

# How things work college course/Cumulative global warming exam/Testbank

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## GlobalWarmingCumulative

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**This document contains either a study guide OR pairs of exams taken from the same exam bank**

If two exams have the same s-number, then v1 and v2 have the same questions, presented in different (random) order.

Exams with different s-numbers have different questions and may not have the same difficulty.

Click items in the table of contents and appropriate page should be reached. This feature should allow you to print only those pages that you need.

**At the end of this document**

**Attribution** for the quizzes identifies where the questions were obtained

**Study guide** links reading materials and/or relevant equations.

## GlobalWarmingCumulative-v1s1

1. Stefan-Boltzmann radiation is called a negative feedback mechanism because if the sun's radiation increases, the Stefan-Boltzmann law ensures that this heat is retained by the planet.

- a) true
- b) false

2. Soot tends to cool the earth when it accumulates in atmospheric brown clouds.

- a) true
- b) false

3. The lede's graphs of the "Global Land Ocean Temperature Index (1880-2013)" indicates that from 1960 to 2012 the average temperature increased by approximately

- a) 0.06° Celsius
- b) 0.16° Celsius
- c) 0.6° Celsius
- d) 16° Celsius
- e) 1.6° Celsius

4. In climate science, mitigation refers to:

- a) climate engineering
- b) adaptation to the effects of global warming
- c) reduction of green house emissions
- d) building systems resilient to the effects of global warming

5. Global dimming, caused by air-borne particulates produced by volcanoes and human made pollutants
- a) exerts a heating effect by absorbing infra-red radiation from earth's surface
  - b) is more related to the ozone problem than to global warming
  - c) exerts a cooling effect by increasing the reflection of incoming sunlight
6. Compared with the first half of the twentieth century, the rate of earth's average temperature rise during the second (latter) half was
- a) twice as much
  - b) about the same
  - c) half as much
7. Which external force plays the smallest role in current efforts to model global warming?
- a) greenhouse gasses
  - b) orbital cycles
  - c) volcanic eruptions
  - d) solar luminosity (i.e. variations in energy from the sun)
8. A rise in the sea level is associated with global warming because
- a) ice and snow melts
  - b) water tends to expand as it warms
  - c) both of these are true

9. The 2007 IPCC report stated that most global warming was likely being caused by increasing concentrations of greenhouse gases produced by human activities. Among the science academies of the major industrialized nations, this finding was recognized by

- a) 60% of the academies of science
- b) 90% of the academies of science
- c) all but the US academy of science
- d) all of the academies of science

10. Proxy temperatures measurements are defined as measurements made using measurements from space.

- a) true
- b) false

11. Carbon dioxide contributes more to the greenhouse effect than does water vapor.

- a) true
- b) false

12. How is the validity of a computer model typically tested?

- a) all of these are true
- b) by making predictions about future years and seeing if they come true.
- c) by verifying its ability to calculate past climate conditions.
- d) by verifying its ability to calculate current climate conditions.

13. The urban heat island effect refers to the fact that urban areas tend to be hotter than rural areas. The urban heat island effect is estimated to account for approximately \_\_\_\_\_ of the temperature rise over the past century.

- a) 30%
- b) 3%
- c) 0.3%
- d) 0%

14. The Earth's average surface temperature rose by approximately \_\_\_\_\_ per decade over the period 1906–2005.}

- a) 0.07°C
- b) 0.7°C
- c) 7.0°C

15. Which statement is FALSE about the lede's map of the temperature anomaly (2000-2009)?

- a) The United States has warmed more than Australia
- b) Central Europe has warmed more than the continental United States
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16. Changes in ice-albedo refers to changes in

- a) how much ice is melted during the summer months
- b) how much CO<sub>2</sub> is absorbed by the sun
- c) how much the Earth's surface absorbs or reflects incoming sunlight

17. The Reconstructed Temperature (0-2000 AD) plot in "Observed Temperature Changes" shows temperature measurements, as well as what curious feature? (See also Divergence problem)

- a) a divergence between the tree and pollen proxy measurements
- b) the Little Ice Age being less prominent than the Medieval Warming period
- c) a tiny gap at the end of the proxy measurements
- d) the fact that the different proxy measurements deviate considerably from the average of all proxy measurements

18. Computer models accurately model feedback mechanisms associated with how the soil will retain or release CO<sub>2</sub> as the earth warms.}

- a) true
- b) false

19. Greenhouse warming acts to cool the stratosphere

- a) true
- b) false

20. The climate change community is divided between those who believe the goal should be to eliminate the earth's greenhouse effect altogether, and those who argue that we should attempt to minimize earth's greenhouse effect.

- a) true
- b) false

21. The lede's "CO2 Emissions per Year" graph (1990-2010) shows dips and rises that are caused by changes in

- a) the sun's energy output
- b) worldwide efforts to curtail emissions
- c) the earth's distance from the sun
- d) the world economy

22. The "Greenhouse effect schematic" in the section on "Temperature changes..." indicates that most of the energy from the Sun is absorbed at the earth's surface.

- a) true
- b) false

23. While computer modeling indicate that the warming since 1970 is dominated by man-made greenhouse gas emissions, they are unable to conclusively ascertain whether the warming from 1910 to 1945 was anthropogenic.

- a) true
- b) false

24. The lede's graph of the "Global Land Ocean Temperature Index (1880-2013)" shows that since 1920, there has never been a decade of overall cooling

- a) true
- b) false

25. Analysis of the uncertainties associated with feedback suggests that the "worst-case" scenario is more difficult to model.

- a) true
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26. The "Greenhouse effect schematic" in the section on "Temperature changes..." indicates that most of the energy from the Sun is absorbed by the earth's atmosphere.

a) true

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27. Analysis of the uncertainties associated with feedback suggests that the "worst-case" scenario is easier to model.

a) true

b) false

28. Stefan-Boltzmann radiation is called a negative feedback mechanism because if the sun's radiation increases, the Stefan-Boltzmann law ensures that more heat is lost from the planet to compensate.

a) true

b) false

29. The lede's graph of the "Global Land Ocean Temperature Index (1880-2013)" shows little or no temperature rise over the last \_\_\_\_ years

a) 300

b) 10

c) 3

d) 100

e) 30



30. Since 1971, 90% of earth's increased energy caused by global warming has been stored in the \_\_\_\_\_, mostly \_\_\_\_\_

- a) land; near the equators
- b) sea; in the bottom kilometer
- c) land; near the poles
- d) air; in the water vapor
- e) sea; in the top kilometer

31. The Reconstructed Temperature (0-2000 AD) plot in "Observed Temperature Changes" shows temperature measurements. The solid black line represents

- a) thermometer measurements
- b) the Medieval Warming Period
- c) a 10 year average
- d) the Little Ice Age
- e) tree proxy measurements

32. Approximately what percent of global warming can be attributed to a long-term trend (since 1978) in the sun's energy?

