

ATMOSPHERE AND CLIMATE

Class 09 - Social Science (Understanding Society)

Time Allowed: 1 hour and 29 minutes

Maximum Marks: 162

1. Which environmental problem is a direct result of an increase in carbon footprint? **[1]**
 - a) Global warming
 - b) Decrease in sea level
 - c) Increased biodiversity
 - d) Ozone layer repair
2. Which instrument is used to show the direction of the wind? **[1]**
 - a) An anemometer
 - b) A wind vane
 - c) A hygrometer
 - d) A barometer
3. Which greenhouse gas is produced by livestock and is a powerful heat-trapping gas? **[1]**
 - a) Methane
 - b) Nitrous Oxide
 - c) Oxygen
 - d) Carbon Dioxide
4. Which of the following is characteristic of the retreating monsoon season known as 'October Heat'? **[1]**
 - a) Clear skies, low temperature, and low humidity
 - b) High temperature and humidity.
 - c) Torrential rainfall with hailstorms
 - d) Low temperature and high humidity
5. What type of carbon footprint includes emissions from directly controlled activities like driving vehicles or using LPG? **[1]**
 - a) Direct Carbon Footprint
 - b) Indirect Carbon Footprint
 - c) Secondary Carbon Footprint
 - d) Embedded Carbon Footprint
6. Which months are generally characterized as the hot weather season in India due to the sun's northward movement causing the global heat belt to shift? **[1]**
 - a) March to May
 - b) June to August
 - c) January to March
 - d) September to November
7. Which human activity is a primary cause of increased greenhouse gases in the atmosphere, leading to climate change? **[1]**
 - a) Planting new forests
 - b) Burning fossil fuels
 - c) Developing renewable energy sources
 - d) Recycling waste materials
8. Which instrument is used to measure changes in temperature? **[1]**
 - a) Anemometer
 - b) Hygrometer
 - c) Thermometer
 - d) Barometer
9. Evaluate the statement: 'The thermosphere acts as Earth's radiation shield and communication' **[1]**

layer, playing a vital role in protecting life and supporting technology.'

- a) Communication yes, shielding partly.
- b) Exosphere does communication
- c) Blocks all radiation
- d) Thermosphere not important.

10. What is the 'probability' period with regard to floods? **[1]**
- a) The initial phase of a flood where water levels are low.
 - b) The period during which relief operations are carried out.
 - c) A heavy rainfall or snowmelt period before a flood.
 - d) The time after a flood has occurred when recovery efforts begin.
11. What is one way individuals can reduce their carbon footprint? **[1]**
- a) Consuming more non-renewable energy sources
 - b) Increasing the use of personal vehicles
 - c) Using energy-inefficient appliances
 - d) Planting more trees
12. Which trade winds prevail over India during the cold weather season, causing most of the country to experience a dry season? **[1]**
- a) Southwest trade winds
 - b) Westerly winds
 - c) Northeast trade winds
 - d) Southeast trade winds
13. What is the local name for the meagre rainfall important for the rabi crops during the cold weather season in north India? **[1]**
- a) Mahawat
 - b) Mango showers
 - c) October Heat
 - d) Loo
14. During the hot weather season (March-May) in India, what temperature range is commonly observed in the northwestern regions around May? **[1]**
- a) Around 42°C
 - b) Around 38°C
 - c) Around 48°C
 - d) Between 24°C and 25°C
15. The exosphere is characterized by the presence of traces of which gases? **[1]**
- a) Water Vapour and Dust
 - b) Carbon Dioxide and Argon
 - c) Oxygen and Nitrogen
 - d) Hydrogen and Helium
16. What is the term for the area drained by the waters of a river? **[1]**
- a) Catchment area
 - b) Flood plain
 - c) Drainage basin
 - d) Water divide
17. Which atmospheric layer contains the ozone layer that protects from harmful UV rays? **[1]**
- a) Troposphere
 - b) Stratosphere
 - c) Thermosphere
 - d) Mesosphere
18. A coastal town in Tamil Nadu is experiencing significant rainfall during December and January, while most of India experiences a dry season. What is the most likely meteorological reason for this anomalous rainfall pattern? **[1]**

- a) Southwest monsoon in winter. b) Cyclonic depressions during retreating monsoon.
- c) Northeast winds from sea to land. d) Pre-monsoon mango showers.

19. What instrument is used to measure atmospheric pressure? [1]

- a) Rain gauge b) Barometer
- c) Thermometer d) Anemometer

20. Which atmospheric layer is characterized by continuous mixing of gases and contains nearly 75 percent mass of the atmosphere? [1]

- a) Troposphere b) Mesosphere
- c) Stratosphere d) Exosphere

21. Match the items in List I with those in List II. [1]

List I	List II
(A) Direct Carbon Footprint	(I) Manufacturing goods
(B) Indirect Carbon Footprint	(II) Global warming
(C) Effect of High Carbon Footprint	(III) Driving vehicles
(D) Carbon Footprint Measurement	(IV) Tonnes CO ₂ equivalent

- a) A-I, B-III, C-II, D-IV b) A-II, B-I, C-III, D-IV
- c) A-IV, B-II, C-I, D-III d) A-III, B-I, C-II, D-IV

22. Match the items in List I with those in List II. [1]

List I	List II
(A) Flash flood	(I) High relief feature
(B) Drainage basin	(II) Area drained by river waters
(C) Water divide	(III) Violent splash of water
(D) Flood plain	(IV) Flattish area alongside river channels

