AIR POLLUTION AND ITS IMPACT

AN ENVIRONMENTAL STUDY

********* - 23C15A0105

UNDER THE GUIDENCE OF
****

INTRODUCTION

- Air is all around us, and it contains about 21% oxygen. This oxygen is very important because we need it to breathe and for our bodies to work properly. But a long time ago, when Earth first formed, the air didn't have any oxygen at all. Even then, tiny and simple life forms were able to live without it.

- Things began to change when green plants appeared on Earth. These plants used sunlight to make their own food through a process called photosynthesis. During this process, they took in carbon dioxide (CO_2) from the air and released oxygen as a result. Slowly, oxygen started building up in the atmosphere, which helped support more complex forms of life.

- Carbon dioxide isn't all bad, though. It helps trap heat from the Sun and keeps our planet warm. This is called the greenhouse effect. Without carbon dioxide, Earth would be freezing, and it would be very hard for any living thing to survive.

CAUSES OF AIR POLLUTION

- **BURNING OF FOSSIL FUELS:** RELEASES SULPHUR DIOXIDE AND CARBON MONOXIDE.

- **AUTOMOBILES:** EMIT CO, NOX, HYDROCARBONS – MAJOR GREENHOUSE CONTRIBUTORS.

- **AGRICULTURAL ACTIVITIES:** AMMONIA AND PESTICIDES POLLUTE THE AIR.

- **MINING ACTIVITIES:** RELEASE DUST AND HARMFUL GASES AFFECTING WORKERS' HEALTH.

- **DEFORESTATION:** THE CUTTING DOWN OF TREES REDUCES THE ABILITY OF FORESTS TO FILTER AIR POLLUTANTS AND CONTRIBUTES TO HIGHER LEVELS OF CO_2 IN THE ATMOSPHERE.

- **WASTE DISPOSAL AND LANDFILLS:** DECOMPOSING WASTE IN LANDFILLS PRODUCES METHANE, A POTENT GREENHOUSE GAS, AND RELEASES TOXIC CHEMICALS INTO THE AIR.

- **HOUSEHOLD ACTIVITIES:** USE OF HOUSEHOLD CLEANING PRODUCTS, PAINTS, AND HEATING METHODS LIKE WOOD BURNING CAN RELEASE VOLATILE ORGANIC COMPOUNDS (VOCS) AND PARTICULATE MATTER.