- a) 50%
- b) 10%
- c) 30%
- d) 0%

33. Greenhouse warming acts to warm the stratosphere

- a) true
- b) false

34. "External forcings" refer to effects that can either increase or decrease, the Earth's temperature.

a) true

b) false

35. In the arctic, soot tends to cool the earth.

a) true

b) false

36. Ocean temperatures are increasing more slowly than land temperatures because oceans have more heat capacity and because evaporation cools the water.

a) true

b) false

37. Soot tends to warm the earth when it accumulates in atmospheric brown clouds.

a) true

b) false

38. in 2013, the IPCC stated that the largest driver of global warming is carbon dioxide (CO<sub>2</sub>) emissions from fossil fuel combustion. Other important sources of CO<sub>2</sub> are

a) cement production and land use changes

b) population growth

c) cement production and waste disposal

d) population growth and waste disposal

39. What happens when water is heated?

- a) it expands at temperatures below  $3.98^{\circ}\text{C}$  and contracts above  $3.98^{\circ}\text{C}$
- b) it expands at temperatures above  $3.98^{\circ}\text{C}$  and contracts below  $3.98^{\circ}\text{C}$
- c) it absorbs  $\text{CO}_2$

40. In the twentieth century, the rate of earth's average temperature rise was closest to

- a)  $0.7^{\circ}\text{C}$  per decade
- b)  $0.7^{\circ}\text{C}$  per century
- c)  $0.7^{\circ}\text{C}$  per year

41. Compared with the second half of the twentieth century, the rate of earth's average temperature rise during the first half was

- a) half as much
- b) about the same
- c) twice as much

42. The largest temperature increases (from 2000-2009) have occurred

- a) near the poles
- b) near the equator
- c) in the western hemisphere
- d) on the ocean surface

43. The carbon cycle

- a) is a proposal to trade carbon credits.
- b) describes how carbon is absorbed and emitted by the oceans, soil, plants, etc.
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44. No direct method exists that permits an independent measurement of the heat content of the oceans, other than the fact that the air is warming

a) true

b) false

45. Depleting the ozone layer cools the stratosphere because ozone allows UV radiation to penetrate.

a) true

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46. Emissions scenarios are

a) estimates of changes in future emission levels of greenhouse gases

b) estimates of how greenhouse gasses are absorbed and emitted by the world's oceans

c) estimates of how greenhouse gasses are absorbed and emitted by nature

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47. It is expected that carbon emissions will begin to diminish in the 21st century as fossil fuel reserves begin to dwindle.

a) true

b) false

48. Water vapor contributes more to the greenhouse effect than does carbon dioxide.

a) true

b) false

49. Computer modeling has conclusively established that anthropogenic warming has occurred since 1910.

a) true

b) false

50. Proxy temperatures measurements are defined as indirect inferences gathered from ice cores, tree rings, and so forth

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c) estimates made in the year 2000 of what would happen in the future

d) estimates of the contributions from everything except fossil fuels

53. The Stefan-Boltzmann law plays a central role in establishing a planets temperature as the sun heats the planet until the thermal (infra-red) radiation away the planet rises to match the solar radiation onto the planet

a) true

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54. The Stefan-Boltzmann law plays a central role in establishing a planet's temperature as the sun heats the planet with thermal (infra-red) radiation adding to the other solar radiation onto the planet

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55. The cryosphere refers to

- a) the upper atmosphere
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56. "External forcings" refer to effects that can increase, but not decrease, the Earth's temperature.

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57. The distinction between the urban heat island effect and land use changes is that the latter involves the earth's average temperature while the former involves only the temperature near weather stations where the measurements are made

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59. Anthropogenic means something that

- a) humans cannot repair
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61. Computer models accurately model feedback mechanisms associated with the role of clouds as a feedback mechanism. }

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## GlobalWarmingCumulative-v2s1

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5. In 2013, the IPCC stated that the largest driver of global warming is carbon dioxide (CO<sub>2</sub>) emissions from fossil fuel combustion. Other important sources of CO<sub>2</sub> are

- a) population growth and waste disposal
- b) cement production and land use changes
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6. Which statement is FALSE about the lead's map of the temperature anomaly (2000-2009)?

- a) Central Europe has warmed more than the continental United States
- b) Northern Asia has warmed more than southern Asia
- c) The United States has warmed more than Australia
- d) all portions of Antarctica have warmed

7. How is the validity of a computer model typically tested?

- a) all of these are true
- b) by making predictions about future years and seeing if they come true.
- c) by verifying its ability to calculate current climate conditions.
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a) 100

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16. The 2007 IPCC report stated that most global warming was likely being caused by increasing concentrations of greenhouse gases produced by human activities. Among the science academies of the major industrialized nations, this finding was recognized by

- a) 90% of the academies of science
- b) all of the academies of science
- c) all but the US academy of science
- d) 60% of the academies of science

17. The lede's "CO2 Emissions per Year" graph (1990-2010) shows solid straight lines that represent

- a) estimates of the contributions from fossil fuels alone
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24. Soot tends to warm the earth when it accumulates in atmospheric brown clouds.

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25. What happens when water is heated?

- a) it expands at temperatures above  $3.98^{\circ}\text{C}$  and contracts below  $3.98^{\circ}\text{C}$
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29. Soot tends to cool the earth when it accumulates in atmospheric brown clouds.

- a) true
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30. Since 1971, 90% of earth's increased energy caused by global warming has been stored in the \_\_\_\_\_, mostly \_\_\_\_\_

- a) sea; in the bottom kilometer
- b) land; near the equators
- c) air; in the water vapor
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31. The lede's graph of the "Global Land Ocean Temperature Index (1880-2013)" shows that since 1920, there has never been a decade of overall cooling

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37. The "Greenhouse effect schematic" in the section on "Temperature changes..." indicates that most of the energy from the Sun is absorbed by the earth's atmosphere.

a) true

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38. Computer models accurately model feedback mechanisms associated with how the soil will retain or release CO<sub>2</sub> as the earth warms.}

a) true

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39. The urban heat island effect refers to the fact that urban areas tend to be hotter than rural areas. The urban heat island effect is estimated to account for approximately \_\_\_\_\_ of the temperature rise over the past century.

- a) 0%
- b) 3%
- c) 30%
- d) 0.3%

40. Changes in ice-albedo refers to changes in

- a) how much the Earth's surface absorbs or reflects incoming sunlight
- b) how much ice is melted during the summer months
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41. The distinction between the urban heat island effect and land use changes is that the latter involves the earth's average temperature while the former involves only the temperature near weather stations where the measurements are made

- a) true
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42. Water vapor contributes more to the greenhouse effect than does carbon dioxide.

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43. Greenhouse warming acts to cool the stratosphere

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- a) 0.6° Celsius
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- a) half as much
- b) about the same
- c) twice as much

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- a) true
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49. The Earth's average surface temperature rose by approximately \_\_\_\_\_ per decade over the period 1906–2005.}

- a) 7.0°C
- b) 0.07°C
- c) 0.7°C

50. Approximately what percent of global warming can be attributed to a long-term trend (since 1978) in the sun's energy?

