# MODULE 5 TAKING CARE OF THE EARTH FOR A CLEANER AND SAFER WORLD

## A. AIR POLLUTION CONTROL TECHNOLOGY \_\_\_\_

#### THE AIR

Air is all around us, and because we cannot see it, we often take it for granted. At times we may forget it is there. Air is, however, needed by every living thing.

Air is a mixture of several different gases. The amount of each gas varies very slightly. 99 per cent of the air is made up from just two gases, nitrogen and oxygen.

Air also contains a variable amount of water vapour. The humidity is a measure of how much water vapour there is in the air.

Respiration is an oxidation reaction. It is the oxidation of carbohydrates and takes place in all living things. The purpose of respiration is to provide energy.

Carbohydrates are chemicals made from the elements carbon, hydrogen and oxygen. Starch and sugar are examples of carbohydrates.

One of the simplest sugars is called glucose.

When glucose is oxidised, carbon dioxide and water are produced.

Photosynthesis is a process that takes place in all green plants. In the presence of sunlight, green plants convert carbon dioxide and water into carbohydrates and oxygen. The reaction is the reverse of respiration. Chlorophyll – the green colour in plants – is a catalyst. It is. So while it is light, all green plants are using up carbon dioxide and making oxygen.

Respiration and photosynthesis maintain fairly constant percentages of oxygen and carbon dioxide in the air.

Nitrogen makes up about 80% of the air. It is essential to all living things as it is in all proteins. Proteins are body buildings materials. As an element, however, nitrogen is very unreactive and only a few other elements will combine with it directly.

Unfortunately animals and most plants cannot use nitrogen gas from the atmosphere directly. Plants must have their nitrogen combined with oxygen in the form of nitrates which they absorb from the soil. Animals get theirs by eating plants. In this way nitrogen passes along food chains. Eventually nitrogen passes back into the air. The circulation of nitrogen compounds in the environment is called nitrogen cycle. Some plants have nitrogen-fixing bacteria in their roots which enable them to use nitrogen gas from the air. The bacteria convert the atmospheric nitrogen into compounds that the plant can make use of.

Plants are either eaten by animals or die and decay in the soil. Animals excrete waste material containing nitrogen compounds and then die and decay. These processes all return nitrogen compounds to the soil.

In the soil, bacteria convert some of these compounds to ammonium compounds and nitrates. Other bacteria (denitrifying bacteria) change the nitrogen compounds back to nitrogen gas. The conversion of nitrogen into its compounds is called the fixation of nitrogen.

(from: Stone-Andrews-Williams, Examining GCSE-Science, Stanley Thornes Ltd.)

#### FOR A CLEANER AND SAFER WORLD UNIT 2

#### MODULE 5

- 1 Ansı
  - Answer these questions about The air.
- a. What is the air made up of?
- b. What are the products of the oxidation of glucose?
- c. How do we get the nitrogen compounds we need?
- d. What is the function of nitrogen-fixing bacteria?
- e. What is the function of denitrifying bacteria?

#### 2 Choose the right meaning of the underlined words.

a. We often take air for granted.

1. we are so familiar with it that we no longer appreciate its value 2. we assume it is true

- **b.** <u>At times</u> we may forget it is there.**1.** always **2.** sometimes
- c. <u>Starch</u> and sugar are examples of carbohydrates.
  1. food substance found in cereals and potatoes 2. stiffening substance
- d. Green plants <u>convert</u> carbon dioxide and water into carbohydrates and oxygen.
  1. change their religious beliefs 2. transform
- e. Nitrogen makes up about 80% of the air.
  - **1.** forms **2.**wears cosmetics
- f. Proteins are <u>body-building materials</u>.
  1. exercises to strengthen the body 2. food substances necessary for the growth and replacement of body tissues
  - **3** Choose the correct option among the adjectives and adverbs in italics in the following sentences.
- a. Compounds are not easy/easily made back into their constituent elements.
- b. It is fairly easy/easily to separate mixtures into their constituents.
- c. In solids, particles are *close/closely* together.
- d. In gases, particles are not packed *close/closely* together, they are *wide/widely* spaced.
- e. There is a wide/widely variety of chemical substances.
- f. All the atoms in an element are *chemical/chemically* the same.
- g. An alkali is the chemical/chemically opposite of an acid.
- h. Both protons and electrons have an *electric/electrically* charge.
- i. All atoms are *electric/electrically* neutral.
- j. Some chemical reactions take place *immediate/immediately*, whereas others are less *immediate/ immediately* and take longer.