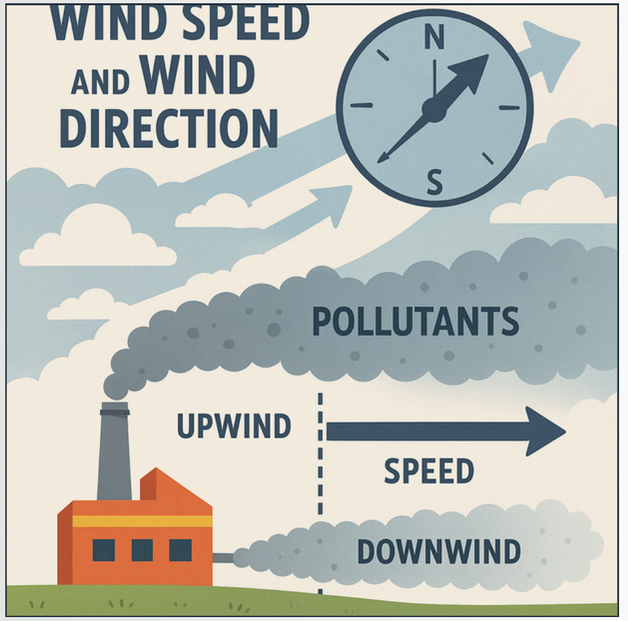
GLOBAL EFFECTS

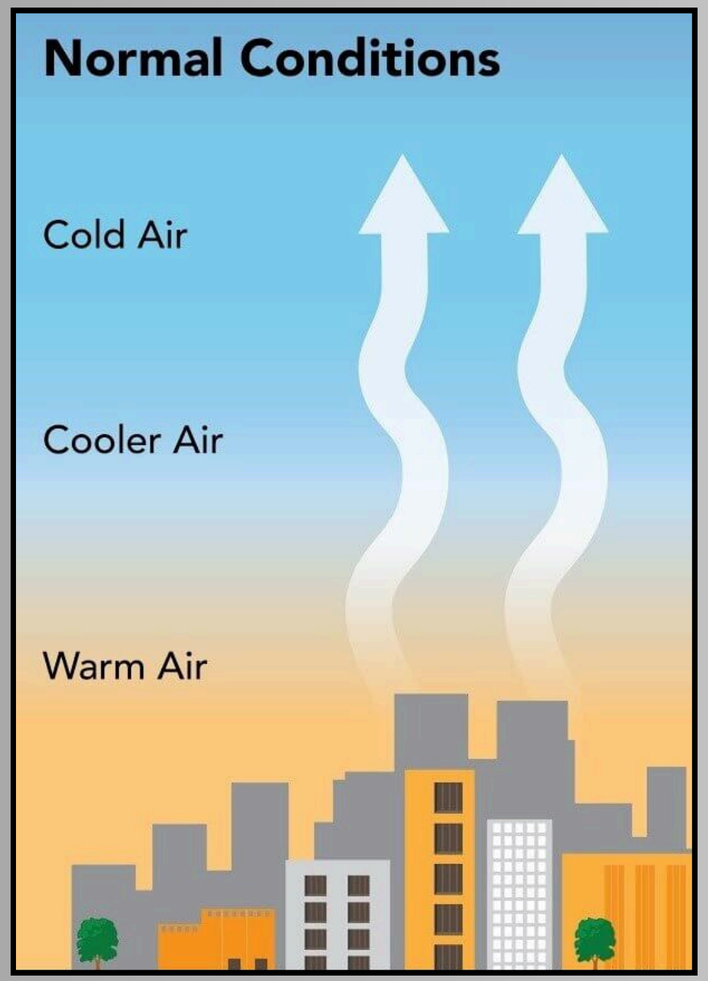
- **Diseases:** Air pollution causes many breathing problems and heart diseases in people. The number of lung cancer cases has gone up in recent years. Children who live near polluted areas are more likely to get pneumonia and asthma. Many people die every year because of air pollution, either directly or indirectly.
- **Global Warming:** The release of greenhouse gases has upset the balance of gases in the air. This has caused the Earth's temperature to rise, a phenomenon known as global warming. As a result, glaciers are melting, and sea levels are rising, flooding many areas.
- **Acid Rain:** Burning fossil fuels releases harmful gases like nitrogen oxides and sulfur oxides into the air. When water droplets mix with these gases, they become acidic and fall as acid rain, which harms humans, animals, and plants.
- **Ozone Layer Depletion:** The release of chemicals like chlorofluorocarbons (CFCs) is a major cause of the depletion of the ozone layer. A thinner ozone layer cannot block harmful ultraviolet (UV) rays from the sun, which can lead to skin diseases and eye problems.
- **Effect on Animals:** Air pollutants also affect water bodies, harming aquatic life. Pollution forces animals to leave their homes and move to new areas, making them stray. This has led to the extinction of many animal species.