- a) 50%
- b) 0%
- c) 10%
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51. "External forcings" refer to effects that can either increase or decrease, the Earth's temperature.

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52. The lede's "CO2 Emissions per Year" graph (1990-2010) shows dips and rises that are caused by changes in

- a) the world economy
- b) the earth's distance from the sun
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53. The Reconstructed Temperature (0-2000 AD) plot in "Observed Temperature Changes" shows temperature measurements, as well as what curious feature? (See also Divergence problem)

- a) the fact that the different proxy measurements deviate considerably from the average of all proxy measurements
- b) a divergence between the tree and pollen proxy measurements
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54. Computer modeling has conclusively established that anthropogenic warming has occurred since 1910.

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62. It is expected that carbon emissions will begin to diminish in the 21st century as fossil fuel reserves begin to dwindle.

- a) true
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## Key to GlobalWarmingCumulative-v2s1

1. In the arctic, soot tends to cool the earth.

- a) true
- + b) false

2. The carbon cycle

- a) is a proposal to trade carbon credits.
- + b) describes how carbon is absorbed and emitted by the oceans, soil, plants, etc.
- c) is an effort to store carbon in underground caves.

3. Analysis of the uncertainties associated with feedback suggests that the "worst-case" scenario is more difficult to model.

- + a) true
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4. The Keeling curve shows that carbon dioxide concentrations

- + a) show a steady rise in CO<sub>2</sub> levels, with increasing slope, and regular and predictable annual fluctuations
- b) show a steady rise in CO<sub>2</sub> levels, at constant slope, and regular and predictable annual fluctuations
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5. in 2013, the IPCC stated that the largest driver of global warming is carbon dioxide (CO<sub>2</sub>) emissions from fossil fuel combustion. Other important sources of CO<sub>2</sub> are

- a) population growth and waste disposal
- + b) cement production and land use changes
- c) population growth
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6. Which statement is FALSE about the lede's map of the temperature anomaly (2000-2009)?

- a) Central Europe has warmed more than the continental United States
- b) Northern Asia has warmed more than southern Asia
- c) The United States has warmed more than Australia
- + d) all portions of Antarctica have warmed

7. How is the validity of a computer model typically tested?

- + a) all of these are true
- b) by making predictions about future years and seeing if they come true.
- c) by verifying its ability to calculate current climate conditions.
- d) by verifying its ability to calculate past climate conditions.

8. In the arctic, soot tends to warm the earth.

- + a) true
- b) false

9. Analysis of the uncertainties associated with feedback suggests that the "worst-case" scenario is easier to model.

- a) true
- + b) false

10. Depleting the ozone layer cools the stratosphere because ozone absorbs UV energy from the sun that heats the stratosphere.

- + a) true
- b) false

11. The lede's graph of the "Global Land Ocean Temperature Index (1880-2013)" shows little or no temperature rise over the last \_\_\_\_ years

- a) 100
- b) 3
- c) 300
- + d) 10
- e) 30

12. The Reconstructed Temperature (0-2000 AD) plot in "Observed Temperature Changes" shows temperature measurements. The solid black line represents

- a) a 10 year average
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62. It is expected that carbon emissions will begin to diminish in the 21st century as fossil fuel reserves begin to dwindle.

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## GlobalWarmingCumulative-v1s2

1. The Reconstructed Temperature (0-2000 AD) plot in "Observed Temperature Changes" shows temperature measurements, as well as what curious feature? (See also Divergence problem)

- a) the Little Ice Age being less prominent than the Medieval Warming period
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2. The Keeling curve shows that carbon dioxide concentrations

- a) show a steady rise in CO<sub>2</sub> levels, at constant slope, and irregular fluctuations due associated with El Ninos and La Ninas.
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4. In the arctic, soot tends to warm the earth.

- a) true
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5. Soot tends to warm the earth when it accumulates in atmospheric brown clouds.

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41. The lede's "CO<sub>2</sub> Emissions per Year" graph (1990-2010) shows dips and rises that are caused by changes in

- a) the earth's distance from the sun
- b) the sun's energy output
- c) worldwide efforts to curtail emissions
- d) the world economy

42. Changes in ice-albedo refers to changes in

- a) how much ice is melted during the summer months
- b) how much the Earth's surface absorbs or reflects incoming sunlight
- c) how much CO<sub>2</sub> is absorbed by the sun



43. How is the validity of a computer model typically tested?

- a) by making predictions about future years and seeing if they come true.
- b) by verifying its ability to calculate past climate conditions.
- c) all of these are true
- d) by verifying its ability to calculate current climate conditions.

44. Anthropogenic means something that

- a) humans cannot repair
- b) human caused
- c) will hurt humans
- d) humans can repair

45. The climate change community is divided between those who believe the goal should be to eliminate the earth's greenhouse effect altogether, and those who argue that we should attempt to minimize earth's greenhouse effect.

- a) true
- b) false

46. Depleting the ozone layer cools the stratosphere because ozone absorbs UV energy from the sun that heats the stratosphere.

- a) true
- b) false

47. Depleting the ozone layer cools the stratosphere because ozone allows UV radiation to penetrate.

- a) true
- b) false

48. The urban heat island effect refers to the fact that urban areas tend to be hotter than rural areas. The urban heat island effect is estimated to account for approximately \_\_\_\_\_ of the temperature rise over the past century.

- a) 0.3%
- b) 3%
- c) 0%
- d) 30%

49. The Earth's average surface temperature rose by approximately \_\_\_\_\_ per decade over the period 1906–2005.}

- a) 7.0°C
- b) 0.07°C
- c) 0.7°C

50. Stefan-Boltzmann radiation is called a negative feedback mechanism because if the sun's radiation increases, the Stefan-Boltzmann law ensures that more heat is lost from the planet to compensate.

