The percentag

* There is no way we can have a dry atmosphere, there will always be water vapour

Layers of the Atmosphere

There are five layers by their thermal composition, density.

(i) Exosphere: Outermost layers of atmosphere, extends ~~600 miles~~ to 10,000km above the earth. Atoms and molecules escapes into space in this layer

(ii) ~~85~~km – 600km lies the thermosphere known as the uppermost layer. Incoming UV and sun radiation are absorbed in this layer. The temperature increases with height due to this absoption, from as low as −120°C at the bottom to as high as 3600F (2000°C

at the top. But despite the high temperature, it still feels cold to the skin.

At the bottom of the thermosphere is the mesopus which links the thermosphere to

(iii) It extends from 31 miles above the earth surface to 53 miles. mesosphere

The gases becomes denser as one descends because of the availability of water vapour, therefore temperature increases as one descends

Stratosphere

(iv) Both the mesophere and the stratosphere are referred to the middle of the layer. The transition boundary which seperates the mesophere and stratsphere is called stratopus

This layer holds 19% of gases and little percent of Water vapour. In this region, the temperature increases with height, heat is produced in the generation of Ozone. This heat produced is responsible for the temperature increase and the very little amount of water vapour.

This increase in temperature means warmer air. There is no upward vertical movement of gases

(iii) troposphere

The transition layer below the stratosphere is called the troposphere

Almost all weather occurs in this region

Exosphere
Thermosphere
Mesosphere
Stratosphere
Troposphere
} layers of the atmosphere

CO_2, NO_x ⟶ Causes of pollution

Environmental pollution

In pollution, all the component causing pollution have exceeded the allowed limit

In contamination, the component causing the impurity is being introduced in a smaller amount; it has not exceeded the allowable limit. E.g water containing 0.05 mg/g of Pb.

pollution is the introduction of waste matter (generated from somewhere) in the environment (which could air, land, water etc) by man, so that it causes damage or deterioration to living systems and/or the environment

e.g acid anhydride affecting stomata of plants

% of cement → $CaCO_3$

A pollutant is any substance produced by human activities ~~that~~ in a unacceptable level that causes damage.

Many pollutants are Chemicals.

It is only chemicals that can form reactions. pollutants don't cause problem if reactions are not taking place

Types of Pollutions

(i) Noise pollution
(ii) Air pollution
(iii) Water pollution
(iv) Land pollution

Air pollutant: CO_2 (generated from hydrocarbons), NO_x, ozone, hydrocarbons, SO_2, Particulates

CO_2

It is generated from hydrocarbons

$CO + O_2 \longrightarrow CO_2 + O$ ⇒ W

↓ It causes depletion of ozone layer

* Write equations, like five, on depletion of ozone layer, you can start with any formation of any of the gases. The conditions of the reactions must be specified.

~~C, NO_2, S~~

SO_2

$SO_2 + 2H_2O \longrightarrow H_2SO_4$

$N_2 + O_2 \longrightarrow NO_2$

$NO_2 \xrightarrow{h\nu} NO$

21/04/26

Air Pollution

① Burning of fossil fuel and other material resources.

Every contaminant in the environment can be traced ultimately in the chemical reaction. The amount of contaminant is linked by a chemical equation to a resource consumed or some other substance chemically altered.

The chemical equation with associated atomic masses serves as quantitative bridge connecting pollution, resources and the level of man's activity.

$$C + O_2 \longrightarrow CO_2$$

Many organic materials including organic waste are largely carbon. So, the same equation expresses the most central features of their oxidation. In terms of mole ratio $C : CO_2$ is 1:1 (from the above equation). However, the mass 44g of CO_2 produced (gained) is more than the mass 12g of C consumed. So, the mass ratio of CO_2 to C is $\frac{44}{12}$

$$\text{Mass ratio} = \frac{44}{12} = \frac{11}{3}$$

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Thus, for every three units of mass of carbon consumed in an environment. There are 11 units of mass of CO_2 produced This is pollution. With this 11/3 ratio, we can calculate the amount of CO_2 that is associated with any mass of carbon bonds. Thus, if 6×10^9 tons of fossil carbon are burnt, the mass of CO_2 produced will be; ~~6×10^9 tons of carbon $\times$ 11 packs of~~

$$\frac{6 \times 10^9 \text{ tons of carbon} \times 11 \text{ parts of } CO_2}{3 \text{ parts of C}}$$

$$= 22 \times 10^9 \text{ tons of } CO_2$$

Similarly, by using masses of oxygen which is 32g and C which is 12g, we can obtain the mass ratio of the consumed oxygen to carbon

$$\text{mass ratio} = \frac{32}{12} = 8/3$$

Thus if 6×10^9 tons of fosil carbons are burnt, the amount of oxygen consumed (removed) from the atmosphere will be;

$$\frac{6 \times 10^9 \text{ tons} \times 8 \text{ packs of oxygen}}{3 \text{ packs of carbon}} = 16 \times 10^9 \text{ tons of oxygen.}$$

The atmosphere presently reserved of oxygen is 10^{15} tons.
The fractional depletion of oxygen brought about is

$$\frac{1.6\times10^{9}\text{ tons}}{10^{15}} = 1.6\times10^{-5} = 0.002\%$$ has been removed from the reserved oxygen in the atmosphere

The problem can be solved by afforestation.

