



GREENHOUSE GASES AND GLOBAL CLIMATE CHANGE

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OVERVIEW:

The presence of greenhouse gases in our atmosphere has contributed to climate change on a global scale.

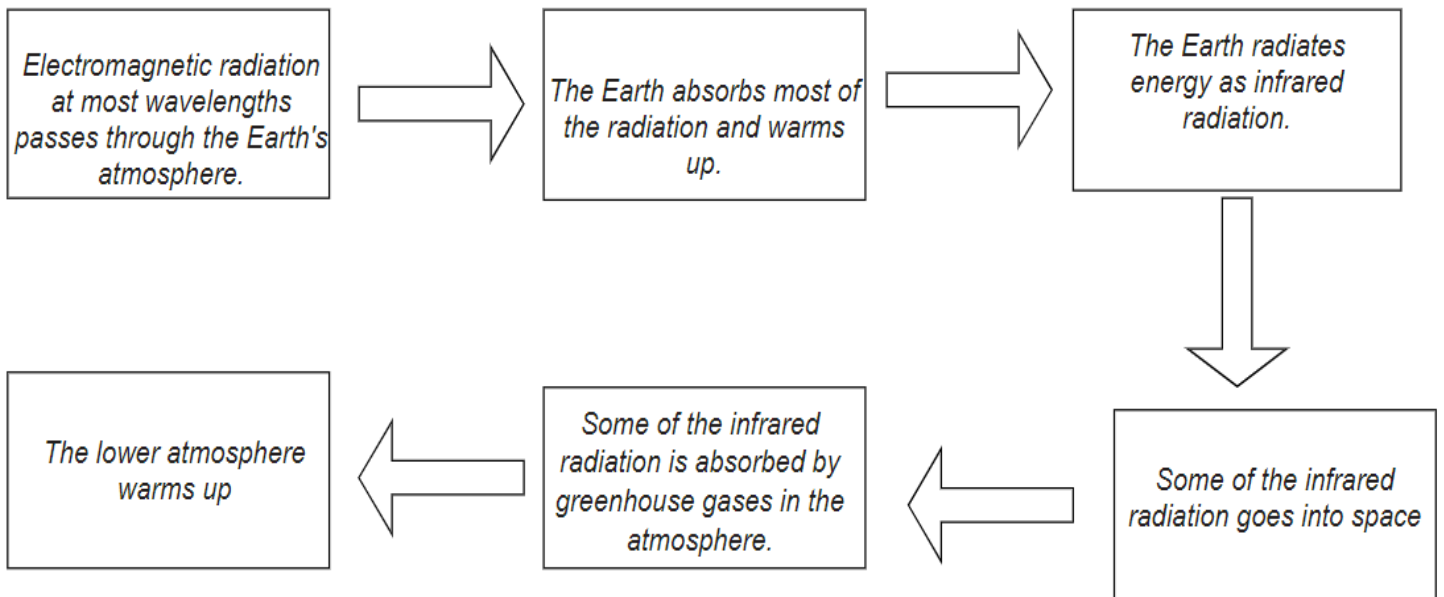
Greenhouse gases

Greenhouse gases are the gases present in the Earth's atmosphere that trap heat and cause and increase in the temperature on earth. These gases play a major role in the greenhouse effect and subsequent global climate change. The greenhouse effect refers to the interaction between the Earth's atmosphere and surface to absorb, transfer, and emit energy as heat, cycling it through the atmosphere and back to the surface. The Earth's natural greenhouse effect is often compared to a nursery greenhouse because of its ability to alter the local environment, keeping heat confined in a specific environment. The main greenhouse gases are Carbon Dioxide, Methane, Nitrous Oxide, and Fluorinated Gases (F- gases) - such as Chlorofluorocarbon. Carbon dioxide is an extremely important greenhouse gas since it is found in extremely high concentrations in our atmosphere and is deposited from both natural - volcanic eruptions - and anthropogenic (manmade) sources - burning fossil fuels and deforestation-. Its high concentration is considered to be toxic and harmful to our environment, however, Methane is considered to be the greenhouse gas which has the highest global warming potential. Methane is predominantly produced through livestock production (released from their digestion and manure) and the degradation of organic matter from landfills, while Nitrous Oxide is predominantly produced from organic fertilizer production and usage. Fluorinated Gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride and nitrogen trifluoride are known to cause damage to the ozone layer and are the only greenhouse gases that are not produced naturally. The F-gases are produced during the use of manmade appliances such as refrigerators,



air-conditioning, and aerosols. Water vapor is the most abundant greenhouse gas, however it is not considered a direct cause of climate change, since the warming of the earth's oceans releases a lot of it into the atmosphere.