- a) true
- b) false

51. Carbon dioxide contributes more to the greenhouse effect than does water vapor.

- a) true
- b) false

52. Proxy temperatures measurements are defined as measurements made using measurements from space.

- a) true
- b) false

53. The lede's "CO2 Emissions per Year" graph (1990-2010) shows solid straight lines that represent
- a) estimates made in the year 2000 of what would happen in the future
  - b) estimates of the contributions from fossil fuels alone
  - c) estimates of the impact on land temperatures
  - d) estimates of the contributions from everything except fossil fuels
54. While computer modeling indicate that the warming since 1970 is dominated by man-made greenhouse gas emissions, they are unable to conclusively ascertain whether the warming from 1910 to 1945 was anthropogenic.
- a) true
  - b) false
55. The cryosphere refers to
- a) the north and south poles
  - b) the upper atmosphere
  - c) the highest mountains
  - d) two of these are true
56. The Stefan-Boltzmann law plays a central role in establishing a planets temperature as the sun heats the planet until the thermal (infra-red) radiation away the planet rises to match the solar radiation onto the planet
- a) true
  - b) false
57. Greenhouse warming acts to warm the stratosphere
- a) true
  - b) false

58. The lede's graph of the "Global Land Ocean Temperature Index (1880-2013)" shows that since 1920, there has never been a decade of overall cooling

a) true

b) false

59. The largest temperature increases (from 2000-2009) have occurred

a) in the western hemisphere

b) near the equator

c) on the ocean surface

d) near the poles

60. The "Greenhouse effect schematic" in the section on "Temperature changes..." indicates that most of the energy from the Sun is absorbed by the earth's atmosphere.

a) true

b) false

61. "External forcings" refer to effects that can either increase or decrease, the Earth's temperature.

a) true

b) false

62. The 2007 IPCC report stated that most global warming was likely being caused by increasing concentrations of greenhouse gases produced by human activities. Among the science academies of the major industrialized nations, this finding was recognized by

- a) all but the US academy of science
- b) 90% of the academies of science
- c) 60% of the academies of science
- d) all of the academies of science

## Key to GlobalWarmingCumulative-v1s2

1. The Reconstructed Temperature (0-2000 AD) plot in "Observed Temperature Changes" shows temperature measurements, as well as what curious feature? (See also Divergence problem)

- a) the Little Ice Age being less prominent than the Medieval Warming period
- b) the fact that the different proxy measurements deviate considerably from the average of all proxy measurements
- + c) a tiny gap at the end of the proxy measurements
- d) a divergence between the tree and pollen proxy measurements

2. The Keeling curve shows that carbon dioxide concentrations

- a) show a steady rise in CO<sub>2</sub> levels, at constant slope, and irregular fluctuations due associated with El Ninos and La Ninas.
- + b) show a steady rise in CO<sub>2</sub> levels, with increasing slope, and regular and predictable annual fluctuations
- c) show a steady rise in CO<sub>2</sub> levels, at constant slope, and regular and predictable annual fluctuations

3. The "Greenhouse effect schematic" in the section on "Temperature changes..." indicates that most of the energy from the Sun is absorbed at the earth's surface.

- + a) true
- b) false

4. In the arctic, soot tends to warm the earth.

- + a) true
- b) false

5. Soot tends to warm the earth when it accumulates in atmospheric brown clouds.

- a) true

+ b) false

6. "External forcings" refer to effects that can increase, but not decrease, the Earth's temperature.

- a) true

+ b) false

7. The Stefan-Boltzmann law plays a central role in establishing a planets temperature as the sun heats the planet with thermal (infra-red) radiation adding to the other solar radiation onto the planet

- a) true

+ b) false

8. Computer models accurately model feedback mechanisms associated with the role of clouds as a feedback mechanism. }

- a) true

+ b) false

9. Approximately what percent of global warming can be attributed to a long-term trend (since 1978) in the sun's energy?

- a) 30%

- b) 50%

+ c) 0%

- d) 10%

10. The Reconstructed Temperature (0-2000 AD) plot in "Observed Temperature Changes" shows temperature measurements. The solid black line represents

- a) a 10 year average
- b) the Little Ice Age
- + c) thermometer measurements
- d) the Medieval Warming Period
- e) tree proxy measurements

11. In climate science, mitigation refers to:

- a) adaptation to the effects of global warming
- b) climate engineering
- + c) reduction of green house emissions
- d) building systems resilient to the effects of global warming

12. In the arctic, soot tends to cool the earth.

- a) true
- + b) false

13. The lede's graph of the "Global Land Ocean Temperature Index (1880-2013)" shows little or no temperature rise over the last \_\_\_\_ years

- a) 3
- b) 100
- c) 300
- + d) 10
- e) 30



14. Stefan-Boltzmann radiation is called a negative feedback mechanism because if the sun's radiation increases, the Stefan-Boltzmann law ensures that this heat is retained by the planet.

- a) true
- + b) false

15. In the twentieth century, the rate of earth's average temperature rise was closest to

- a) 0.7 °C per year
- b) 0.7 °C per decade
- + c) 0.7 °C per century

16. The lede's graphs of the "Global Land Ocean Temperature Index (1880-2013)" indicates that from 1960 to 2012 the average temperature increased by approximately

- a) 0.06° Celsius
- b) 16° Celsius
- c) 1.6° Celsius
- + d) 0.6° Celsius
- e) 0.16° Celsius

17. Water vapor contributes more to the greenhouse effect than does carbon dioxide.

- + a) true
- b) false

18. Analysis of the uncertainties associated with feedback suggests that the "worst-case" scenario is easier to model.

- a) true
- + b) false

19. The distinction between the urban heat island effect and land use changes is that the latter involves the earth's average temperature while the former involves only the temperature near weather stations where the measurements are made

+ a) true

- b) false

20. Which external force plays the smallest role in current efforts to model global warming?

- a) solar luminosity (i.e. variations in energy from the sun)

+ b) orbital cycles

- c) greenhouse gasses

- d) volcanic eruptions

21. It is expected that carbon emissions will begin to diminish in the 21st century as fossil fuel reserves begin to dwindle.

- a) true

+ b) false

22. No direct method exists that permits an independent measurement of the heat content of the oceans, other than the fact that the air is warming

- a) true

+ b) false

23. Global dimming, caused by air-borne particulates produced by volcanoes and human made pollutants

+ a) exerts a cooling effect by increasing the reflection of incoming sunlight

- b) exerts a heating effect by absorbing infra-red radiation from earth's surface

- c) is more related to the ozone problem than to global warming

24. A rise in the sea level is associated with global warming because

- a) ice and snow melts
- + b) both of these are true
- c) water tends to expand as it warms

25. Proxy temperatures measurements are defined as indirect inferences gathered from ice cores, tree rings, and so forth

- + a) true
- b) false

26. Ocean temperatures are increasing more slowly than land temperatures because oceans have more heat capacity and because evaporation cools the water.

- + a) true
- b) false

27. Compared with the first half of the twentieth century, the rate of earth's average temperature rise during the second (latter) half was

- a) about the same
- + b) twice as much
- c) half as much

28. Computer models accurately model feedback mechanisms associated with how the soil will retain or release CO<sub>2</sub> as the earth warms.}

- a) true
- + b) false

29. Compared with the second half of the twentieth century, the rate of earth's average temperature rise during the first half was

- a) twice as much
- b) about the same
- + c) half as much

30. Ocean temperatures are increasing more slowly than land temperatures because the oceans are absorbing less heat energy from the sun

- a) true
- + b) false

31. What happens when water is heated?

- + a) it expands at temperatures above 3.98°C and contracts below 3.98°C
- b) it expands at temperatures below 3.98°C and contracts above 3.98°C
- c) it absorbs CO<sub>2</sub>

32. Greenhouse warming acts to cool the stratosphere

- + a) true
- b) false

33. Which statement is FALSE about the lede's map of the temperature anomaly (2000-2009)?

- a) Central Europe has warmed more than the continental United States
- + b) all portions of Antarctica have warmed
- c) Northern Asia has warmed more than southern Asia
- d) The United States has warmed more than Australia

34. Computer modeling has conclusively established that anthropogenic warming has occurred since 1910.

- a) true
- + b) false

35. Analysis of the uncertainties associated with feedback suggests that the "worst-case" scenario is more difficult to model.

