemisphere.
    B. Southern Hemisphere.



39. The PDO is
    A. A computer model that can be used to study climate change
    B. A low-pressure belt near the equator where air converges
    C. A phenomenon in the tropical Pacific Ocean that can impact climate worldwide
    D. Atmospheric pressure oscillations in the north Atlantic that influences climate in Europe and the United States
    E. A phenomenon in the north Pacific Ocean where atmospheric pressure oscillates on decadal time scales

40. Ekman is the family name of a scientist who
A. first observed a north-south giant convection cell in the tropics
B. discovered an east-west giant convection cell in the tropics
C. first calculated that the moving subsurface seawater is turned with depth, progressively farther to the right in the northern hemisphere
D. found orbital-scale oscillations in ice sheets
E. discovered the ozone hole

41. Why has Earth remained habitable throughout its history?
a. Because chemical weathering of continental rocks both responds to and modifies the level of CO_2 greenhouse gases in the atmosphere over geologic time scales
b. Because it is exactly the right distance from the Sun
c. Because Earth is balanced between warming and cooling as it rotates on its axis
d. Because the incoming radiation from the Sun has been constant over time
e. Both B and D

42. Which of the following would be an appropriate archive for reconstructing what the climate was like 50 Myr ago?
a. Ice cores
b. Instrumental records
c. Tree rings
d. Ocean sediments cores
e. All but C

43. The climate of the last 1 million years can be characterized as:
a. mostly warm and without ice sheets on Earth
b. mostly cold but with a strong warming trend
c. mostly warm but with very strong glacial periods
d. mostly cold with relatively short warm periods
e. similar to the climate 100 million years ago

44. The science of reconstructing past climates advances best when
a. Mismatched data from geologic archives and model outputs are disregarded or thrown out
b. Climate modelers distance themselves from field geologists
c. The strengths and limitations of both the data derived from geologic archives and the models are constantly tested against one another
d. All of the above
e. Both B and C

45. The gas law is
a. $p \propto T \times \rho$
b. $T \propto p \times \rho$
c. $\rho \propto T \times p$

46. Which of the following weather elements always decreases as we climb upward in the atmosphere? [Hint: Imagine you are climbing a mountain.]
    a. wind
    b. temperature
    c. pressure
    d. moisture
    e. all of the above

47. Which of the following is present in the ozone layer (or in the stratosphere)?
    a. oxygen
    b. nitrogen
    c. ozone
    d. all of the above
    e. none of the above

48. The word "weather" is defined as:
    a. the average of the weather elements
    b. the climate of a region
    c. the condition of the atmosphere at a particular time and place
    d. any type of falling precipitation
    e. the condition during chemical weathering

49. The wind direction is:
    a. the direction from which the wind is blowing
    b. the direction to which the wind is blowing
    c. always directly from high toward low pressure
    d. always directly from low toward high pressure
    e. the same as the pressure gradient force

50. Which of the following is **not** true in describing ocean sediments?
    a. Ocean sediments have the best resolution to describe how El Niño has evolved over tens of millions of years.
    b. Ocean sediments contain key indicators of past glaciations: ice-rafted debris, $\delta^{18}O$ records, and $\delta^{13}C$ records.
    c. Ocean sediments are available in the northern Atlantic Ocean only.
    d. All of the above.
    e. a and c only.

51. The hydrostatic equation describes the equilibrium between the
    a. friction force and gravity
    b. horizontal pressure gradient force and gravity
    c. Coriolis force and gravity
    d. vertical pressure gradient force and gravity
    e. horizontal pressure gradient force and gravity

52. Tree rings
   a. can reveal how methane varied over the last few tens, hundreds, or (in exceptional cases) thousands of years.
   b. are best developed in the tropics where it is pleasantly warm and wet.
   c. can tell us about a wide range of past climate conditions including rainbow, salinity, wind direction, and atmospheric pressure.
   d. are a good indicator of how fast the ocean-floor is spreading.
   e. are a useful proxy for rainfall and temperature in the past.