The 6 main steps involved in the greenhouse effect



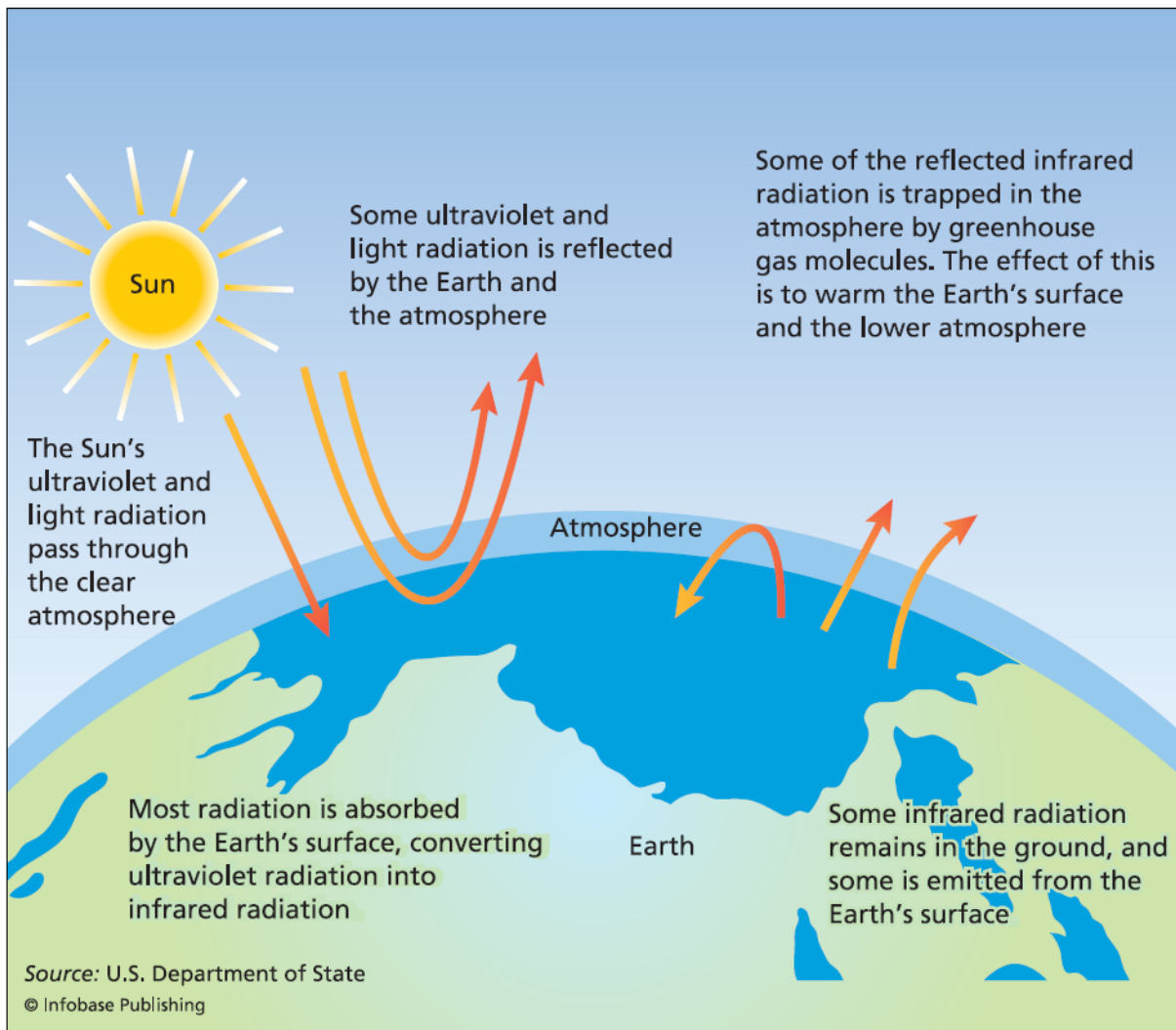


Fig. 1 - Diagram illustrating the greenhouse effect



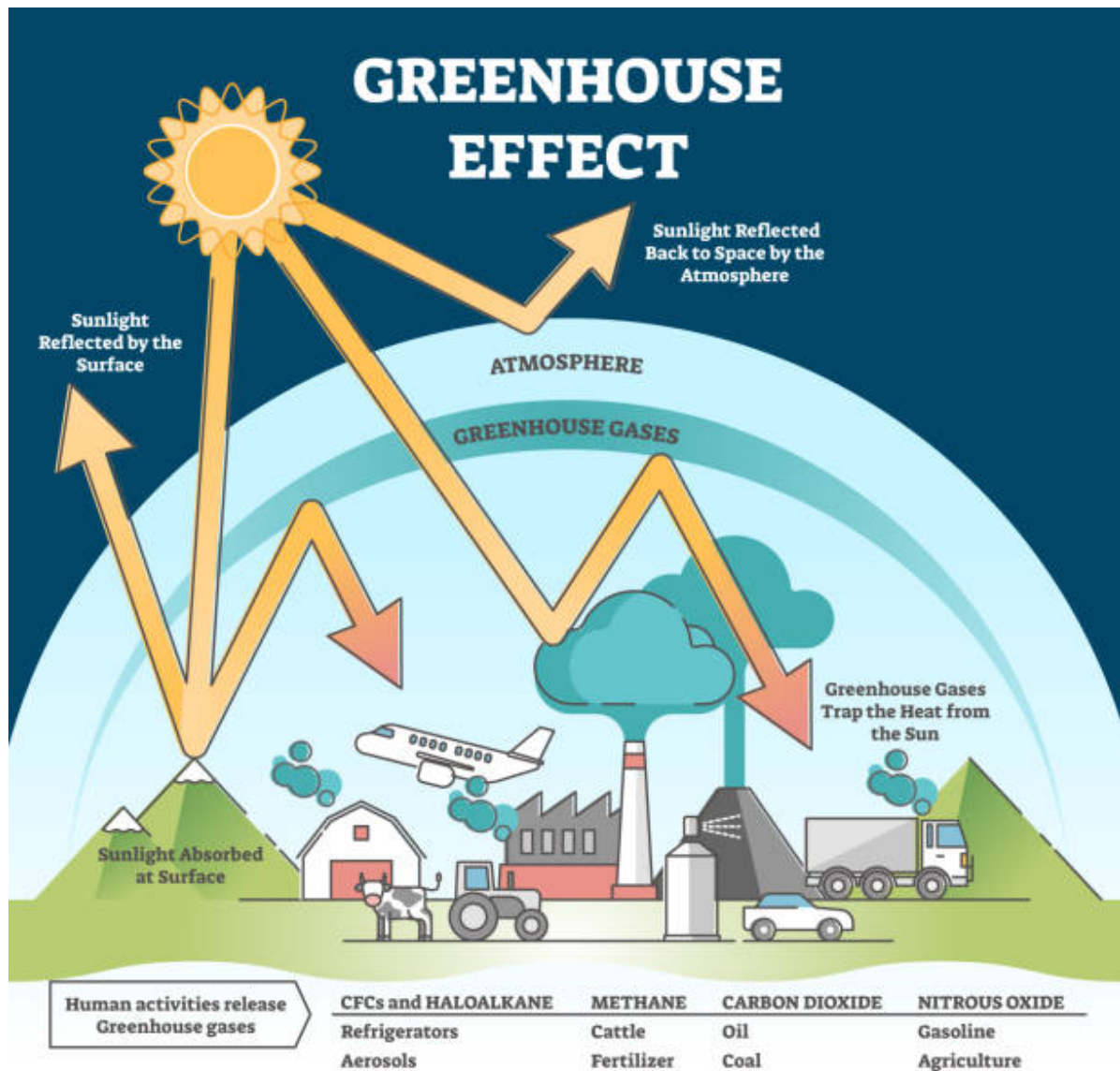


Fig 2. Diagram illustrating the greenhouse effect and common causes of this phenomenon

Global Climate Change

This term is often used interchangeably with global warming, however global climate change does not only refer to the increase in the temperature of the earth but rather any changes in the climate and weather patterns on the earth over a long period of time.