(2) Burning of Sulphur and Sulphur containing compound

$$S + O_2 \longrightarrow SO_2$$

~~The ratio of SO_2 to S is 16:32 = 2:1~~

The ratio of SO_2 to S is 64:1 : 32 = 2:1

The Sulphur in SO_2 has it origin in certain ore, such as chalcocite (Cu_2S) and chalcopyrite ($CuFeS_2$)

$$\underset{159.1}{Cu_2S} + \underset{32.0}{O_2} \longrightarrow \underset{127}{2Cu} + \underset{64.1}{SO_2}$$

In this equation, we can determine the mass of SO_2 and Cu_2S $\frac{64.1}{127} = 0.505$

$$SO_2 : Cu_2S = \frac{64.1}{159.1} = 0.423$$

For each of tons of Chalcocite that is smelted, 0.423 tons of SO_2 is released to the atmosphere

(3) Burning of Nitrogen and Oxides of Nitrogen

There are at least 5 kinds of nitrogen containing as molecules in the atmosphere, i.e N_2, NO, N_2O, NO_2, NH_3.

Nitrogen (N_2) dominates them all and their environmental role is to provide a large reservoir from which nitrogen containing compound including essential of life originates.

Upon raising air to a high temperature, NO is produced.

$N_2 + O_2 \rightarrow 2NO$

Such heating occurs in flames and therefore, most NO comes from combustion of fuel, i.e, coal petrol, oil etc

After formation of NO, it is oxidized by atmospheric ozone. The resultant NO_2 is partly absorbed by vegation, water and soil, and some converted trigonitric(V) acid

$NO + O_3 \rightarrow NO_2$

by hydrolysis with air borne water, i.e, NO_2

$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$ — formation of acid rain

The acid may be brought down by rain or first combined with NH_3 to form Ammonium nitrate

$HNO_3 + NH_3 \rightarrow NH_4NO_3$

This is washed to the earth, where it becomes nutrients to the plants

④ Industrial Emission.

Industries emits smokes and various gases of various magnitude into the atmosphere, this leads to formation of smog, ~~fog~~

Fog consists of a collidal dispersion of lipid in the air. Fog produced from photochemical reaction is commonly referred to as photochemical smog.

The term Smog originated from the term smoke and fog

⑤ Automobile Exhaust Emission

Combustion of gasoline or petrol

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$

CO may be formed due to incomplete combustion

(6) Particulate from construction sites, burners eg house lanterns, refuse, industrial burners, incinerators

Health Effects of Air-pollution

(1) Haemoglobin in the blood carries oxygen round to cells and tissues for survival

$$Hb + O_2 \rightleftharpoons HbO_2$$

When CO is released into the atmosphere and inhaled

$$Hb + CO \longrightarrow HbCO \quad \text{(not reversible)}$$

~~When~~ It ~~poisons~~ poisons the Hb and leads to acute shortage of oxygen in the blood which leads to headache, drizziness and eventually death

(2) Nitrogen oxides leads to formation of acid rain, photochemical smog, damage to lung tissues and blood vessels to result.

(3) Sulphur oxides form acid rain, H_2SO_4. It increases asthmatic attack and damage to respiratory system

(4) Hydrocarbons leads to photochemical smog and cancer

(5) Particulate matter inhaled can cause, asthma

Bronchitis and lung cancer

(6) Lead containing particulates from automobiles exhaust transmit toxic lead to lungs and hence to blood streams affect central nervous system, damage brain, kidney, liver and reproductive system

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Green House Effect

The so called green house effect describes the trapping of heat near Earth surface by gases in the atmosphere particularly CO_2. The Sun hits the earth's surface by its UV light and reflects back to the upper atmosphere, but the presence of CO_2 in the atmosphere traps the heat and emits back to the air, the Earth is heated up.

Eg in a green house, the glass roof transmits visible light and absorbs some of the outgoing IR radiation thereby trapping the heat.

CO_2 acts somewhat as a glass roof except that the temperature rises in the green house is due mainly to the restricted air circulation inside.

*Which of the following do you consider as a green house gas and why?

The green house gases e.g CO_2, CHCl, Water vapour plays crucial role in regulating the temperature of the Earth and its atmosphere
In the absence of these gases, the average surface temperature will be $-19°C$. There is concern of the rising of atmospheric temperature called global warming or green house warming, due to steady increase in CO_2 in the atmosphere.