"METEOROLOGICAL FACTORS INFLUENCING AIR POLLUTION"

1.Wind Speed and Wind Direction:

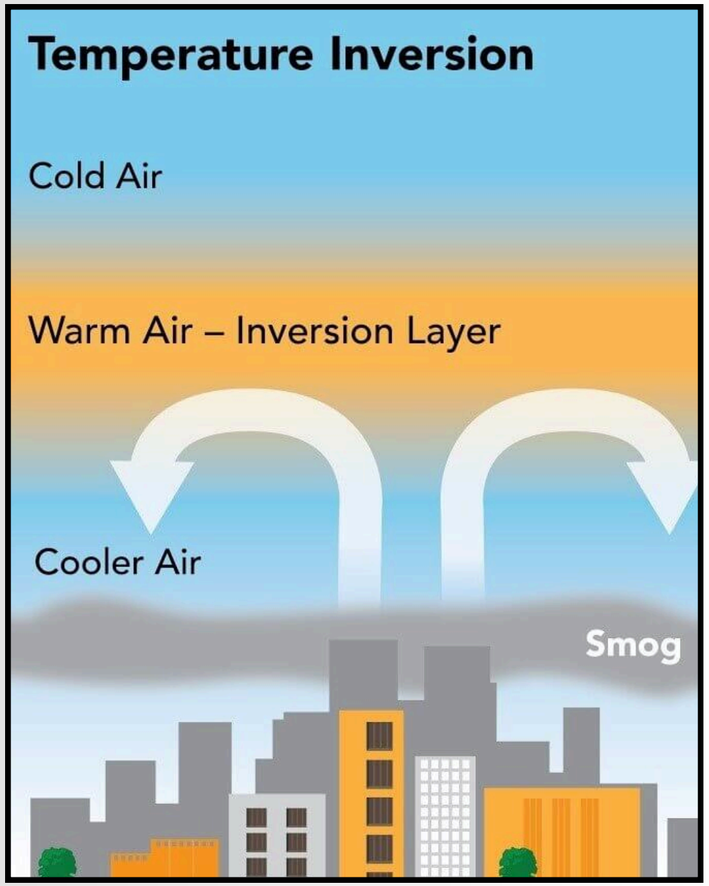
- Wind is air in motion and transports pollutants from one place to another.
- Only the horizontal motion is usually considered for direction and speed.
- Vertical air movement is called an air current.
- Pollutant dilution at the source depends on wind direction and speed.
- Wind direction shows where pollutants are headed.
- Wind speed affects how quickly pollutants disperse.
- Higher wind speed = lower pollutant concentration downwind.