Global climate change is heavily influenced by the increase in greenhouse gas concentrations in the atmosphere and as a result the greenhouse effect - as depicted above - also plays a big role in climate change. As a result of the natural and anthropogenic activities aforementioned which drastically change the proportionality and concentration of greenhouse gases, climate change has become more evident. An increase in the global temperatures, changes in the seasons and precipitation patterns, melting of ice caps and glaciers, rise in sea levels, floods, ocean acidification, loss of biodiversity, droughts and wildfires are a few of the consequences of global climate change. Panels, such as The Intergovernmental Panel on Climate Change (IPCC) which is the international body for assessing the science related to climate change, along with global agreements like the Kyoto protocol and Paris agreement are few of the efforts and implementations being made globally to mitigate the harmful effects of greenhouse gases, global warming and by extension, climate change. The Kyoto Protocol is an international agreement that aims to reduce carbon dioxide emissions and the presence of greenhouse gases in the atmosphere, while the Paris agreement is a legal binding international treaty on climate change whose goal is to sustain the increase in the global average temperature “to well below 2°C above pre-industrial levels” and pursue efforts “to limit the temperature increase to 1.5°C above pre-industrial levels.”

In addition, in order to mitigate climate change and prevent further damage to the environment, the reduction of greenhouse gas emissions is necessary. This can be achieved by car pooling, limiting or avoiding the use of contents from aerosol cans, reforestation, using renewable energy, etc.



Key terms relating to greenhouse gases and global climate change

- **Greenhouse gases** - Gases that slow the outgoing heat in the atmosphere and cause the planet to warm.
- **Carbon footprint**- The sum total of all the greenhouse gas emissions that had to take place in order for a product to be produced or for an activity to take place.
- **Greenhouse effect**- The process by which heat is trapped close to the surface of the Earth by greenhouse gases.
- **Climate Change** - The average weather shifts over a long period of time, in a specific location, a region, or the entire planet.
- **Carbon Cycle** - continuous flow of carbon between organic and inorganic carbon reservoirs, or areas of Earth where large amounts of carbon are stored
- **Deforestation** - Deforestation is the purposeful clearing of forested land.
- **Reforestation**- The replanting of deforested areas to restore forests destroyed in the recent past



ACTIVITY 1:

From the word bank given, complete the passage about greenhouse gases and global climate change. Tip - Some of the words provided will not be used and one word / phrase can be used twice