- a) A-IV, B-III, C-II, D-I b) A-II, B-III, C-I, D-IV
- c) A-I, B-II, C-IV, D-III d) A-III, B-II, C-I, D-IV

23. Match the instruments in List I with what they measure in List II. [1]

List I	List II
(A) Thermometer	(I) Atmospheric Pressure
(B) Barometer	(II) Wind Direction
(C) Anemometer	(III) Temperature
(D) Wind Vane	(IV) Wind Speed

- a) A-I, B-III, C-IV, D-II b) A-III, B-I, C-IV, D-II

c) A-III, B-I, C-II, D-IV

d) A-IV, B-II, C-III, D-I

24. Match the items in List I with those in List II.

[1]

List I	List II
(A) Western Ghats rain	(I) Decreases westward
(B) Leeward side of Ghats	(II) Over 250 cm
(C) Northern Plains rainfall pattern	(III) Less than 50 cm
(D) Kolkata rainfall	(IV) 120 cm

a) A-IV, B-II, C-III, D-I

b) A-I, B-II, C-IV, D-III

c) A-III, B-I, C-II, D-IV

d) A-II, B-III, C-I, D-IV

25. Match the items in List I with those in List II.

[1]

List I	List II
(A) Troposphere	(I) Satellite communication
(B) Stratosphere	(II) Meteoroids burn up
(C) Mesosphere	(III) Weather phenomena
(D) Ionosphere	(IV) Ozone layer

a) A-III, B-IV, C-II, D-I

b) A-I, B-II, C-III, D-IV

c) A-II, B-I, C-IV, D-III

d) A-IV, B-III, C-I, D-II

26. **Assertion (A):** Western disturbances are crucial for winter rain in northern plains.

[1]

Reason (R): These low-pressure systems originate over the Mediterranean Sea.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

27. **Assertion (A):** Rising global temperatures lead to more frequent heatwaves.

[1]

Reason (R): Melting glaciers and polar ice caps cause rising sea levels.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

28. **Assertion (A):** Rain gauges are essential for effective disaster management and crop planning.

[1]

Reason (R): Accurate rainfall data aids in predicting floods, droughts, and irrigation needs.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

29. **Assertion (A):** Barometer readings below 1000 millibars often indicate unstable weather conditions.

[1]

Reason (R): Low atmospheric pressure systems are associated with rising air and cloud formation.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

30. **Assertion (A):** The exosphere is crucial for global communication and weather monitoring. [1]

Reason (R): Many communication and weather satellites orbit within this outermost layer.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

31. Which atmospheric layer protects Earth from meteors and how does it accomplish this? [2]

32. Explain the distinguishing features and impacts of the 'loo' winds during the hot weather season in India. [2]

33. Explain the interconnectedness between deforestation and the concentration of carbon dioxide in the atmosphere. [2]

34. How do industrial and agricultural practices contribute to the increase of heat-trapping gases in the atmosphere? [2]

35. What is the primary function of the thermosphere? [2]

36. Explain the diverse typical effects of floods on communities, encompassing panic, disease, and both physical damage to infrastructure and environmental changes. [2]

37. How does the level of moisture in the air influence the efficiency of evaporative cooling? [2]

38. Explain the fundamental concept of atmospheric greenhouse gas accumulation resulting from human activities. [2]

39. Explain how the physical characteristics of a river system, such as its drainage basin and flood plain, contribute to the occurrence and impact of floods. [2]

40. Which gas is primarily responsible for preventing rapid combustion and aiding plant growth? [2]

41. Explain how the atmosphere regulates Earth's temperature and sustains life. [2]

42. Explain how changes in atmospheric pressure are indicative of impending weather phenomena. [2]

43. How does the ozone layer within the stratosphere contribute to the protection of ecosystems? [2]

44. Discuss the origin, movement, and significance of Western Disturbances for the winter precipitation in the north Indian Plains. [2]

45. Describe the potential environmental consequences of an elevated presence of greenhouse gases in the atmosphere. [2]

46. How does the shifting of the global heat belt influence the onset and characteristics of the hot weather season across different regions of India? [2]

47. Discuss the primary purpose of mapping, land-use control, and flood forecasting in non-structural flood mitigation strategies. [2]

48. Evaluate the long-term societal implications if collective efforts to reduce atmospheric greenhouse gases are insufficient. [2]

49. Explain how the seasonal northward shift of the global heat belt influences the onset of the hot weather season in India and its impact on temperature distribution across different regions. [3]

50. Discuss two distinct ways in which water vapor in the atmosphere is essential for both weather patterns and the Earth's climate regulation. [3]
51. Describe the various natural phenomena and geographical features that can lead to an area becoming submerged. [3]
52. Explain the concept of a carbon footprint and its primary measurement unit. [3]
53. Articulate the significance of relative humidity in defining atmospheric moisture content and its implications for human comfort. [3]
54. Discuss the impact of altitude on atmospheric pressure and how this change affects human physiology. [3]
55. Name the atmospheric layer where all weather phenomena occur and where the majority of atmospheric mass is concentrated. [3]
56. Explain how temperature variations influence both immediate weather patterns and long-term climate trends. [3]
57. Hypothesize what significant changes would occur on Earth if the normal lapse rate in the troposphere ceased to exist. [3]
58. Explain the concept of 'probability period' in the context of flood occurrence. [3]
59. Describe the primary mechanisms through which human activities, particularly industrial and agricultural practices, enhance the greenhouse effect. [3]
60. Analyse the potential negative consequences of floods on public health and the agricultural sector, and propose how typical effects can be mitigated. [3]
61. On the outline map of India [3]
 - (a) Mark and label **Mawsynram (or Cherrapunji)** and **Jaisalmer**.
 - (b) Identify which location receives the **highest rainfall** and which receives the **lowest rainfall**.
 - (c) Mark and label the **Aravalli Range**, whose orientation influences rainfall distribution in northwestern India.
62. On the outline map of India [3]
 - (a) Mark and label the region that receives the **highest annual rainfall** in India.
 - (b) Draw and label the direction of the **Arabian Sea Branch** of the Southwest Monsoon.
 - (c) Mark and label the **state** in which this highest-rainfall region is located.
63. On the outline map of India [3]
 - (a) Draw and label the **Bay of Bengal Branch** of the Southwest Monsoon.
 - (b) Mark and label the state that first receives heavy rainfall from this branch in northeastern India.
 - (c) Mark and label the **Ganga-Brahmaputra Delta**, an important region influenced by the Bay of Bengal Branch.
64. On the outline map of India [3]
 - (a) Mark and label **Chennai**.
 - (b) Draw arrows showing the direction of the **Northeast (Retreating) Monsoon Winds**.
 - (c) Mark and label the **Coromandel Coast**, which receives rainfall during the retreating monsoon season.
65. On the outline map of India [3]
 - (a) Shade the **Thar Desert region**, which experiences low rainfall.
 - (b) Mark and label the **Western Ghats**.