53. The _____ by humans is the largest source of emissions of carbon dioxide.
   a. breathing
   b. burning of fossil fuels
   c. lack of recycling
   d. burning of biofules
   e. planting of forests

54. Which of the following could be made into biodiesel?
   a. algae oil
   b. animal fat
   c. vegetable oil
   d. all of the above
   e. none of the above

55. How do CO_2 oscillations from ice cores compare with changes in ice volume, as recorded by $\delta^{18}O$ records in marine sediments?
   a. CO_2 is high when ice volume is high.
   b. CO_2 is low when ice volume is high.
   c. CO_2 lags ice volume by 41,000 years.
   d. CO_2 shows small changes at glacial to interglacial transitions.
   e. Both B and D are correct.

56. Which of the following carbon reservoirs *gained* carbon biomass during the last glacial maximum?
   a. The atmosphere
   b. The vegetation on land
   c. The soil
   d. The surface ocean
   e. The deep ocean

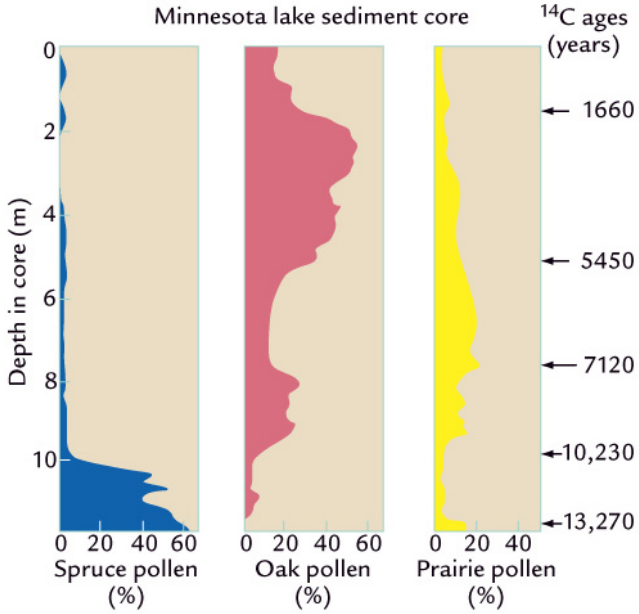
57. Which of the following factors helps explain the colder and drier glacial maximum climate compared to today?
   a. Lower insolation
   b. Lower greenhouse gas levels
   c. Large ice sheet feedbacks
   d. All of the above
   e. B and C only

58. The "force exerted on an object equals its mass times the acceleration produced" is a description of:
    a. Newton's second law of motion
    b. Buys-Ballot's law
    c. the isobaric law
    d. hydrostatic equilibrium

59. Which of the following forces does not have a direct effect on horizontal wind motions?
    a. pressure gradient force
    b. frictional force
    c. gravitational force
    d. Coriolis force
    e. none of the above

60. Clouds often form in the:
    a. rising air in the center of a low pressure area
    b. rising air in the center of a high pressure area
    c. sinking air in the center of a low pressure area
    d. sinking air in the center of a high pressure area
    e. none of the above

61. Examine the following figure and determine which of the following statements is a logical interpretation of the southeast Minnesota lake pollen record.



    a. Climate was warmest between ~12,000 and 10,000 years ago.
    b. Climate became drier at ~6000 years ago.
    c. Climate was the coolest between ~5000 and ~1000 years ago.
    d. There is more spruce than oak in southeast Minnesota today
    e. Both A and C are correct.

62. The Vostok ice core was extracted from
    a. Alaska
    b. Tibet
    c. Greenland
    d. Russia
    e. Antarctica

63. Suppose last night was clear and calm. Tonight low clouds will be present. Assuming everything else is the same, from this you would conclude that tonight's temperature will be:
    a. higher than last night's temperature
    b. lower than last night's temperature
    c. the same as last night's temperature
    d. above freezing
    e. near boiling

64. If the present concentration of CO_2 doubles in 100 years, and climate models predict that for the earth's average temperature to rise 5°C, what gas must also increase in concentration?
    a. nitrogen
    b. oxygen
    c. ozone
    d. water vapor
    e. noble gas

65. The albedo of the earth's surface is only about 4%, yet the combined albedo of the earth and the atmosphere is about 30%. Which set of conditions below best explains why this is so?
    a. high albedo of clouds, low albedo of water
    b. high albedo of clouds, high albedo of water
    c. low albedo of clouds, low albedo of water
    d. low albedo of clouds, high albedo of water