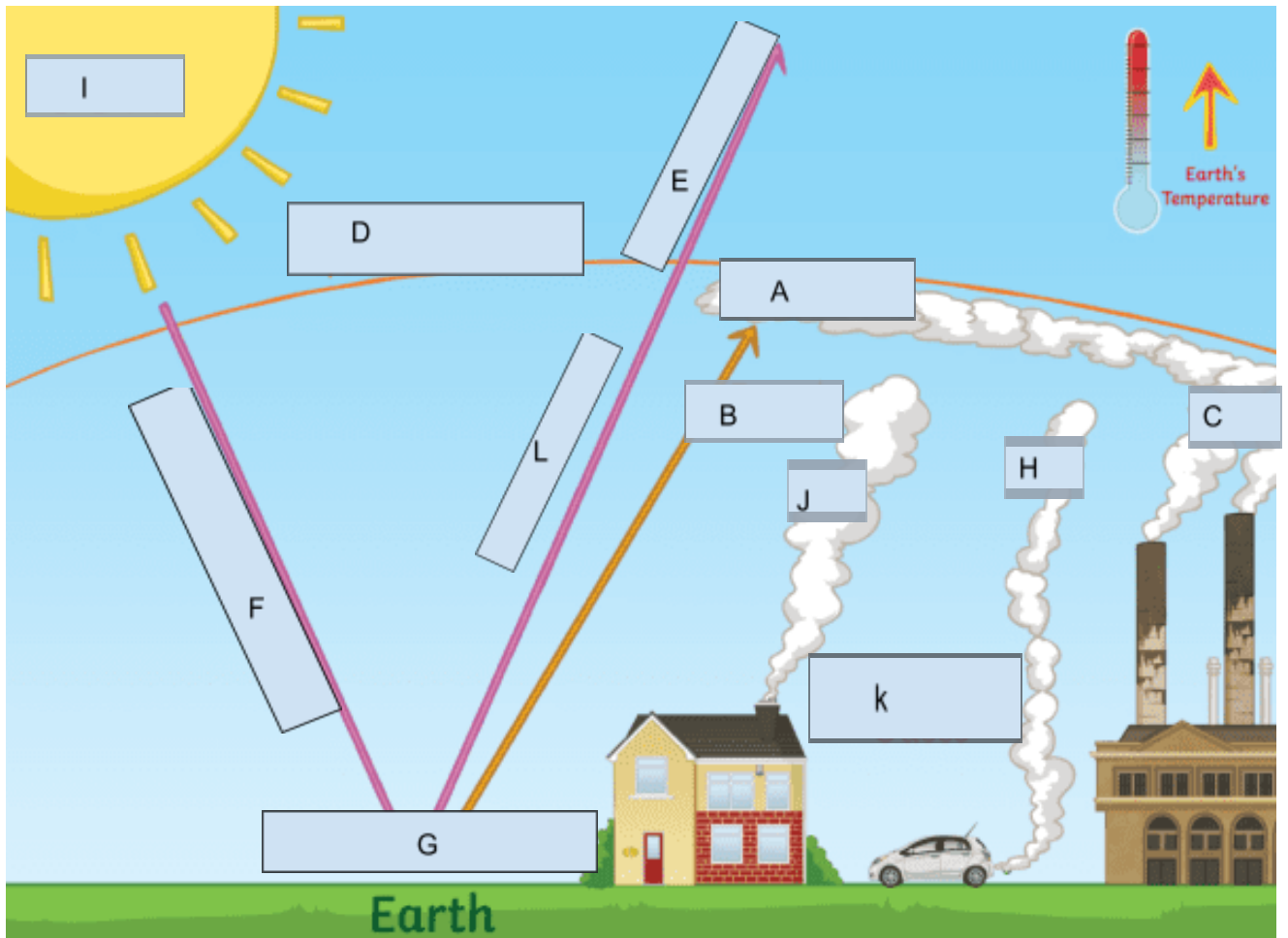
Climate Change, Global Warming, Greenhouse gases, Deforestation, Ozone (O₃), Methane (CH₄), Emissions, Cars, CFCs, Atmosphere, Reduction; greenhouse effect, Fossil Fuels, Ozone layer, Carbon Dioxide (CO₂), Mitigate, Climate, Factories, Pollutants, Water Vapour Environment, Global, Increase, fluorinated gases, Temperatures, Reduction, Anthropogenic, Nitrous Oxide, Climate, Helium,

Changes in our **climate** have over the years been heavily influenced by human behavior. Our increased usage of **factories** and other production industries contribute to the release of **pollutants** into the atmosphere. Sadly, these **emissions** cause a change in the concentration of **greenhouse gases** in the **atmosphere**. Some of these gases include, **Methane** which is predominantly produced in livestock rearing and has the highest global warming potential, **Water vapour** which is most abundant, **Carbon dioxide** produced from the burning of fossil fuels, **Nitrous Oxide**, **Ozone** and **fluorinated gases** such as PFCs (perfluorocarbons) and **CFCs**. In the last few decades, high concentrations of **greenhouse gases** have caused damage to the **environment** and has resulted in **global climate change**. The intensification of the **greenhouse effect** has caused **global warming**, which refers to an **increase** in atmospheric **temperatures**. In order to **mitigate** these environmental issues a **reduction** of **anthropogenic** CO₂ emissions from **cars**, the burning of garbage and **fossil fuels** is necessary.