- 4 Oxygen, nitrogen, carbon dioxide and ozone are among the gases which are all around us. Can you complete the sentences below with the name of the right gas?
- **a.** ..... appeared in the atmosphere of the Earth about two billion years ago when it began to arise from photosynthesis occurring in the earliest green plants.
- **b.** ..... compounds are used to make fertilizers, explosives, dyes and drugs.
- c. ..... dilutes oxygen in the air.
- **d.** ..... forms a blanket which surrounds the earth and protects us from dangerous radiation from the sun.
- **e.** In its liquid state ...... is used to freeze substances and to preserve biological samples (e.g. blood and semen).
- f. In its solid form ..... is used to refrigerate foods.
- **g.** ..... is a colourless gas at room temperature, it is blue in the liquid and solid states.
- **h.** ..... is taken up by plants and converted to sugars and other substances essential for life.
- i. ..... is the most abundant element on our planet.
- j. ..... is used in fizzy drinks and in fire extinguishers.
- k. ..... is used to provide a non-oxidising atmosphere for packaged food and
- I. The layer of ...... around the Earth is being depleted because of its reactions with organic compounds deriving from human activities.

### **B. AIR SAMPLING AND ANALYSIS**

#### WHAT POLLUTES EVERY BREATH WE TAKE

Air pollution is a phenomenon by which solid or liquid particles and gases contaminate the <u>environment</u> resulting in health effects on the population, damage to materials, agricultural damage and even climate change.

Not all pollutants are a result of human activity. Natural pollutants are those that are found in nature or are emitted from natural sources. Anthropogenic pollutants are those that are produced by humans.

Air pollutants also are classified as primary or secondary. Primary pollutants are those that are emitted directly into the <u>atmosphere</u> from an identifiable source. Secondary pollutants are those that are produced in the atmosphere by chemical and physical processes from primary pollutants and natural constituents.

Particulate matter (PM) - solid or liquid particles that are airborne and dispersed - originates from a variety of anthropogenic sources, including diesel trucks, power plants, wood stoves and industrial processes. 'Fine' particles are especially detrimental to human health because they can penetrate deep into the lungs.

Carbon monoxide (CO) is a fairly unreactive colourless, odourless and poisonous gas. It is formed when carbon in fuels is not burned completely. The major sources of CO are motor vehicle exhausts, industrial processes, fuel combustion and natural sources such as <u>wildfires</u>.

Sulphur dioxide  $(SO_2)$  is colourless, non-flammable, non-explosive gas which is one of the precursors of acid rain. Most anthropogenic SO<sub>2</sub> emissions are the result of fossil fuel combustion in power plants. A natural source of sulphur oxides is volcanic activities. Exposure to SO<sub>2</sub> irritates the human respiratory tract.

Nitrogen dioxide  $(NO_2)$  is a reddish-brown gas which is a lung irritant. Anthropogenic emissions of  $NO_x$  come from combustion processes such as those occurring in automobiles and power plants. Natural sources of  $NO_2$  are <u>lightning</u> and various biological processes in soil.

Ozone  $(O_3)$  is a secondary pollutant and is formed in the atmosphere by the reaction of molecular oxygen  $(O_2)$  and atomic oxygen (O) which comes from the photochemical decomposition of NO<sub>2</sub>. Volatile organic compounds (VOCs) must also be present if  $O_3$  is to accumulate in the atmosphere.  $O_3$  occurs naturally in the <u>stratosphere</u> and provides a protective layer from the sun's ultraviolet rays high above the earth. However, at ground level,  $O_3$  is a lung and eye irritant and can cause asthma attacks.  $O_3$ , being a powerful oxidant, also attacks materials. Lead (Pb) is a toxic metal and can accumulate in the blood, bones, and soft tissues.