66. During the last glacial maximum, where was the highest rate of deposition of ice-rafted debris in the North Atlantic Ocean?
    a. Near the Arctic Circle
    b. Near their sources areas in Greenland and Canada
    c. Near their source areas in Scandinavia and Iceland
    d. Where the icebergs first encountered warm water, at 45–50ºN
    e. Where the icebergs first encountered warm water, at 5–15ºN

67. How much colder were the tropics during the last glacial maximum?
    a. They were 1 to 2 ºC cooler than today according to CLIMAP reconstructions.
    b. They were 1 to 2 ºC cooler than today according to Alkenones research, a marine biochemical method of temperature reconstruction.
    c. They were 4 to 6 ºC cooler than today according to the continental record of the lower limit of mountain glaciers.
    d. They were about 3 ºC cooler, when accounting for errors in the analysis of the earlier marine CLIMAP temperature estimates and the continental temperature estimates.
    e. Both A and B are correct.

68. The earth is tilted at an angle of 23.5^{o} with respect to the plane of its orbit around the sun. If the amount of tilt were increased to 40^{o}, we would expect in middle latitudes:

a. hotter summers and colder winters than at present
b. cooler summers and milder winters than at present
c. hotter summers and milder winters than at present
d. cooler summers and colder winters than at present
e. no appreciable change from present conditions

69. In Honolulu, Hawaii (latitude 21^{o}N), you would most likely experience winds blowing from the:

a. northeast
b. south
c. southwest
d. northwest
e. none of the above

70. If the ozone level were to decrease significantly, which of the following might also occur?

a. more absorption of ultraviolet radiation in the stratosphere.
b. an increase in the number of cases of skin cancer
c. the stratosphere would warm
d. less ultraviolet radiation would be absorbed at the earth's surface
e. all of the above

71. Which of the conditions below would most likely produce warming at the earth's surface?

a. increase the amount of low-level global cloudiness (e.g. stratus)
b. increase the amount of sulfur-rich particles in the stratosphere
c. decrease the energy output of the sun
d. increase the amount of global snow cover
e. increase the amount of high-level global cloud cover (e.g. cirrus)

72. The Milankovitch Theory proposes that climatic changes are due to:

a. variations in the earth's orbit as it travels through space
b. volcanic eruptions
c. changing levels of CO_2 in the earth's atmosphere
d. particles suspended in the earth's atmosphere
e. all of the above

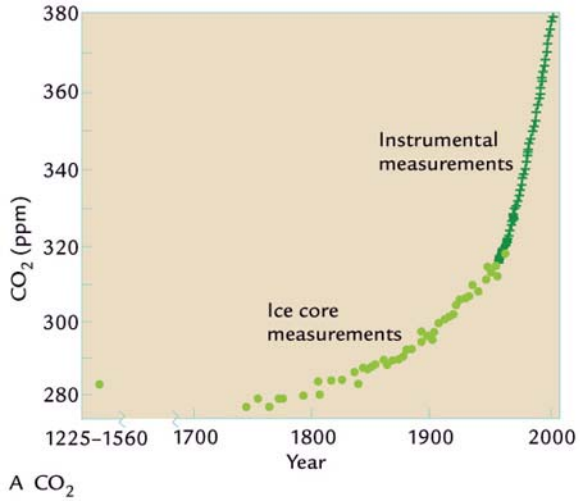
73. Which statement below is not correct concerning the Coriolis force?

a. It causes the winds to deflect to the right in the Northern Hemisphere
b. It is zero at the equator
c. It can cause winds to change direction, but not to increase or decrease in speed
d. It deflects winds in opposite directions in the Northern and Southern Hemispheres
e. It modulates the concentrations of atmospheric carbon dioxide