(c) Mark and label **Mumbai**, a city receiving heavy rainfall from the Arabian Sea Branch.

66. **Read the given source carefully and answer the questions that follow:**

[4]

Beyond the tropopause lie specialized atmospheric zones that shield the planet and facilitate modern human technology. The stratosphere, extending up to 50 km, contains the protective ozone layer, which filters out lethal solar ultraviolet (UV) radiation, protecting terrestrial and marine food chains. Characterized by minimal air turbulence and negligible moisture, the stratosphere provides an ideal environment for long-distance aviation. Directly above the stratopause is the mesosphere, reaching up to 80 km, which burns up incoming meteorites through friction with gaseous particles. Above this middle zone rests the ionosphere, or thermosphere, where solar radiation strips electrons from gas molecules to create charged ions. This thermally intense region, reaching temperatures up to 2000°C , reflects radio waves back to Earth, enabling long-distance telecommunications. Finally, the exosphere forms the highly rarefied outermost boundary. Lacking heavy gases, it contains traces of hydrogen and helium and houses orbiting satellites that manage global GPS, weather tracking, and internet networks.

Questions:

- Which specific layer of the Earth's atmosphere contains the ozone layer that filters out harmful solar ultraviolet radiation? **(1)**
- What physical process causes incoming meteoroids to burn up and appear as shooting stars within the mesosphere? **(1)**
- Analyze the technological importance of the ionosphere and exosphere in maintaining modern global communication and navigation networks. **(2)**

67. **Read the given source carefully and answer the questions that follow:**

[4]

Atmospheric pressure-the weight of the air column pressing down on the Earth's surface-varies dynamically across altitude and weather systems. It is measured in millibars (mb) using a barometer, with standard sea-level pressure averaging about 1013 mb. As altitude increases, the air column thins, causing barometric pressure to drop. This reduction in pressure can induce hypoxia and dizziness in humans due to a lower concentration of oxygen molecules. Horizontally, pressure differences drive the movement of air, creating wind as air naturally migrates from high-pressure cells to low-pressure zones. When regional temperatures rise, the air expands and lifts, creating a low-pressure system or depression. If the pressure drops below 1000 mb, the system stabilizes into an area of atmospheric vulnerability, generating cloud cover, heavy rainfall, and storms. Conversely, high-pressure systems feature sinking, dense air masses that prevent condensation, leading to clear skies and calm weather conditions.

Questions:

- What is the average value of atmospheric pressure recorded at sea level, measured in millibars? **(1)**
- Which scientific instrument is utilized by meteorologists to measure changes in atmospheric barometric pressure? **(1)**
- Analyze how the development of a localized low-pressure depression alters regional weather patterns compared to a high-pressure system. **(2)**

68. **Read the given source carefully and answer the questions that follow:**

[4]

The monsoon climate of India is defined by a distinct seasonality, transitioning through four primary seasons: summer, winter, advancing monsoon, and retreating monsoon. During the hot weather season from March to May, intense solar heating shifts the global heat belt northward, creating an extended low-pressure trough over northern India. This phase is characterized by the "loo"-strong, hot, dry winds blowing across the northern plains. By June, this low-pressure system intensifies enough to draw in moisture-laden trade winds from the Southern Hemisphere, initiating the advancing southwest monsoon. The Indian peninsula splits this air current into the Arabian Sea branch and the Bay of Bengal branch, dropping heavy precipitation influenced by regional relief features like the Western Ghats and Himalayan foothills. As solar intensity declines in October and November, the low-pressure system weakens and migrates toward the Bay of Bengal, marking the retreating monsoon stage, which frequently triggers destructive tropical cyclones along the eastern delta coasts.

Questions

- What are the "loo" winds, and during which specific season do they blow across northern India? **(1)**
- Which low-pressure system originates over the Mediterranean Sea and brings vital winter rainfall to the northern plains? **(1)**
- Contrast the rainfall patterns received by the windward and leeward sides of the Western Ghats during the advancing monsoon season, and explain the role that geographical relief plays in causing this difference. **(2)**

69. **Read the given source carefully and answer the questions that follow:**

[4]

A carbon footprint is the total volume of greenhouse gases, primarily carbon dioxide (CO_2), released into the atmosphere as a direct or indirect result of human actions. Measured in tonnes of carbon dioxide equivalent (tCO_2e), it serves as an indicator of how much an individual, industry, or nation contributes to global warming. A direct carbon footprint comes from activities under our immediate control, such as burning fuel in a car or using liquid petroleum gas (LPG) at home. Conversely, an indirect carbon footprint accounts for the emissions generated during the entire life cycle of products we buy, including the manufacturing, packaging, and shipping of clothes, food, and electronics. Accumulating a large global carbon footprint traps excessive solar heat, leading to rapid climate change and rising sea levels. Mitigating these effects requires a shared responsibility to lower emissions through lifestyle adjustments, sustainable consumption, and energy conservation.