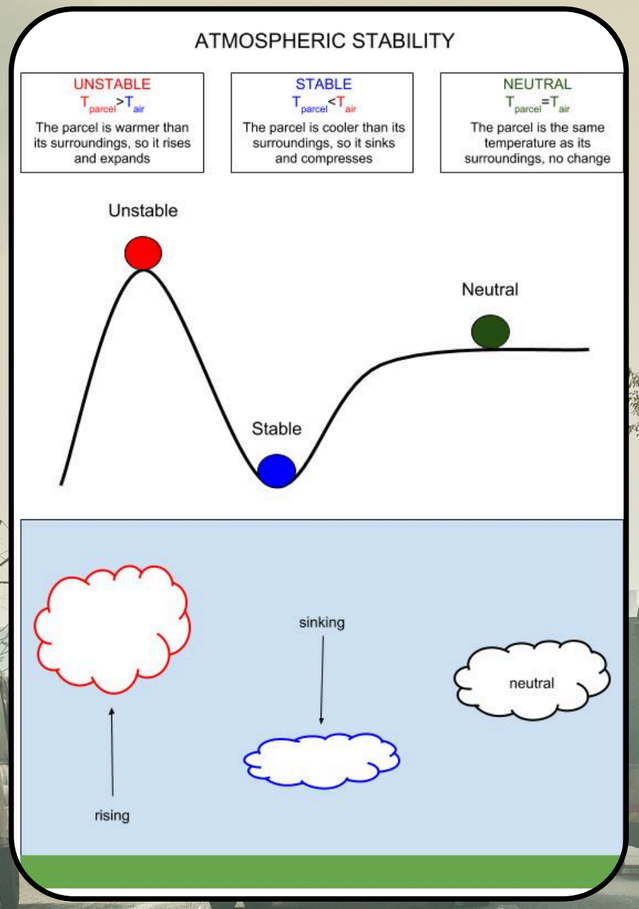
2.TEMPERATURE INVERSIONS

- Temperature inversion occurs when air temperature increases with altitude, instead of decreasing.
- This creates high atmospheric stability, halting vertical air movement.
- As a result, pollutants get trapped below the stagnant air layer.
- Inversions are responsible for localized air pollution buildup.
- The relationship between environmental lapse rate and dry adiabatic lapse rate during inversion.
- Often occurs at night, when earth's surface loses heat, especially in urban areas with little greenery.
- Humidity and cold air accelerate surface cooling, causing fog and dew formation.
- A warmer layer above traps the cooler air, preventing vertical mixing.
- Inversion ends when sunrise warms the lower layer, restoring normal air movement.



ATMOSPHERIC STABILITY & ADIABATIC LAPSE RATE

- **Atmospheric Stability:** Stability of atmosphere is highly dependent upon the vertical distribution of temperature with height. It is important to understand the following terms in this context and their significance thereof.
- **Adiabatic Lapse Rate** You have read that temperature of atmosphere is basically a result of the solar energy received by earth. The solar energy gets redistributed by movement of heavy mass of air with varying pressures. Due to the decrease of pressure with height, a parcel of air lifted to a higher altitude encounters decreased pressure and expands. This expansion causes cooling. If this expansion takes place without loss or gain of heat (that is isothermally) to the parcel, the change is called adiabatic. Similarly, a parcel of air forced downward in the atmosphere will encounter higher pressure, will contract and will become warmer. The rate of cooling with lifting or heating with descent is called the dry adiabatic lapse rate and is approximately 1°C/100 metres of altitude



SECONDARY EFFECTS

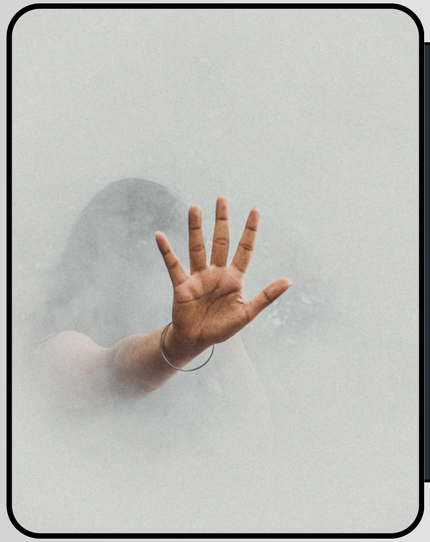
Humidity, Precipitation, and Washout

- Water is present in the atmosphere as vapour, liquid (clouds), or ice.
- Water vapour in the air is called humidity, and too much of it adds to global warming.
- Relative humidity is the amount of water vapour in the air compared to how much it can hold at a certain temperature.
- Clouds are made of tiny water droplets and lead to precipitation (rain).
- Rain is a natural way the atmosphere cleans itself.
- Tiny pollutants in clouds grow into raindrops and fall to the ground.
- Small particles in the air act as centers for water to condense and form raindrops.
- During rainfall, some pollutants are removed from the air — this is called the washout effect.
- Washout mainly removes larger particles from the air.

VISIBILITY AND RADIATION

Visibility

1. Fog forms when water droplets are suspended in the air near the ground.
2. It reduces visibility, making it hard to see long distances.
3. Fog can trap pollutants close to the ground.
4. This makes air pollution levels worse, especially in cities.
5. Poor visibility can also affect transportation and health