ACTIVITY 2:

Label the diagram below that depicts the greenhouse effect and answer the questions to follow. Feel free to use the letter corresponding to your answer in the spaces provided.



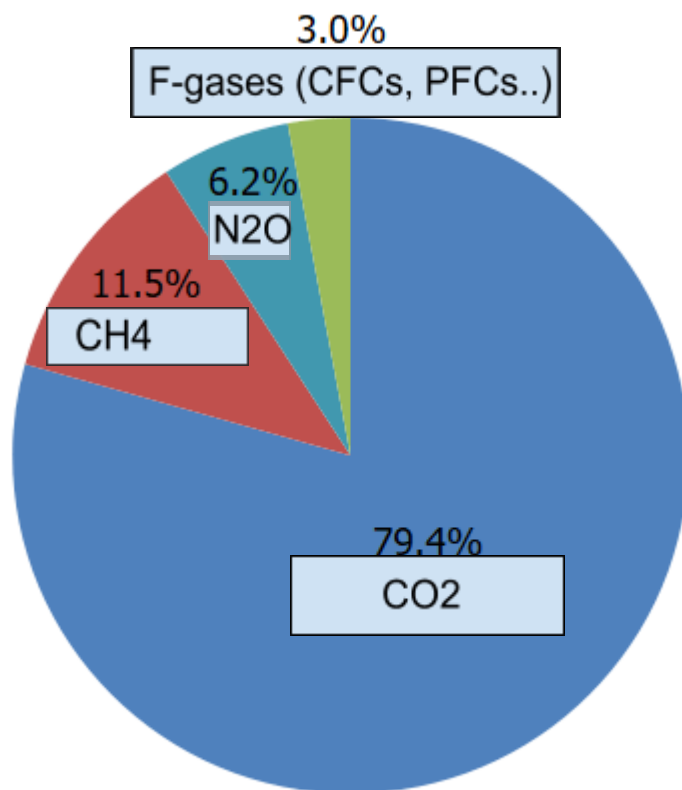
A. Ch ₄	G. Energy Absorbed on Earth
B. Trapped Radiation	H. Co ₂
C. N ₂ O	I. Sun
D. Atmosphere	J. SF ₆
E. Expanding Radiation	K. Greenhouse Gases
F. Solar Radiation	L. Reflected Sunlight



Using the diagram above and your previous knowledge on greenhouse gases, briefly explain why the phenomenon illustrated above is called the greenhouse effect.

In a greenhouse, sunlight enters, and heat is trapped or retained. The greenhouse effect describes a similar phenomenon where the greenhouse gases aid the trapping of heat in the atmosphere and as a result the earth's temperature rises.

The pie chart below obtained from the U.S environmental protection agency depicts greenhouse gas emissions from 1990- 2021. Complete the pie chart by inserting the greenhouse gas you expect to find in each segment.



U.S. Environmental Protection Agency (2023). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021



ACTIVITY 3:

Match the definition of the key terms relating to greenhouse gases and global climate change to their meaning.