Questions:

- What is the standard scientific unit used to measure a carbon footprint? **(1)**
- Distinguish between a direct carbon footprint and an indirect carbon footprint by providing one daily example for each. **(1)**
- Analyze how purchasing locally grown, seasonal food items reduces a consumer's indirect carbon footprint compared to buying imported packaged goods. **(2)**

70. **Read the given source carefully and answer the questions that follow:**

[4]

The Earth's atmosphere is a carefully balanced gaseous envelope held close by gravity, structurally divided into five distinct layers based on thermal variations relative to altitude. The lowest layer is the troposphere, extending up to 18 km near the equator and compressing to 8

km near the poles. This layer contains nearly 75 percent of the total atmospheric mass and hosts all essential water vapor and primary greenhouse gases. Because temperature in the troposphere drops uniformly at a standard lapse rate of 1°C per 165 meters of ascent, it acts as the exclusive zone for life-sustaining weather phenomena, including cloud formation, precipitation, and storms. The upper boundary of this highly dynamic mixing zone is marked by the tropopause, a transitional threshold that separates it from the stratosphere. Understanding the troposphere is critical for meteorology, as its continuous gaseous mixing and thermal properties directly regulate global climate stability, support biological respiration, and sustain the fundamental ecosystems necessary for life on Earth.

Questions:

- a. What is the standard thermal lapse rate observed within the troposphere as altitude increases? **(1)**
 - b. Which transitional boundary marks the uppermost limit of the troposphere, separating it from the stratosphere? **(1)**
 - c. Analyze why virtually all active weather phenomena and life forms are restricted to the troposphere rather than higher atmospheric layers. **(2)**
71. Analyze how sustained changes in wind patterns, distinct from mere temporary gusts, could significantly impact agricultural practices and environmental dynamics in a specific region. **[5]**
 72. How does the concept of relative humidity inform our perception of air moisture, and what distinguishes 'dry' from 'humid' weather in terms of this scale? **[5]**
 73. Discuss the primary health and environmental consequences that typically arise during and immediately after a significant flood event. Elaborate on the factors contributing to these impacts. **[5]**
 74. Explain how the 'mean daily temperature' is calculated and its utility in understanding daily thermal conditions. **[5]**
 75. Discuss the significant environmental and health consequences that arise from a consistently high carbon footprint. **[5]**

Solution
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1. **(a)** Global warming
Explanation:
An increase in carbon footprint leads to serious environmental problems such as global warming.
2. **(b)** A wind vane
Explanation:
A wind vane shows the direction of the wind.
3. **(a)** Methane
Explanation:
Farming produces methane from livestock, which is identified as a very powerful heat-trapping greenhouse gas.
4. **(b)** High temperature and humidity.
Explanation:
During the retreating monsoon, clear skies and rising temperature are prominent, but high temperature and humidity cause the daytime weather to become rather oppressive, known as 'October Heat'.
5. **(a)** Direct Carbon Footprint
Explanation:
Direct Carbon Footprint includes emissions from activities we directly control, such as driving vehicles or using LPG.
6. **(a)** March to May
Explanation:
The sun's northward movement causes the global heat belt to shift northwards, resulting in the hot weather season from March to May in India.
7. **(b)** Burning fossil fuels
Explanation:
Burning fossil fuels for electricity, transport, and industry releases greenhouse gases like carbon dioxide, which trap heat in the atmosphere and cause climate change.
8. **(c)** Thermometer
Explanation:
A thermometer is the instrument specifically designed to measure temperature.
9. **(a)** Communication yes, shielding partly.
Explanation:
The statement is partially true. The thermosphere (ionosphere) plays a vital role in communication due to its ionized gases reflecting radio waves. However, the stratosphere, through its ozone layer, is primarily responsible for shielding Earth from harmful solar (UV) radiation, not the thermosphere.
10. **(c)** A heavy rainfall or snowmelt period before a flood.
Explanation:

The probability period is when floods are preceded by heavy rainfall and melting of snow over several days, allowing an ordinary person to get an idea of potential flooding.

11.

(d) Planting more trees

Explanation:

Planting more trees is listed as a way individuals can reduce their carbon footprint.

12.

(c) Northeast trade winds

Explanation:

In the winter season, the northeast trade winds prevail over the country, blowing from land to sea, and primarily causing a dry season.

13.

(a) Mahawat

Explanation:

The vital winter rain caused by Western Disturbances, which is important for the rabi crops, is known locally as 'mahawat'.

14.

(c) Around 48°C

Explanation:

The hot weather season sees temperatures around 48°C in northwestern India in May.

15.

(d) Hydrogen and Helium

Explanation:

The exosphere is the outermost layer and contains traces of hydrogen and helium.

16.

(c) Drainage basin

Explanation:

The area drained by the waters of the river is called drainage basin.

17.

(b) Stratosphere

Explanation:

The ozone layer is located in the stratosphere, providing protection from harmful ultraviolet (UV) rays.

18.

(c) Northeast winds from sea to land.

Explanation:

During the winter season, northeast trade winds prevail. While they typically cause a dry season as they blow from land to sea for most of India, the coasts of Tamil Nadu receive rain from these winds because they blow from sea to land in this specific region, picking up moisture.