- + a) true
- b) false

36. The carbon cycle

- + a) describes how carbon is absorbed and emitted by the oceans, soil, plants, etc.
- b) is a proposal to trade carbon credits.
- c) is an effort to store carbon in underground caves.

37. Soot tends to cool the earth when it accumulates in atmospheric brown clouds.

- + a) true
- b) false

38. Emissions scenarios are

- a) estimates of how greenhouse gasses are absorbed and emitted by the world's oceans
- + b) estimates of changes in future emission levels of greenhouse gases
- c) estimates of how greenhouse gasses are absorbed and emitted by agriculture
- d) estimates of how greenhouse gasses are absorbed and emitted by nature

39. in 2013, the IPCC stated that the largest driver of global warming is carbon dioxide (CO<sub>2</sub>) emissions from fossil fuel combustion. Other important sources of CO<sub>2</sub> are

- a) population growth and waste disposal
- b) cement production and waste disposal
- + c) cement production and land use changes
- d) population growth

40. Since 1971, 90% of earth's increased energy caused by global warming has been stored in the \_\_\_\_\_, mostly \_\_\_\_\_

- a) land; near the poles
- + b) sea; in the top kilometer
- c) sea; in the bottom kilometer
- d) air; in the water vapor
- e) land; near the equators

41. The lede's "CO<sub>2</sub> Emissions per Year" graph (1990-2010) shows dips and rises that are caused by changes in

- a) the earth's distance from the sun
- b) the sun's energy output
- c) worldwide efforts to curtail emissions
- + d) the world economy

42. Changes in ice-albedo refers to changes in

- a) how much ice is melted during the summer months
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44. Anthropogenic means something that

- a) humans cannot repair
- + b) human caused
- c) will hurt humans
- d) humans can repair

45. The climate change community is divided between those who believe the goal should be to eliminate the earth's greenhouse effect altogether, and those who argue that we should attempt to minimize earth's greenhouse effect.

- a) true
- + b) false

46. Depleting the ozone layer cools the stratosphere because ozone absorbs UV energy from the sun that heats the stratosphere.

- + a) true
- b) false

47. Depleting the ozone layer cools the stratosphere because ozone allows UV radiation to penetrate.

- a) true
- + b) false

48. The urban heat island effect refers to the fact that urban areas tend to be hotter than rural areas. The urban heat island effect is estimated to account for approximately \_\_\_\_\_ of the temperature rise over the past century.

- a) 0.3%
- + b) 3%
- c) 0%
- d) 30%

49. The Earth's average surface temperature rose by approximately \_\_\_\_\_ per decade over the period 1906–2005.}

- a) 7.0°C
- + b) 0.07°C
- c) 0.7°C

50. Stefan-Boltzmann radiation is called a negative feedback mechanism because if the sun's radiation increases, the Stefan-Boltzmann law ensures that more heat is lost from the planet to compensate.

- + a) true
- b) false

51. Carbon dioxide contributes more to the greenhouse effect than does water vapor.

- a) true
- + b) false

52. Proxy temperatures measurements are defined as measurements made using measurements from space.

- a) true
- + b) false



53. The lede's "CO2 Emissions per Year" graph (1990-2010) shows solid straight lines that represent

- + a) estimates made in the year 2000 of what would happen in the future
- b) estimates of the contributions from fossil fuels alone
- c) estimates of the impact on land temperatures
- d) estimates of the contributions from everything except fossil fuels

54. While computer modeling indicate that the warming since 1970 is dominated by man-made greenhouse gas emissions, they are unable to conclusively ascertain whether the warming from 1910 to 1945 was anthropogenic.

- + a) true
- b) false

55. The cryosphere refers to

- a) the north and south poles
- b) the upper atmosphere
- c) the highest mountains
- + d) two of these are true

56. The Stefan-Boltzmann law plays a central role in establishing a planets temperature as the sun heats the planet until the thermal (infra-red) radiation away the planet rises to match the solar radiation onto the planet

- + a) true
- b) false

57. Greenhouse warming acts to warm the stratosphere

- a) true
- + b) false

58. The lede's graph of the "Global Land Ocean Temperature Index (1880-2013)" shows that since 1920, there has never been a decade of overall cooling

- a) true
- + b) false

59. The largest temperature increases (from 2000-2009) have occurred

- a) in the western hemisphere
- b) near the equator
- c) on the ocean surface
- + d) near the poles

60. The "Greenhouse effect schematic" in the section on "Temperature changes..." indicates that most of the energy from the Sun is absorbed by the earth's atmosphere.

- a) true
- + b) false

61. "External forcings" refer to effects that can either increase or decrease, the Earth's temperature.

- a) true
- + b) false

62. The 2007 IPCC report stated that most global warming was likely being caused by increasing concentrations of greenhouse gases produced by human activities. Among the science academies of the major industrialized nations, this finding was recognized by

- a) all but the US academy of science
- b) 90% of the academies of science
- c) 60% of the academies of science
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## GlobalWarmingCumulative-v2s2

1. Changes in ice-albedo refers to changes in

- a) how much ice is melted during the summer months
- b) how much the Earth's surface absorbs or reflects incoming sunlight
- c) how much CO<sub>2</sub> is absorbed by the sun

2. How is the validity of a computer model typically tested?

- a) by making predictions about future years and seeing if they come true.
- b) all of these are true
- c) by verifying its ability to calculate current climate conditions.
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3. Water vapor contributes more to the greenhouse effect than does carbon dioxide.

- a) true
- b) false

4. The largest temperature increases (from 2000-2009) have occurred

- a) near the equator
- b) near the poles
- c) on the ocean surface
- d) in the western hemisphere

5. In climate science, mitigation refers to:

- a) building systems resilient to the effects of global warming
- b) adaptation to the effects of global warming
- c) reduction of green house emissions
- d) climate engineering

6. Depleting the ozone layer cools the stratosphere because ozone absorbs UV energy from the sun that heats the stratosphere.

- a) true
- b) false

7. The climate change community is divided between those who believe the goal should be to eliminate the earth's greenhouse effect altogether, and those who argue that we should attempt to minimize earth's greenhouse effect.

- a) true
- b) false

8. Greenhouse warming acts to cool the stratosphere

- a) true
- b) false

9. Greenhouse warming acts to warm the stratosphere

- a) true
- b) false

10. Analysis of the uncertainties associated with feedback suggests that the "worst-case" scenario is more difficult to model.