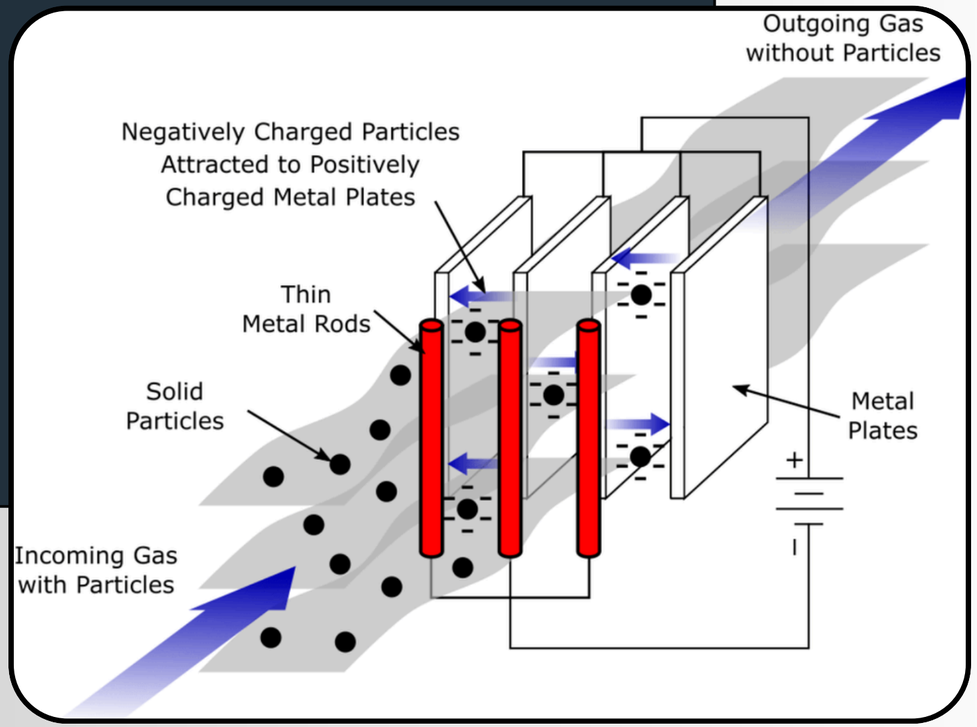


Radiation

1. Radiation fog forms when the ground cools at night, making air above it cooler.
2. High albedo surfaces (like snow or bright ground) reflect sunlight and slow ground warming.
3. This delays the dispersion of pollutants.
4. Solar radiation powers chemical reactions in the air, like forming ozone.
5. It also affects how sunlight is scattered, changing visibility and temperature.

ESP - ELECTROSTATIC PRECIPITATOR

- An Electrostatic Precipitator (ESP) is a device that utilizes static electricity to remove particulate matter from a gas stream.
- ESPs control fine particulates using five processes:
- Electric field generation
- Corona generation
- Ionization of gas stream
- Charging of particles
- Migration to collection electrode
- Corona discharge imparts electrical charges to particles.
- Charged particles migrate and collect on electrodes.
- Modern ESPs achieve >99% efficiency for submicron particles.
- Equations used:
- Deutsch-Anderson Equation
- Matts–Ohnfeldt Modified Equation



ESP - FACTORS AFFECTING EFFICIENCY

Migration Velocity (w):

- Depends on particle charge, field strength, gas viscosity.
- Larger particles are collected more easily.

Specific Collection Area (SCA):

- Larger SCA = Higher collection efficiency.

Aspect Ratio (AR):

- Ratio of length to height (>1.0 for better efficiency).

Other important factors:

- Particle resistivity
- Gas temperature
- Particle size distribution

ESP - APPLICATIONS AND MODERN TRENDS

ESPs are widely used in:

- Cement plants, steel industries, copper production, power plants.

Challenges:

- High resistivity dust reduces efficiency.
- Higher temperatures lower performance.

Solutions:

- Flue Gas Desulfurization (FGD)
- Wet ESPs for better performance

Future Trends:

- Hybrid ESPs combined with baghouse filters and scrubbers.
- Focus on increasing durability and cost-effectiveness.


THANK YOU!