19.

(b) Barometer

Explanation:

A barometer is the device used to measure atmospheric pressure.

20. **(a)** Troposphere
Explanation:
The troposphere is known for the continuous mixing of gases (from 'tropo' meaning mixing) and contains nearly 75 percent of the atmosphere's mass.
21.
(d) A-III, B-I, C-II, D-IV
Explanation:
Direct carbon footprint includes emissions from activities directly controlled, like driving vehicles. Indirect carbon footprint arises from emissions during manufacturing and transportation of goods and services. A high carbon footprint directly causes environmental problems such as global warming. Carbon footprint is typically measured in tonnes of carbon dioxide equivalent.
22.
(d) A-III, B-II, C-I, D-IV
Explanation:
A violent splash of water is called flash flood. The area drained by the waters of the river is called drainage basin. The high relief feature that separates two drainage basins is called water divide. The flattish area alongside river channels covered by water during floods is called flood plain.
23.
(b) A-III, B-I, C-IV, D-II
Explanation:
A thermometer measures temperature, a barometer measures atmospheric pressure, an anemometer measures wind speed, and a wind vane shows wind direction.
24.
(d) A-II, B-III, C-I, D-IV
Explanation:
- (A) Western Ghats rain → (II) Over 250 cm (very heavy rainfall on windward side)
 - (B) Leeward side of Ghats → (III) Less than 50 cm (rain shadow area)
 - (C) Northern Plains rainfall pattern → (I) Decreases westward (rainfall reduces from east to west)
 - (D) Kolkata rainfall → (IV) 120 cm (moderate rainfall region)
25. **(a)** A-III, B-IV, C-II, D-I
Explanation:
- A) Troposphere → (III) Weather phenomena (all weather happens here)
 - B) Stratosphere → (IV) Ozone layer (ozone is present here)
 - C) Mesosphere → (II) Meteoroids burn up (shooting stars burn here)
 - D) Ionosphere → (I) Satellite communication (radio and satellite signals reflect here)
26. **(a)** Both A and R are true and R is the correct explanation of A.
Explanation:
Western disturbances, originating over the Mediterranean, are responsible for the vital winter rainfall ('mahawat') in the northern plains.
27.
(b) Both A and R are true but R is not the correct explanation of A.
Explanation:
Both statements are true effects of climate change, but melting ice and rising sea levels are not a direct explanation for increased heatwaves, although they are both consequences of global temperature rise.

28. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

The ability to accurately measure rainfall provides critical data for forecasting hydrological events and agricultural requirements, thus supporting disaster management and crop planning. R directly explains the utility stated in A.

29. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

Low-pressure systems (below 1000 mb) are characterized by air rising, which cools and condenses to form clouds and precipitation, leading to unstable weather. Thus, R correctly explains A.

30.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation:

The exosphere is important for communication and weather monitoring because satellites operate there. However, its importance is not only due to satellite orbiting but also because it is the outermost layer with extremely low air resistance, which allows satellites to move freely and efficiently.

31. The mesosphere is the atmospheric layer responsible for protecting Earth from falling meteoroids. As meteorites enter this layer, they burn up due to friction with the gaseous particles present. This process causes them to appear as 'shooting stars' and prevents them from impacting the Earth's surface. Additionally, the mesosphere plays a role in maintaining energy balance by absorbing and redistributing heat within the atmosphere, further contributing to planetary stability.

32. The 'loo' constitutes strong, hot, and dry winds prevalent during summer days, mainly in north and northwestern India, often persisting until midnight. These winds contribute to a unique aspect of the hot weather season, frequently leading to heat strokes and other severe health consequences for individuals exposed to them. Additionally, in May, these regions experience evening dust storms, which offer temporary relief from the intense heat through accompanying light drizzles and cool breezes, occasionally accompanied by violent winds, torrential rainfall, and hailstorms in localized areas.

33. Deforestation directly impacts atmospheric carbon dioxide levels because trees naturally absorb carbon dioxide. When forests are cleared or burned, the carbon previously stored within these trees is released back into the atmosphere. Furthermore, the removal of trees reduces the planet's capacity to absorb future carbon emissions. This dual effect of releasing stored carbon and diminishing absorption capabilities leads to an overall increase in atmospheric carbon dioxide concentration, exacerbating global warming.

34. Industrial processes generate greenhouse gases through factory emissions. Agricultural activities, particularly livestock farming, produce methane, while the use of fertilizers releases nitrous oxide. Both methane and nitrous oxide are potent heat-trapping gases that accumulate in the atmosphere, intensifying the greenhouse effect. These human-driven emissions from both sectors significantly elevate the concentration of gases that warm the planet, distinct from natural sources.

35. The thermosphere, also known as the ionosphere, is crucial for long-distance communication as it facilitates satellite communication and radio transmission. Its ionized gases convert due to solar radiation, making it essential for reflecting radio waves back to Earth. This layer also acts as Earth's radiation shield, protecting life and supporting technological advancements. Without it, global communication systems would be severely hampered, affecting various essential services.

36. Floods induce immediate panic, leading to higher mortality among vulnerable populations. They also cause widespread disease outbreaks like epidemics, viral infections, malaria, and diarrhoea, due to the mixing of waste and organic decomposition, especially in warm climates. Physically, floods devastate standing crops, damage houses, cause dam bursts, and trigger landslides. Environmentally, while some floods deposit sediment, severe events lead to significant soil erosion and alter soil characteristics through the deposition of non-degradable materials, profoundly impacting ecosystems and agriculture.