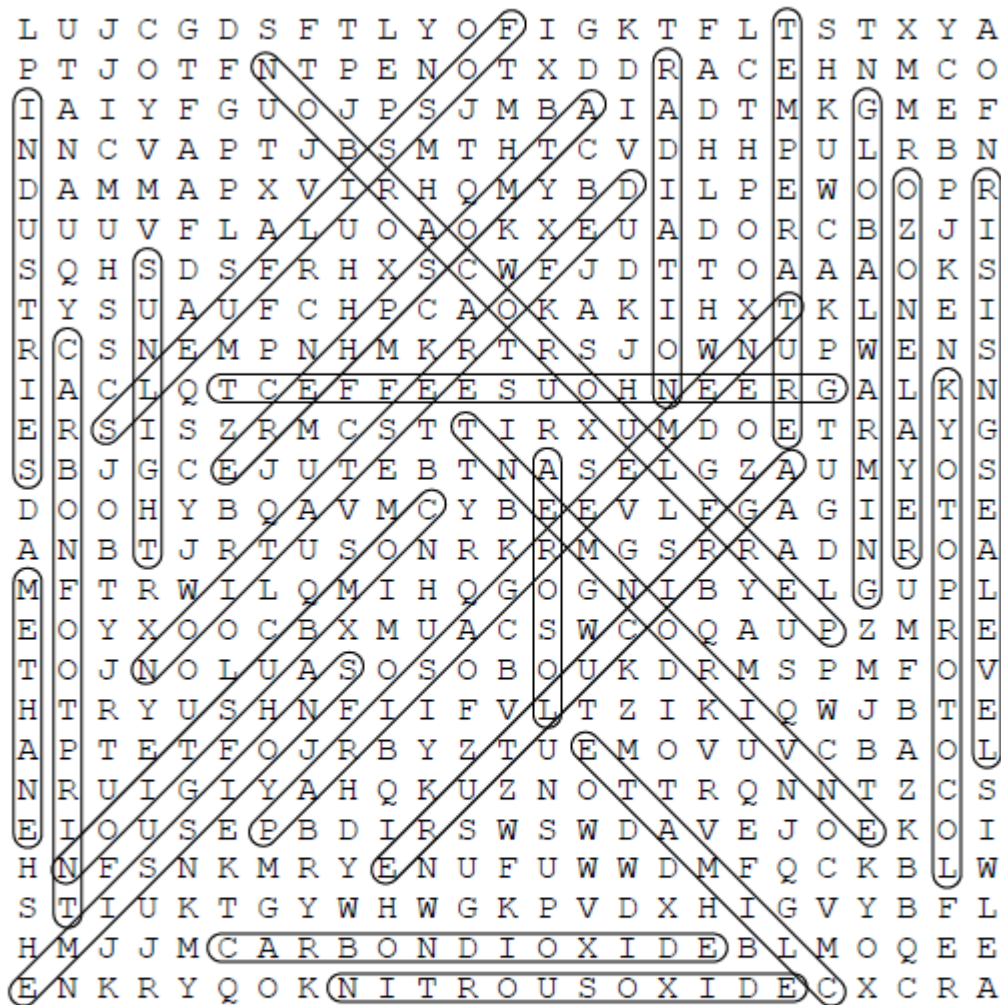
1.	f	Ozone Layer	a. any gas with the capacity of absorbing infrared radiation emitted from Earth's surface and reradiating it back to Earth
2.	g	Carbon Footprint	b. an increase in the temperature of the earth's surface due to the heating of the lower layers of the atmosphere
3.	b	Greenhouse Effect	c. substances made from decomposing plants and animals that can be found in Earth's crust and contain carbon and hydrogen
4.	a	Greenhouse Gas	d. changes in weather patterns and growing seasons around the world
5.	d	Climate Change	e. unusually rapid increase in Earth's average surface temperature over a long period of time
6.	e	Global Warming	f. a thin part of Earth's atmosphere that absorbs almost all of the sun's harmful ultraviolet light
7.	c	Fossil Fuels	g. a measure of greenhouse gas contributed to the atmosphere on a daily basis
8.	h	Kyoto Protocol	h. an international agreement that called for industrialized nations to significantly reduce their greenhouse gas emissions
9.	i	Emissions	i. an amount of a substance that is produced and sent out into the air that is harmful to the environment
10.	j	Paris Agreement	j. global plan to tackle climate change and restrict global warming to well below 2°C above pre-industrial levels.



Complete the word search below using the words from the previous activity and other key terms relating to greenhouse gases and global climate change.

Tip - Words can also be found diagonally .

Greenhouse gases and global climate change



1. carbondioxide
2. methane
3. nitrousoxide
4. greenhouseeffect
5. globalwarming
6. fossilfuels
7. deforestation
8. ozonelayer
9. carbonfootprint
10. emissions
11. temperature
12. climate
13. parisagreement
14. kyotoprotocol
15. perfluorocarbon
16. risisngsealevel
17. environment
18. atmosphere
19. combustion
20. aerosol
21. agriculture
22. industries
23. radiation
24. sunlight



ACTIVITY 4:

Choose the correct alternative that best answers the questions or completes the phrase.