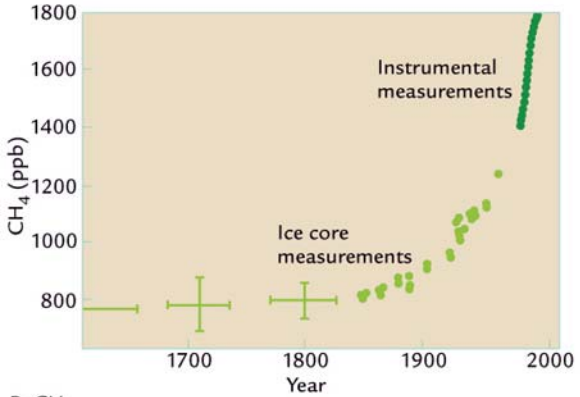
74. A Heinrich event is

A. a period of sudden big drop in temperature during the middle of the last deglaciation in the North Atlantic region
B. a period of very few sunspots during 1645–1715 A.D.
C. a period between 1400–1900 A.D. when Europe was colder than today
D. an interval of rapid flow of icebergs into the North Atlantic, causing deposition of debris eroded from land
E. 2000–7000-year oscillations recorded in Greenland ice during glacial intervals

75. Examine the following figure and determine which statement correctly describes the information shown.



A CO_2



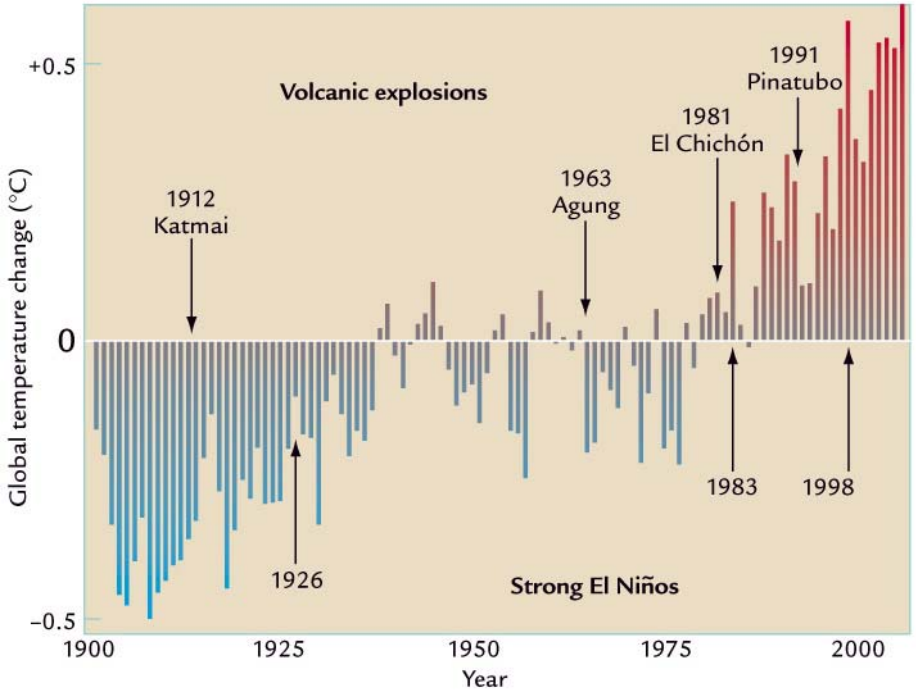
B CH_4

a. Atmospheric CO_2 levels since 1700 have risen linearly (i.e. like a straight line).
b. Instrumental measurements of CO_2 and CH_4 disagree with ice core measurements prior to 1950.
c. Concentrations of CH_4 are much greater than those of CO_2 in the atmosphere.
d. Levels of CO_2 and CH_4 are higher today than at any time in the past several hundred years.
e. None of the above is correct.

76. Where does most of CO_2 produced by *humans* go?

a. The atmosphere
b. The biosphere
c. Glaciers and ice sheets
d. Oceans
e. Rocks

77. 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 coolings, 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.

78. Global dimming
a. Is irreversible
b. Is caused by rising CO_2 levels
c. Will produce a solar eclipse
d. Masks the effects of global warming
e. Is more prominent in polar regions

79. Methane
a. Occurs in higher abundances in the atmosphere than CO_2 does
b. Is a more effective greenhouse gas than CO_2 on a molecule-by-molecule basis
c. Rise for the last 150 years is equivalent to a CO_2 rise
d. All of the above
e. Both A and C

80. The melting of mountain glaciers will result in water stress in nearby and downstream populations. Where will this likely occur?
a. The Andes
b. South Asia
c. East Africa
d. The Canadian and U.S. Rockies
e. All of the above