37. The level of moisture, or humidity, in the air significantly impacts the rate of evaporative cooling. When the air already contains substantial water vapor (high humidity), its capacity to absorb additional moisture through evaporation is reduced. This causes the evaporation process to slow down, lessening

- the cooling effect it can produce. Conversely, in drier conditions with lower humidity, air can absorb more moisture, leading to a more pronounced cooling effect through faster evaporation.
38. The fundamental concept of atmospheric greenhouse gas accumulation due to human activities refers to the total amount of greenhouse gases, primarily carbon dioxide, released into the atmosphere by various human actions. This measurement reflects an individual's or entity's contribution to air pollution and global warming. These emissions lead to an increased concentration of heat-trapping gases, intensifying the greenhouse effect and ultimately causing environmental changes. Understanding this concept is crucial for assessing environmental impact and developing strategies for mitigation.
 39. The drainage basin funnels rainfall and runoff into the river, increasing its volume. The flood plain, being a flat area alongside the river, is naturally prone to inundation when the river exceeds its banks. This combination means that excess water from the drainage basin will spread across the flood plain, leading to floods. Understanding these geographical elements helps in predicting the potential extent and severity of flooding in a given region.
 40. Nitrogen, which constitutes 78% of the atmosphere, is primarily responsible for preventing rapid combustion by reducing the intensity of oxygen. Although it does not directly support respiration or burning, it is vital for plant growth through the nitrogen cycle. Nitrogen-enriched soil leads to enhanced crop yields, making it indispensable for agriculture and global food production. Its abundance ensures a steady supply for agricultural demands.
 41. The atmosphere regulates Earth's temperature by trapping some of the sun's heat, preventing extreme fluctuations between day and night. Without this insulating blanket, days would be excessively hot and nights frigidly cold, making the planet uninhabitable. It also provides essential gases like oxygen for respiration and carbon dioxide for photosynthesis, protecting life from harmful solar radiation through layers like the ozone layer. This multifaceted regulation ensures stable conditions conducive to life.
 42. Atmospheric pressure changes directly correlate with shifts in weather. A sudden decrease in pressure typically signals the formation of a low-pressure system, often associated with unstable weather such as cloudiness, rain, and strong winds. Conversely, high-pressure systems, characterized by increased pressure, usually bring clear skies and calm conditions. Monitoring these pressure variations allows meteorologists to anticipate and predict weather changes, providing essential warnings for potential storms or fair weather.
 43. The ozone layer within the stratosphere significantly protects ecosystems by absorbing harmful ultraviolet (UV) radiation from the sun. By filtering these rays, it prevents severe damage to crops, forests, plankton, and marine ecosystems, which are fundamental for food chains and oxygen production. Without this protection, increased UV exposure would lead to skin cancer, cataracts, and genetic damage, severely disrupting biological processes and biodiversity globally.
 44. Western Disturbances are crucial low-pressure systems that originate over the Mediterranean Sea and Western Asia. These systems are brought into the north Indian Plains by westerly jet streams during the cold weather season. They are responsible for vital winter rainfall over the plains and snowfall in the Himalayas. This precipitation, locally known as 'mahawat', is particularly significant for the cultivation of rabi crops. Their inflow is a prominent characteristic of the season, impacting the agricultural productivity of the region despite the generally dry conditions caused by the northeast trade winds.
 45. An elevated presence of greenhouse gases in the atmosphere can lead to several severe environmental consequences. These include an increase in global temperatures, resulting in climate instability. This can further cause the melting of ice formations at the poles and on glaciers, leading to a rise in oceanic water levels. Additionally, it increases the frequency and intensity of severe weather events and contributes to the degradation of natural habitats, causing a reduction in the variety of animal and plant life. Air pollution also poses significant health challenges.
 46. The northward movement of the sun causes the global heat belt to shift in the same direction, initiating the hot weather season. This leads to rising temperatures and falling air pressure across north India, forming an extended low-pressure area from the Thar Desert to the Chotanagpur plateau. While interior regions like Gujarat and Madhya Pradesh experience high temperatures (around 42°C in April), coastal areas exhibit less temperature variation due to oceanic influence, though their rainfall patterns become distinct. Northwestern regions commonly register temperatures of 48°C by May, highlighting the varied impact of the heat belt shift.