- a) true
- b) false

11. The lede's "CO2 Emissions per Year" graph (1990-2010) shows dips and rises that are caused by changes in

- a) the world economy
- b) the sun's energy output
- c) the earth's distance from the sun
- d) worldwide efforts to curtail emissions

12. The urban heat island effect refers to the fact that urban areas tend to be hotter than rural areas. The urban heat island effect is estimated to account for approximately \_\_\_\_\_ of the temperature rise over the past century.

- a) 30%
- b) 0.3%
- c) 3%
- d) 0%

13. A rise in the sea level is associated with global warming because

- a) ice and snow melts
- b) both of these are true
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14. Which external force plays the smallest role in current efforts to model global warming?

- a) orbital cycles
- b) greenhouse gasses
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15. The distinction between the urban heat island effect and land use changes is that the latter involves the earth's average temperature while the former involves only the temperature near weather stations where the measurements are made

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16. The Keeling curve shows that carbon dioxide concentrations

- a) show a steady rise in CO<sub>2</sub> levels, at constant slope, and irregular fluctuations due associated with El Ninos and La Ninas.
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- c) show a steady rise in CO<sub>2</sub> levels, with increasing slope, and regular and predictable annual fluctuations

17. Ocean temperatures are increasing more slowly than land temperatures because oceans have more heat capacity and because evaporation cools the water.

- a) true
- b) false

18. "External forcings" refer to effects that can either increase or decrease, the Earth's temperature.

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19. The Stefan-Boltzmann law plays a central role in establishing a planet's temperature as the sun heats the planet until the thermal (infra-red) radiation away from the planet rises to match the solar radiation onto the planet

a) true

b) false

20. In the arctic, soot tends to warm the earth.

a) true

b) false

21. Proxy temperature measurements are defined as indirect inferences gathered from ice cores, tree rings, and so forth

a) true

b) false

22. Stefan-Boltzmann radiation is called a negative feedback mechanism because if the sun's radiation increases, the Stefan-Boltzmann law ensures that more heat is lost from the planet to compensate.

a) true

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23. The Earth's average surface temperature rose by approximately \_\_\_\_\_ per decade over the period 1906–2005.}

a) 7.0°C

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24. Compared with the second half of the twentieth century, the rate of earth's average temperature rise during the first half was

- a) about the same
- b) half as much
- c) twice as much

25. in 2013, the IPCC stated that the largest driver of global warming is carbon dioxide (CO<sub>2</sub>) emissions from fossil fuel combustion. Other important sources of CO<sub>2</sub> are

- a) population growth and waste disposal
- b) cement production and waste disposal
- c) population growth
- d) cement production and land use changes

26. Which statement is FALSE about the lede's map of the temperature anomaly (2000-2009)?

- a) Central Europe has warmed more than the continental United States
- b) The United States has warmed more than Australia
- c) Northern Asia has warmed more than southern Asia
- d) all portions of Antarctica have warmed

27. While computer modeling indicate that the warming since 1970 is dominated by man-made greenhouse gas emissions, they are unable to conclusively ascertain whether the warming from 1910 to 1945 was anthropogenic.

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- b) describes how carbon is absorbed and emitted by the oceans, soil, plants, etc.
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31. Emissions scenarios are

- a) estimates of changes in future emission levels of greenhouse gases
- b) estimates of how greenhouse gasses are absorbed and emitted by nature
- c) estimates of how greenhouse gasses are absorbed and emitted by the world's oceans
- d) estimates of how greenhouse gasses are absorbed and emitted by agriculture

32. Stefan-Boltzmann radiation is called a negative feedback mechanism because if the sun's radiation increases, the Stefan-Boltzmann law ensures that this heat is retained by the planet.

- a) true
- b) false

33. Soot tends to warm the earth when it accumulates in atmospheric brown clouds.

- a) true
- b) false

34. The Reconstructed Temperature (0-2000 AD) plot in "Observed Temperature Changes" shows temperature measurements, as well as what curious feature? (See also Divergence problem)

- a) the fact that the different proxy measurements deviate considerably from the average of all proxy measurements
- b) a tiny gap at the end of the proxy measurements
- c) the Little Ice Age being less prominent than the Medieval Warming period
- d) a divergence between the tree and pollen proxy measurements

35. In the twentieth century, the rate of earth's average temperature rise was closest to

- a) 0.7 °C per century
- b) 0.7 °C per decade
- c) 0.7 °C per year

36. The Reconstructed Temperature (0-2000 AD) plot in "Observed Temperature Changes" shows temperature measurements. The solid black line represents

- a) the Little Ice Age
- b) the Medieval Warming Period
- c) thermometer measurements
- d) tree proxy measurements
- e) a 10 year average

37. The 2007 IPCC report stated that most global warming was likely being caused by increasing concentrations of greenhouse gases produced by human activities. Among the science academies of the major industrialized nations, this finding was recognized by

- a) 60% of the academies of science
- b) all of the academies of science
- c) all but the US academy of science
- d) 90% of the academies of science

38. Carbon dioxide contributes more to the greenhouse effect than does water vapor.

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39. The lede's graphs of the "Global Land Ocean Temperature Index (1880-2013)" indicates that from 1960 to 2012 the average temperature increased by approximately

- a) 1.6° Celsius
- b) 0.6° Celsius
- c) 16° Celsius
- d) 0.06° Celsius
- e) 0.16° Celsius

40. The lede's "CO<sub>2</sub> Emissions per Year" graph (1990-2010) shows solid straight lines that represent

- a) estimates made in the year 2000 of what would happen in the future
- b) estimates of the contributions from fossil fuels alone
- c) estimates of the contributions from everything except fossil fuels
- d) estimates of the impact on land temperatures

41. Computer modeling has conclusively established that anthropogenic warming has occurred since 1910.

a) true

b) false

42. Ocean temperatures are increasing more slowly than land temperatures because the oceans are absorbing less heat energy from the sun

a) true

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43. Analysis of the uncertainties associated with feedback suggests that the "worst-case" scenario is easier to model.

a) true

b) false

44. The lede's graph of the "Global Land Ocean Temperature Index (1880-2013)" shows little or no temperature rise over the last \_\_\_\_ years

a) 30

b) 100

c) 3

d) 300

e) 10

45. Depleting the ozone layer cools the stratosphere because ozone allows UV radiation to penetrate.

a) true

b) false

46. The "Greenhouse effect schematic" in the section on "Temperature changes..." indicates that most of the energy from the Sun is absorbed by the earth's atmosphere.

a) true

b) false

47. The lede's graph of the "Global Land Ocean Temperature Index (1880-2013)" shows that since 1920, there has never been a decade of overall cooling

a) true

b) false

48. Computer models accurately model feedback mechanisms associated with how the soil will retain or release CO<sub>2</sub> as the earth warms.}

a) true

b) false

49. Soot tends to cool the earth when it accumulates in atmospheric brown clouds.

a) true

b) false

50. Global dimming, caused by air-borne particulates produced by volcanoes and human made pollutants

a) exerts a cooling effect by increasing the reflection of incoming sunlight

b) is more related to the ozone problem than to global warming

c) exerts a heating effect by absorbing infra-red radiation from earth's surface

51. It is expected that carbon emissions will begin to diminish in the 21st century as fossil fuel reserves begin to dwindle.