81. Which of the following statements is true about climate change and global warming?
    a. "True, climate changes year to year, but over a long period of time, climate does not change."
    b. "Today's global average temperature is greater than 100 Myr ago."
    c. "The *rate* of current global warming is greater than at any time in the past millions of years."
    d. None of the above
    e. All of the above

82. Which is <u>not</u> correct about acid deposition?
    a. it is only a problem in New England and Scandinavia
    b. it can damage plants and water resources
    c. it is caused mainly by the release of oxides of sulfur and nitrogen
    d. can fall to ground in dry or wet forms

83. The formation of continental glaciers over vast areas of North America is most favorable when Northern Hemisphere summers are ___ and winters are ___.
    a. cool, extremely cold
    b. warm, mild
    c. warm, extremely cold
    d. cool, mild

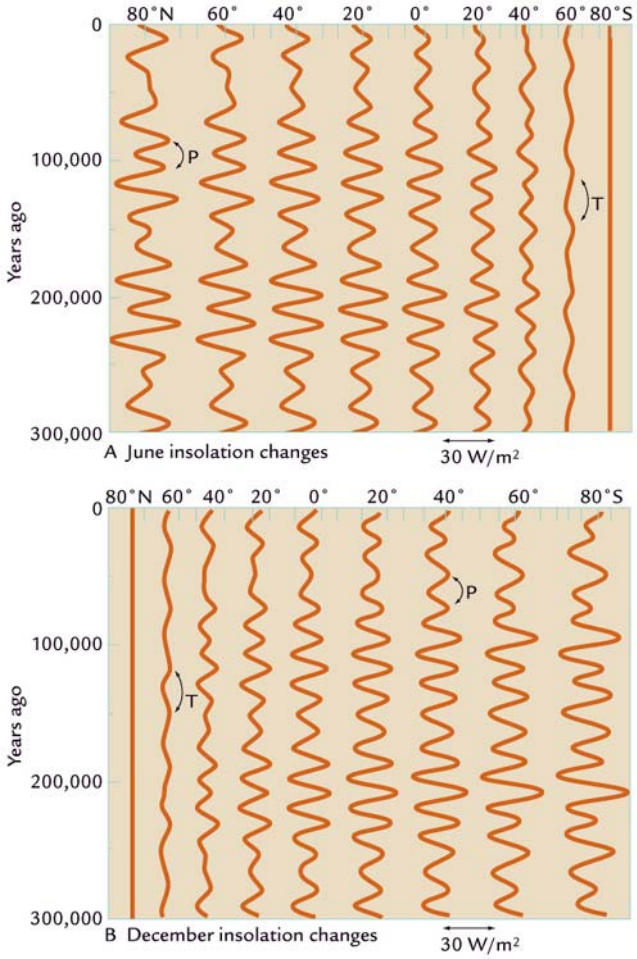
84. The Nobel Peace Prize winners in 2007 were _____.
    a. Al Gore only
    b. Al Gore and George Bush
    c. IPCC only
    d. Al Gore and IPCC
    e. None of the above

85. The IPCC assessment report published in 2007 is also known as _____.
    a. FAR
    b. SAR
    c. TAR
    d. AR4
    e. AR5

86. Earth's seasons are caused by
    a. The rate of Earth's spin around its axis
    b. The distance between Earth and the Sun
    c. The rate of Earth's movement around the Sun
    d. The changing position of the tilted Earth with respect to the Sun
    e. The interaction of the Moon and Sun on Earth's orbit

87. When is Earth closest to the Sun in its present orbit?
    a. During the northern hemisphere's winter
    b. During the southern hemisphere's winter
    c. During the northern hemisphere's fall equinox
    d. During the southern hemisphere's spring equinox
    e. A and C only

88. Examine the following figure to determine which of the following statements best describes your observations.



a. Low-latitude insolation is dominated by an orbital obliquity cycle in both June and December.
b. Eccentricity cycles of insolation change are dominant variation overall.
c. At any particular time, the northern hemisphere's insolation in June essentially matches that of the southern hemisphere's insolation in December.
d. The greatest changes in insolation in the high latitudes occur in the winter.
e. Both C and D only

89. At the northern hemisphere summer solstice
a. The sun is most directly aligned with the Tropic of Capricorn
b. The sun is highest in the sky in the northern hemisphere
c. The Earth's rotational axis is neither tilted toward or away from the Sun, but is parallel to the direction of Earth's orbit
d. The Antarctic Circle receives 24 hours of sunlight
e. None of the above