47. Mapping provides essential data on river systems, flood plains, and basins, crucial for informed decision-making by flood control personnel. Land-use control aims to restrict development in flood-prone areas, thereby minimizing risks to life and property; critical facilities like hospitals are sited in safer locations. Flood forecasting and warning systems leverage data and technology to predict floods and alert communities, allowing for timely evacuation and preparation. Together, these non-structural strategies focus on prevention, planning, and preparedness rather than physical barriers.
48. If collective efforts to reduce atmospheric greenhouse gases are insufficient, the long-term societal implications would be severe and widespread. Persistent global warming would intensify, leading to more frequent and extreme weather events, which can devastate infrastructure and agriculture, causing food scarcity and economic disruption. Rising sea levels would displace coastal populations and incur massive costs for adaptation or relocation. Increased health problems due to air pollution and altered ecosystems would strain healthcare systems and reduce biodiversity, potentially leading to resource conflicts and social instability on a global scale. This scenario presents a substantial threat to human well-being and civilization.
49. The sun's northward movement causes the global heat belt to shift towards the north. This shift brings the hot weather season to India, primarily from March to May. Temperatures significantly rise, with western and northwestern regions experiencing up to 48°C, while coastal areas and peninsular India demonstrate more moderate temperatures due to oceanic influence. This highlights a clear latitudinal temperature variation.
50. Water vapor is essential for weather patterns as it is the primary component for forming clouds, rain, fog, and dew; its varying amount across locations dictates humidity levels and precipitation. For climate regulation, water vapor absorbs heat, moderating temperature fluctuations and preventing extreme heat or cold. It also plays a central role in the hydrological cycle, facilitating the movement of water between oceans, the atmosphere, and land, impacting global energy distribution and regional climates.
51. Human activities enhance the greenhouse effect by increasing the concentration of greenhouse gases in the atmosphere. Industrial activities, such as burning coal, oil, and natural gas, release large amounts of carbon dioxide. Agricultural practices contribute methane from livestock and rice cultivation, and nitrous oxide from fertilizers. These gases trap more heat in the atmosphere, leading to global warming and climate change, and disrupting Earth's natural energy balance.
52. A carbon footprint represents the total amount of greenhouse gases, predominantly carbon dioxide, released into the atmosphere as a direct result of human activities. It serves as an indicator of an individual's, community's, or nation's contribution to air pollution and global warming. This crucial metric is typically quantified in tonnes of carbon dioxide equivalent (CO₂e), providing a standardized way to assess environmental impact. Understanding one's carbon footprint highlights the need for sustainable practices to mitigate climate change. It encompasses emissions from various sources like fossil fuel combustion, transportation, and industrial processes. By measuring it in CO₂e, different greenhouse gases are consolidated into a single, comparable unit.
53. Relative humidity measures the proportion of water vapor present in the air compared to the maximum it could hold at a specific temperature. High relative humidity, typically between 60% and 80%, makes the air feel sticky and moist due to reduced evaporation from the skin, impacting human comfort. Conversely, low relative humidity, 20% to 40%, indicates drier conditions.
54. As altitude increases, atmospheric pressure decreases because the air becomes thinner, meaning fewer air molecules exert pressure. This reduction in pressure also implies a lower concentration of oxygen. At high altitudes, individuals may experience symptoms like fatigue, dizziness, or shortness of breath as their bodies struggle to acquire sufficient oxygen due to the thinner air.
55. The troposphere is the atmospheric layer where all major weather phenomena, such as clouds, rain, storms, and winds, occur. It is the lowest layer of the atmosphere, extending from the Earth's surface to about 8–18 km in height. Nearly 75% of the atmosphere's total mass and most of its water vapour are concentrated in this layer. Because of these characteristics, the troposphere plays a crucial role in regulating weather and supporting life on Earth.
56. Temperature variations determine the degree of hotness or coldness of the air. Immediate changes in temperature significantly impact daily weather elements like air pressure, wind, and rainfall. Over

- extended periods, these cumulative temperature variations are crucial in identifying and understanding broader climate trends, allowing scientists to characterize a region's long-term atmospheric conditions.
57. If the normal lapse rate (temperature decrease with altitude) in the troposphere ceased to exist, Earth's weather patterns and life support systems would be drastically altered. Without temperature stratification, the vertical movement of air masses that drives convection and precipitation would diminish significantly, leading to a reduction in cloud formation and rainfall. This would result in widespread drought and impact water resources. Furthermore, the stable temperature inversion could trap pollutants near the surface, severely affecting air quality and human as well as ecological health. The fundamental dynamics of weather and climate, on which life depends, would be profoundly disrupted.
58. The 'probability period' refers to the time preceding a flood when there are clear indications of its impending occurrence. This often involves several days of heavy rainfall or significant snowmelt. During this phase, even an ordinary individual can discern the likelihood of flooding due to persistent rain and increased runoff. For significant hazards like dam bursts, this period might involve observing structural weaknesses such as breaches or cracks in reservoir walls. This predictive interval allows for potential warnings and preparatory actions.
59. Human activities enhance the greenhouse effect by increasing the concentration of greenhouse gases in the atmosphere. Industrial activities, such as burning coal, oil, and natural gas, release large amounts of carbon dioxide. Agricultural practices contribute methane from livestock and rice cultivation, and nitrous oxide from fertilizers. These gases trap more heat in the atmosphere, leading to global warming and climate change, and disrupting Earth's natural energy balance.
60. Floods severely impact public health and agriculture. Public health suffers from panic, which disproportionately affects vulnerable groups. The mixing of waste and water creates an optimal breeding ground for diseases like epidemics, viral infections, malaria, and diarrhoea, especially in warm, wet climates, leading to widespread illness. Agriculturally, standing crops in flood plains are destroyed by sediment deposition and the sheer force of water, causing significant economic losses. Mitigation involves robust public awareness campaigns to manage panic, implementing strict sanitation measures post-flood to prevent disease outbreaks, and developing flood-resistant crop varieties or adopting agricultural practices that account for flood cycles. Additionally, early warning systems enable proactive harvests or livestock relocation, reducing losses.
61. Do it yourself
62. Do it yourself
63. Do it yourself
64. Do it yourself
65. Do it yourself
66. a. The ozone layer, which filters out harmful ultraviolet radiation, is located within the stratosphere.
b. Incoming meteoroids burn up due to the intense friction generated when they strike gaseous particles while traveling at high speeds through the mesosphere.
c. The ionosphere contains electrically charged particles that reflect radio frequencies back to Earth, enabling long-distance wireless transmissions. Meanwhile, the exosphere provides a stable, friction-free orbit for advanced satellites that manage modern GPS navigation, television broadcasts, and global internet networks.
67. a. The average atmospheric pressure recorded at sea level is approximately 1013 millibars (mb).
b. Meteorologists utilize a barometer to measure changes and trends in atmospheric barometric pressure.
c. A low-pressure depression occurs when warm, light air rises, causing atmospheric instability that generates cloud formation, strong winds, and heavy precipitation. In contrast, a high-pressure system contains heavy, sinking air that suppresses cloud formation, resulting in clear skies and stable, calm weather.
68. a. The loo winds are strong, hot, and dry winds that blow during the daytime in the hot weather season, specifically between March and May, over northern and northwestern India. Direct exposure to these oppressive summer winds can be highly dangerous, frequently causing severe heat strokes.