a) true

b) false

52. The "Greenhouse effect schematic" in the section on "Temperature changes..." indicates that most of the energy from the Sun is absorbed at the earth's surface.

a) true

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53. The Stefan-Boltzmann law plays a central role in establishing a planet's temperature as the sun heats the planet with thermal (infra-red) radiation adding to the other solar radiation onto the planet

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54. Proxy temperatures measurements are defined as measurements made using measurements from space.

a) true

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55. Since 1971, 90% of earth's increased energy caused by global warming has been stored in the \_\_\_\_\_, mostly \_\_\_\_\_

a) sea; in the bottom kilometer

b) land; near the equators

c) air; in the water vapor

d) sea; in the top kilometer

e) land; near the poles

56. The cryosphere refers to

- a) the highest mountains
- b) the north and south poles
- c) two of these are true
- d) the upper atmosphere

57. Computer models accurately model feedback mechanisms associated with the role of clouds as a feedback mechanism. }

- a) true
- b) false

58. Compared with the first half of the twentieth century, the rate of earth's average temperature rise during the second (latter) half was

- a) half as much
- b) about the same
- c) twice as much

59. No direct method exists that permits an independent measurement of the heat content of the oceans, other than the fact that the air is warming

- a) true
- b) false

60. Approximately what percent of global warming can be attributed to a long-term trend (since 1978) in the sun's energy?

- a) 10%
- b) 30%
- c) 50%
- d) 0%



61. "External forcings" refer to effects that can increase, but not decrease, the Earth's temperature.

a) true

b) false

62. What happens when water is heated?

a) it expands at temperatures below  $3.98^{\circ}\text{C}$  and contracts above  $3.98^{\circ}\text{C}$

b) it absorbs  $\text{CO}_2$

c) it expands at temperatures above  $3.98^{\circ}\text{C}$  and contracts below  $3.98^{\circ}\text{C}$

## Key to GlobalWarmingCumulative-v2s2

1. Changes in ice-albedo refers to changes in

- a) how much ice is melted during the summer months
- + b) how much the Earth's surface absorbs or reflects incoming sunlight
- c) how much CO<sub>2</sub> is absorbed by the sun

2. How is the validity of a computer model typically tested?

- a) by making predictions about future years and seeing if they come true.
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- c) by verifying its ability to calculate current climate conditions.
- d) by verifying its ability to calculate past climate conditions.

3. Water vapor contributes more to the greenhouse effect than does carbon dioxide.

- + a) true
- b) false

4. The largest temperature increases (from 2000-2009) have occurred

- a) near the equator
- + b) near the poles
- c) on the ocean surface
- d) in the western hemisphere

5. In climate science, mitigation refers to:

- a) building systems resilient to the effects of global warming
- b) adaptation to the effects of global warming
- + c) reduction of green house emissions
- d) climate engineering

6. Depleting the ozone layer cools the stratosphere because ozone absorbs UV energy from the sun that heats the stratosphere.

- + a) true
- b) false

7. The climate change community is divided between those who believe the goal should be to eliminate the earth's greenhouse effect altogether, and those who argue that we should attempt to minimize earth's greenhouse effect.

- a) true
- + b) false

8. Greenhouse warming acts to cool the stratosphere

- + a) true
- b) false

9. Greenhouse warming acts to warm the stratosphere

- a) true
- + b) false

10. Analysis of the uncertainties associated with feedback suggests that the "worst-case" scenario is more difficult to model.

+ a) true

- b) false

11. The lede's "CO2 Emissions per Year" graph (1990-2010) shows dips and rises that are caused by changes in

+ a) the world economy

- b) the sun's energy output

- c) the earth's distance from the sun

- d) worldwide efforts to curtail emissions

12. The urban heat island effect refers to the fact that urban areas tend to be hotter than rural areas. The urban heat island effect is estimated to account for approximately \_\_\_\_\_ of the temperature rise over the past century.

- a) 30%

- b) 0.3%

+ c) 3%

- d) 0%

13. A rise in the sea level is associated with global warming because

- a) ice and snow melts

+ b) both of these are true

- c) water tends to expand as it warms

14. Which external force plays the smallest role in current efforts to model global warming?

- + a) orbital cycles
- b) greenhouse gasses
- c) solar luminosity (i.e. variations in energy from the sun)
- d) volcanic eruptions

15. The distinction between the urban heat island effect and land use changes is that the latter involves the earth's average temperature while the former involves only the temperature near weather stations where the measurements are made

- + a) true
- b) false

16. The Keeling curve shows that carbon dioxide concentrations

- a) show a steady rise in CO<sub>2</sub> levels, at constant slope, and irregular fluctuations due associated with El Ninos and La Ninas.
- b) show a steady rise in CO<sub>2</sub> levels, at constant slope, and regular and predictable annual fluctuations
- + c) show a steady rise in CO<sub>2</sub> levels, with increasing slope, and regular and predictable annual fluctuations

17. Ocean temperatures are increasing more slowly than land temperatures because oceans have more heat capacity and because evaporation cools the water.

- + a) true
- b) false

18. "External forcings" refer to effects that can either increase or decrease, the Earth's temperature.

- a) true
- + b) false

19. The Stefan-Boltzmann law plays a central role in establishing a planet's temperature as the sun heats the planet until the thermal (infra-red) radiation away from the planet rises to match the solar radiation onto the planet

+ a) true

- b) false

20. In the arctic, soot tends to warm the earth.

+ a) true

- b) false

21. Proxy temperature measurements are defined as indirect inferences gathered from ice cores, tree rings, and so forth

+ a) true

- b) false

22. Stefan-Boltzmann radiation is called a negative feedback mechanism because if the sun's radiation increases, the Stefan-Boltzmann law ensures that more heat is lost from the planet to compensate.

+ a) true

- b) false

23. The Earth's average surface temperature rose by approximately \_\_\_\_\_ per decade over the period 1906–2005.}

- a) 7.0°C

+ b) 0.07°C

- c) 0.7°C

24. Compared with the second half of the twentieth century, the rate of earth's average temperature rise during the first half was

- a) about the same
- + b) half as much
- c) twice as much

25. in 2013, the IPCC stated that the largest driver of global warming is carbon dioxide (CO<sub>2</sub>) emissions from fossil fuel combustion. Other important sources of CO<sub>2</sub> are

- a) population growth and waste disposal
- b) cement production and waste disposal
- c) population growth
- + d) cement production and land use changes

26. Which statement is FALSE about the lede's map of the temperature anomaly (2000-2009)?

- a) Central Europe has warmed more than the continental United States
- b) The United States has warmed more than Australia
- c) Northern Asia has warmed more than southern Asia
- + d) all portions of Antarctica have warmed

27. While computer modeling indicate that the warming since 1970 is dominated by man-made greenhouse gas emissions, they are unable to conclusively ascertain whether the warming from 1910 to 1945 was anthropogenic.