Climate Change

Global warming jeopardize full security for world's poorest people arising from extreme climate condition

(i) Drought
(ii) flood
(iii) Area that are normally dry will be dryer with increased Overgrazing, there would be desertification
Area that are normally wet will be wetter
Melting of ice cap
Rising in sea level

Solution

(i) Reduction of emission of green house gases, hydrocarbon & CO_2
(ii) Planting trees or aforestation
(iii) Reduction in the use of fossil fuels
(iv) Building against sea rise
(v) Resulting in ocean surge

Ozone Formation

The formation of ozone in the stratosphere begins with photo dissociation of oxygen by solar radiation

$$O_2 \xrightarrow[<240nm]{UV} O^{\cdot} + O^{\cdot}$$

At wavelength below 240nm leading to cleavage of molecules and formation of very reactive oxygen

The high reacting oxygen atom, combines with oxygen molecules to form ozone.

eqn: $O^{\cdot} + O_2 \longrightarrow O_3$

$M + O^{\cdot} + O_2 \longrightarrow O_3 + M$

M ↓ inert

The energy that is not absorbed by M is given off as heat, as molecules becomes excited, they release more

$CFCF_3$

heat to the Surrounding

In addition, Ozone itself absorb UV light between 200nm – 300nm

$$O_3 \xrightarrow{UV} O^{\cdot} + O_2$$

The process continues when Oxygen radical $O^{\cdot}$ and Oxygen O_2 recombines to form ozone, it acts as protective shield against UV radiation, and prevents skin cancer

The formation and destruction of ozone by natural processes is a dynamic equilibrium and maintain at constant temperature of ozone in the stratosphere

Freon

The harmful effect of freon $CFCl_3$ on ozone layer has become worrisome

$CFCl_3$, CF_2Cl_2, $C_2F_3Cl_3$, $C_2F_4Cl_2$

They are non toxic, inert, and non-combustible, and thus, used as coolant in referator and air conditioners

Because of their reactive inertness, the CFCS slowly diffuse to the stratosphere where UV radiation of λ between 175nm – 220nm causes them to decompose

$$CFCl_3 \longrightarrow CFCl_2 + \dot{C}l$$

$CF_2Cl_2 \longrightarrow CF_2Cl + {}^{\cdot}Cl$

In the Earth's atmosphere the $^{\cdot}Cl$ produced in this way reacts to destroy ozone, in the manner of NO

$NO + O_3 \longrightarrow NO_2 + O_2$

$^{\cdot}Cl + O_3 \longrightarrow ClO^{\cdot} + O_2$

$O_2 \longrightarrow O^{\cdot} + O^{\cdot}$

$ClO^{\cdot} + O^{\cdot} \longrightarrow ClO_2$

* Account for how ozone serves as pollutant and as screen

~~Smog~~ Pan

Photochemical ~~smog~~ is a type of smog formed under the influence of sunlight. It is actually a mixture of pollutant including particulate matter, nitrogen oxide, aldehyde, peroxyl acetyl nitrates and unreacted hydrocarbon

Pan is peroxyl acetyl nitrate

A brownish haze that irritates our eyes is indicative of photochemical smog. Nitrogen dioxide is responsible for the brownish colour of the haze.

The reactions that leads to the formation of photochemical smog are initiated by sunlight and involves hydrocarbon and nitrogen oxides emitted from automobiles. Combination of sunlight catalyzed by particulate matter and abundant pollutant present in modern cities provide favourable conditions for smog formation

Nitrogen oxide from automobile exhaust first absorbs light and breaks down into NO (nitrogen mono oxide)

$$NO_{2(g)} \xrightarrow{\text{UV light}} NO_{(g)} + O^{\cdot}_{(g)}$$

The oxygen radical then reacts with other component of automobile exhaust eg unburnt hydrocarbons and those of the atmosphere eg O_2 and H_2O (Water vapour)

In a series of complex reactions, they produce a varieties of compound and toxic chemicals such as Pan.

$$CH_3\overset{O}{\overset{\|}{C}}-O-O-NO_2$$

Very much simplified, some principal reactions in the formation of photochemical smog are illustrated as,

$$O + O_2 + M \longrightarrow O_3 + M$$

O + hydrocarbons ⟶ aldehyde + R coo H

O_3 + hydrocarbons ⟶ aldehyde + ROOH

$HC + O_2 + NO_2$ — PAN

Measures of Improving Air Quality

(i) The use of unleaded petrol
(ii) Installation of catalytic converter in car exhaust system
(iii) Desulphurization of flue gases through the use of wet limestone gypsum scrubbing process which is capable of improving 90% of SO_2
(iv) Installation of electrostatic precipitation in power plants
(v) Installation of low nitrogen oxide burners in power plants