- b. The low-pressure systems responsible for bringing vital winter rain to the northern plains are known as the Western Disturbances. These systems originate over the Mediterranean Sea and Western Asia, and they are carried into the Indian subcontinent by high-speed westerly jet streams.
 - c. During the advancing monsoon, the Arabian Sea branch hits the Western Ghats, forcing moisture-heavy winds to climb the mountains. As the air rises on the windward side, it cools and condenses, dropping heavy rainfall exceeding 250 cm over the Sahyadris. However, when the winds cross the crest and descend onto the leeward side, they lose most of their moisture and warm up. This relief barrier creates a rain-shadow zone over the interior Deccan Plateau, which receives scanty precipitation of less than 50 cm.
69. a. A carbon footprint is standardly measured and expressed in tonnes of carbon dioxide equivalent (tCO_2e).
- b. A direct carbon footprint comes from activities you control firsthand, like burning petrol while driving a car. An indirect carbon footprint comes from emissions produced making things you buy, like the energy factories use to manufacture your mobile phone.
 - c. Purchasing imported packaged goods increases your indirect carbon footprint because it requires extensive fossil fuel energy to process the food, manufacture the plastic packaging, and transport the cargo across long international distances via planes or cargo ships. Choosing locally grown, seasonal food items bypasses these energy-intensive industrial steps. Minimizing the factory processing and long-distance transport logistics effectively cuts down the total greenhouse gases emitted before the food reaches your plate.
70. a. The standard thermal lapse rate within the troposphere is a temperature decrease of $1^\circ C$ for every 165 meters of vertical ascent.
- b. The transitional boundary that marks the uppermost limit of the troposphere and separates it from the stratosphere is the tropopause.
 - c. The troposphere contains nearly 75 percent of the atmosphere's mass and holds virtually all the essential water vapor. Because it retains these heavy gases and moisture, along with a declining thermal gradient, it is the only layer structurally capable of generating clouds, storms, and precipitation to sustain biological ecosystems.
71. Sustained changes in wind patterns, such as a prolonged shift in prevailing wind direction or consistent increases in wind speed, can have profound impacts on agriculture and environmental dynamics. Agriculturally, altered wind patterns can affect crop yields by influencing temperature and moisture regimes. For instance, winds from a new direction might bring drier air, increasing evaporation from soil and plants, thus demanding more irrigation and potentially leading to drought stress. Conversely, winds bringing consistent moisture could increase disease risk. Stronger sustained winds can also cause soil erosion, damage crops directly through lodging, and interfere with pollination. Environmentally, persistent shifts in wind can redistribute pollutants or wildfire smoke over new areas, impacting air quality and ecosystems. They also play a critical role in seed and pollen dispersal, potentially altering plant distribution and biodiversity. Furthermore, long-term wind changes can influence ocean currents and local climate, affecting rainfall patterns and the viability of certain agricultural crops over time, potentially necessitating changes in farming practices or crop selection.
72. Relative humidity measures the amount of water vapour present in the air compared to the maximum amount the air can hold at a given temperature, expressed as a percentage. It helps us understand how moist or dry the air feels. When relative humidity is low (generally below 40%), the weather is considered **dry**, and the air feels less moist. When relative humidity is high (generally above 60%), the weather is considered **humid**, making the air feel damp and often causing discomfort because sweat evaporates more slowly from the skin. This influences our perception of temperature and comfort.
73. A significant flood event can have serious health and environmental consequences. During floods, people may suffer injuries, drowning, and loss of life due to fast-moving water and collapsing structures. Floodwaters often contaminate drinking water with sewage, chemicals, and waste, increasing the risk of water-borne diseases such as cholera, diarrhoea, and typhoid. Stagnant water after floods also provides breeding grounds for mosquitoes, leading to diseases like malaria and dengue. Environmentally, floods cause soil erosion, destruction of vegetation, damage to crops, and loss of wildlife habitats. They can also spread pollutants and debris over large areas. These impacts occur

because excessive water overwhelms natural drainage systems, inundates land, and carries contaminants from affected regions, disrupting both human and natural environments.

74. The mean daily temperature is calculated by adding the highest (maximum) and lowest (minimum) temperatures recorded during a day and dividing the sum by two.

$$\text{Mean Daily Temperature} = \frac{\text{Maximum Temperature} + \text{Minimum Temperature}}{2}$$

For example, if the maximum temperature is 32°C and the minimum temperature is 20°C , the mean daily temperature is 26°C .

This value provides an average measure of the day's thermal conditions, helping meteorologists compare temperatures across different days and locations. It is useful for studying climate patterns, weather changes, agriculture, and assessing the overall warmth or coolness experienced during a day.

75. A high carbon footprint leads to numerous adverse environmental and health consequences.

Environmentally, it accelerates global warming and climate change, causing glaciers and polar ice to melt, which in turn raises sea levels and increases the frequency and intensity of extreme weather events. This also contributes to a significant loss of biodiversity as habitats are altered or destroyed.

From a health perspective, elevated carbon footprints are associated with increased air pollution, which can exacerbate respiratory illnesses and other health problems in human populations. These integrated impacts underscore the urgency of reducing greenhouse gas emissions globally.

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