1. The two major causes of global climate change are


a) Earth's magnetic field changes and greenhouse gases in the lower levels of Earth's atmosphere 

b) Greenhouse gases and Rainfall

c) Earth's magnetic field changes and Rainfall

d) Burning of fossil fuels and water pollution

2. What is the primary source of carbon dioxide emissions?

a) Burning fossil fuels 

b) Deforestation


c) Industrial processes

d) Agricultural activities

3. The anthropogenic causes of climate change include

a) population growth, solar activity, economic growth, production of industrial goods


b) deforestation, rotation of the earth, production of industrial goods, volcanic activity

c) population growth, deforestation, globalization, production of industrial goods 


d) deforestation, economic growth, production of industrial goods, earth's reflectivity



4. All the following are major contributors to the greenhouse effect except :


- a) Use of body lotions 
- b) Use of combustible materials such as coal
- c) use of aerosol body spray
- d) burning of garbage at landfill and incense

5. The Paris protocol's goal is to :


- a) develop low-carbon technologies, build a spaceship and the adaptation of countries to climate change
- b) end the fossil fuels era, the development of low-carbon technologies and the adaptation of countries to climate change 
- c) end the fossil fuels era, collect samples of water and air and the adaptation of countries to climate change.
- d) end the fossil fuels era, produce more sugar cane and the adaptation of countries to climate change.




6. Which of the following best describes what greenhouse gases are?

- a) Gases that trap the sun's heat in the atmosphere 
- b) Gases produced in greenhouses
- c) Gases produced for cooking
- d) Gases produced during photosynthesis

7. Which of the following is not a greenhouse gas ?


- a) Carbon Dioxide
- b) Nitrogen 
- c) Water Vapour
- d) Methane

8. Which greenhouse gas contributes the most to global warming or has the highest global warming potential ?


- a) Carbon Dioxide
- b) Argon
- c) Water Vapour
- d) Methane 




9. What is global climate change?

- a) The seasonal variations in temperature and precipitation
- b) Long-term changes in Earth's climate patterns 
- c) Changes in the climate of specific regions
- d) Changes in weather conditions over a short period of time

10. In general, how long do greenhouse gases stay in the atmosphere ?

- a) weeks
- b) months
- c) days
- d) years 

11. Carbon dioxide emissions and methane emissions can be reduced by :

- a) Modifying animal feeding practice and fuel switching respectively
- b) Replace aerosol and reforestation respectively
- c) Fuel switching and Modifying animal feeding practices respectively 
- d) Deforestation and fuel switching



12. The greenhouse effect in the atmosphere alters our climate, which of the following is a main impact of climate change ?


a) shifts in snow and rainfall patterns

b) rise in sea levels

c) melting of glaciers and Icecaps

d) all of the above 

13. Which greenhouse gas/ gases has the highest concentration in the atmosphere but contributes little to global warming?

a) Water Vapour 

b) Nitrous Oxide


c) Fluorinated Gases (F-gases)

d) Carbon Dioxide and Oxygen

14. Which of the following is not an impact of high concentrations of Carbon Dioxide on Marine life ?

a) coral bleaching

b) ocean acidification

c) depletion of the ozone layer 

d) loss of biodiversity



Match the major greenhouses gases to their sources :

- | | |
|---|---|
| 1. Carbon dioxide (CO ₂): | a. Industrial Processes - Refrigeration , Aerosol |
| 2. Methane (CH ₄): | b. Fossil fuels- Oil, Coal |
| 3. Nitrous Oxide (N ₂ O): | c. Fertilizer, Gasoline |
| 4. F-gases (HFCs, PFCs, SF ₆) | d. Cattle, Fertilizer |

1-b , 2-d, 3-c,4-a

True (T) or False (F)

1. The transportation industry is the fastest growing source of emissions, behind only the power sector - **T**
2. The reduction of ice cover and snowfall has no impact on climate change - **F**
3. High levels of CO₂ from global warming is causing the oceans to become more basic-**F**
4. Many animals are prone to extinction to due to climate change -**T**



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