- + a) true
- b) false

28. Anthropogenic means something that

- a) humans can repair
- b) humans cannot repair
- c) will hurt humans
- + d) human caused

29. In the arctic, soot tends to cool the earth.

- a) true
- + b) false

30. The carbon cycle

- a) is an effort to store carbon in underground caves.
- + b) describes how carbon is absorbed and emitted by the oceans, soil, plants, etc.
- c) is a proposal to trade carbon credits.

31. Emissions scenarios are

- + a) estimates of changes in future emission levels of greenhouse gases
- b) estimates of how greenhouse gasses are absorbed and emitted by nature
- c) estimates of how greenhouse gasses are absorbed and emitted by the world's oceans
- d) estimates of how greenhouse gasses are absorbed and emitted by agriculture

32. Stefan-Boltzmann radiation is called a negative feedback mechanism because if the sun's radiation increases, the Stefan-Boltzmann law ensures that this heat is retained by the planet.

- a) true
- + b) false



33. Soot tends to warm the earth when it accumulates in atmospheric brown clouds.

- a) true
- + b) false

34. The Reconstructed Temperature (0-2000 AD) plot in "Observed Temperature Changes" shows temperature measurements, as well as what curious feature? (See also Divergence problem)

- a) the fact that the different proxy measurements deviate considerably from the average of all proxy measurements
- + b) a tiny gap at the end of the proxy measurements
- c) the Little Ice Age being less prominent than the Medieval Warming period
- d) a divergence between the tree and pollen proxy measurements

35. In the twentieth century, the rate of earth's average temperature rise was closest to

- + a) 0.7 °C per century
- b) 0.7 °C per decade
- c) 0.7 °C per year

36. The Reconstructed Temperature (0-2000 AD) plot in "Observed Temperature Changes" shows temperature measurements. The solid black line represents

- a) the Little Ice Age
- b) the Medieval Warming Period
- + c) thermometer measurements
- d) tree proxy measurements
- e) a 10 year average

37. The 2007 IPCC report stated that most global warming was likely being caused by increasing concentrations of greenhouse gases produced by human activities. Among the science academies of the major industrialized nations, this finding was recognized by

- a) 60% of the academies of science
- + b) all of the academies of science
- c) all but the US academy of science
- d) 90% of the academies of science

38. Carbon dioxide contributes more to the greenhouse effect than does water vapor.

- a) true
- + b) false

39. The lede's graphs of the "Global Land Ocean Temperature Index (1880-2013)" indicates that from 1960 to 2012 the average temperature increased by approximately

- a) 1.6° Celsius
- + b) 0.6° Celsius
- c) 16° Celsius
- d) 0.06° Celsius
- e) 0.16° Celsius

40. The lede's "CO<sub>2</sub> Emissions per Year" graph (1990-2010) shows solid straight lines that represent

- + a) estimates made in the year 2000 of what would happen in the future
- b) estimates of the contributions from fossil fuels alone
- c) estimates of the contributions from everything except fossil fuels
- d) estimates of the impact on land temperatures

41. Computer modeling has conclusively established that anthropogenic warming has occurred since 1910.

- a) true

+ b) false

42. Ocean temperatures are increasing more slowly than land temperatures because the oceans are absorbing less heat energy from the sun

- a) true

+ b) false

43. Analysis of the uncertainties associated with feedback suggests that the "worst-case" scenario is easier to model.

- a) true

+ b) false

44. The lede's graph of the "Global Land Ocean Temperature Index (1880-2013)" shows little or no temperature rise over the last \_\_\_\_ years

- a) 30

- b) 100

- c) 3

- d) 300

+ e) 10

45. Depleting the ozone layer cools the stratosphere because ozone allows UV radiation to penetrate.

- a) true

+ b) false

46. The "Greenhouse effect schematic" in the section on "Temperature changes..." indicates that most of the energy from the Sun is absorbed by the earth's atmosphere.

- a) true
- + b) false

47. The lede's graph of the "Global Land Ocean Temperature Index (1880-2013)" shows that since 1920, there has never been a decade of overall cooling

- a) true
- + b) false

48. Computer models accurately model feedback mechanisms associated with how the soil will retain or release CO<sub>2</sub> as the earth warms.}

- a) true
- + b) false

49. Soot tends to cool the earth when it accumulates in atmospheric brown clouds.

- + a) true
- b) false

50. Global dimming, caused by air-born particulates produced by volcanoes and human made pollutants

- + a) exerts a cooling effect by increasing the reflection of incoming sunlight
- b) is more related to the ozone problem than to global warming
- c) exerts a heating effect by absorbing infra-red radiation from earth's surface

51. It is expected that carbon emissions will begin to diminish in the 21st century as fossil fuel reserves begin to dwindle.

- a) true
- + b) false

52. The "Greenhouse effect schematic" in the section on "Temperature changes..." indicates that most of the energy from the Sun is absorbed at the earth's surface.

- + a) true
- b) false

53. The Stefan-Boltzmann law plays a central role in establishing a planet's temperature as the sun heats the planet with thermal (infra-red) radiation adding to the other solar radiation onto the planet

- a) true
- + b) false

54. Proxy temperatures measurements are defined as measurements made using measurements from space.

- a) true
- + b) false

55. Since 1971, 90% of earth's increased energy caused by global warming has been stored in the \_\_\_\_\_, mostly \_\_\_\_\_

- a) sea; in the bottom kilometer
- b) land; near the equators
- c) air; in the water vapor
- + d) sea; in the top kilometer
- e) land; near the poles

56. The cryosphere refers to

- a) the highest mountains
- b) the north and south poles
- + c) two of these are true
- d) the upper atmosphere

57. Computer models accurately model feedback mechanisms associated with the role of clouds as a feedback mechanism. }

- a) true
- + b) false

58. Compared with the first half of the twentieth century, the rate of earth's average temperature rise during the second (latter) half was

- a) half as much
- b) about the same
- + c) twice as much

59. No direct method exists that permits an independent measurement of the heat content of the oceans, other than the fact that the air is warming

- a) true
- + b) false

60. Approximately what percent of global warming can be attributed to a long-term trend (since 1978) in the sun's energy?

- a) 10%
- b) 30%
- c) 50%
- + d) 0%

61. "External forcings" refer to effects that can increase, but not decrease, the Earth's temperature.

- a) true

+ b) false

62. What happens when water is heated?

- a) it expands at temperatures below  $3.98^{\circ}\text{C}$  and contracts above  $3.98^{\circ}\text{C}$

- b) it absorbs  $\text{CO}_2$

+ c) it expands at temperatures above  $3.98^{\circ}\text{C}$  and contracts below  $3.98^{\circ}\text{C}$

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