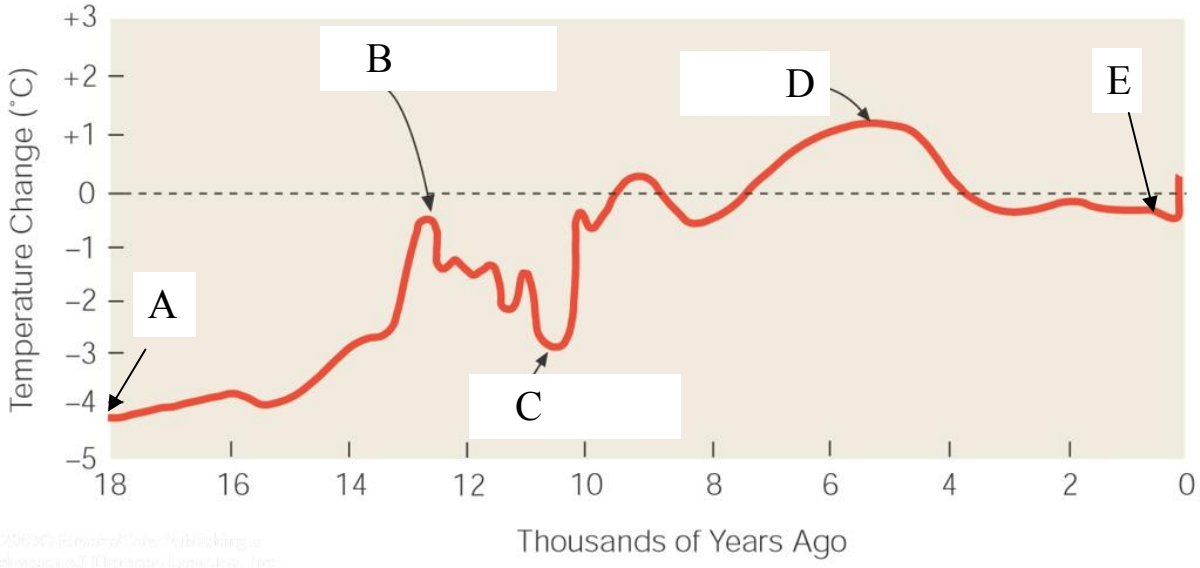
90. What accounts for the sea level rise of the twentieth century?
    a. Melting of sea ice
    b. Melting of land-based ice (e.g. glaciers and ice sheets)
    c. Thermal expansion of sea water
    d. Both A and B
    e. Both B and C

91. Which of the following types of climate data has been measured with satellites?
    a. Snow cover
    b. Sea ice cover
    c. Vegetation growing conditions
    d. All of the above
    e. A and B only

92. Which of the following is evidence for warming of the middle and high northern latitudes?
    a. Decrease in northern mid- to high-latitude snow cover
    b. Increase in the length of the growing season in Alaska
    c. Melting of the Greenland ice sheet
    d. All of the above
    e. A and C only

93. Critics of global warming have strong supporting evidence in
    a. Weather balloon atmospheric temperature measurements
    b. Satellite estimates of sea surface temperature
    c. Satellite estimates of tropospheric temperature
    d. All of the above
    e. None of the above because the full range of instrumental and satellite data now indicate major warming occurred over the last century

The figure below describes the average air temperature variations for the past 18,000 years. Refer to this figure to answer the remaining questions.



94. The above figure is also called the
a. Hockey Stick
b. Younger-Dryas
c. Bering Land Bridge
d. All of the above
e. None of the above

95. Data used in the figure were from
a. lake sediments, ice cores, corals, tree rings, and historical documents
b. tree rings only
c. corals only
d. ice cores only
e. lake sediments only

96. The Little Ice Age is marked by ____ in the figure.
A
B
C
D
E

97. The Younger-Dryas is marked by ____ in the figure.
A
B
C
D
E

98. The Last Glacial Maximum is marked by ____ in the figure.
A
B
C
D
E

99. The Holocene Maximum is marked by ____ in the figure.
A
B
C
D
E

100. The Bolling-Allerod is marked by ____ in the figure.
A
B
C
D
E