Hazardous air pollutants (HAPs), commonly referred to as air toxics or toxic air pollutants, are pollutants known to cause serious human health effects or damage to the <u>ecosystem</u>. Potential human health effects of HAPs include headache, dizziness, nausea, birth defects, and cancer.

Primary pollutants may be controlled at the source. For example,  $SO_2$  is controlled by the use of scrubbers, which are industrial devices that remove  $SO_2$  from the exhaust gases from power plants.  $SO_2$  emissions are also reduced by the use of low-sulphur coal or other fuels, such as natural gas, that contain lower amounts of sulphur.  $NO_2$  from industrial sources also may be minimized by scrubbing.  $NO_2$  from cars, as well as CO, are controlled by the use of catalytic converters, engine design modifications, and the use of cleaner burning grades of gasoline. Lead emissions have been reduced significantly since the introduction of lead-free gasoline.

Ozone and particulate matter are two of the most difficult pollutants to control. Reduction of oxides of nitrogen emissions, together with a reduction of VOC emissions is the primary control strategy for minimizing ozone concentrations.

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#### Answer these questions about What pollutes every breath we take.

a. What is air pollution? • b. What are the main damages it causes? • c. What is the difference between natural and anthropogenic pollutants? • d. What is the difference between primary and secondary pollutants? • e. What is particulate matter? • f. Where does particulate matter originate from? • g. What is carbon monoxide? • h. What are the main sources of carbon monoxide in the air? • i. What is sulphur dioxide? • j. What are the health effects of sulphur dioxide? • k. What is nitrogen dioxide? • l. What do emissions of nitrogen dioxide derive from? • m. How is ozone formed in the atmosphere?
n. What is the function of stratospheric ozone? • o. What are the effects of ozone at ground level? • p. Where does lead accumulate in the body? • q. What are HAPs? • r. How can the amount of sulphur dioxide in the air be diminished? • s. How can the amount of nitrogen dioxide in the air be decreased?
• t. What has reduced lead emissions? • u. How can ozone concentration be minimized?

Complete these definitions choosing among the words underlined in What pollutes every breath we take. Tip: copy the definitions in your indexed book.

- **a.** ..... are uncontrolled fires in areas of combustible vegetation in the countryside or in the wilderness.
- b. A ..... is a discharge of atmospheric electricity.
- **c.** An ..... is a community of plants, animals and smaller organisms that live, feed, reproduce and interact in the same environment.
- **d.** The ..... is the complex set of physical, geographic, biological, social, cultural and political conditions that surround an individual or organism.
- e. The ..... is the layer of gases which surround the Earth.
- f. The ..... is the second layer of the Earth's atmosphere.

Combine words a-h with words 1-8 into meaningful pairs which complete the definitions below. Tip: copy the definitions in your indexed book.

a.	acid	1.	activity
b.	birth	2.	converter
c.	catalytic	3.	defect
d.	fossil	4.	exhaust
e.	power	5.	fuel
f.	ultraviolet	6.	plant
g.	vehicle	7.	rain
h.	volcanic	8.	ray

- **a.** ..... is an electromagnetic radiation emitted by the sun.
- **b.** ..... is a health problem that happens while a baby is developing in the mother's womb.
- **c.** ..... is a vehicle emissions control device.
- d. ..... is an eruption which may release noxious gases in the lower atmosphere.
- e. ..... is an hydrocarbon formed from the remains of dead plants and animals.
- f. ..... is an industrial facility for the generation of electric power.
- g. ..... is rain made acidic by pollutants.
- **h.** ..... is the emission created by the mixture burning inside an internal combustion engine.

## C. POTABLE WATER SUPPLIES\_\_\_\_\_ D. THE TYPES AND CAUSES OF WATER POLLUTION \_\_

#### WATER

Water is the most common and a very special liquid. It exists as a solid, liquid or gas over a relatively short range of temperature. Chemically, it is a compound of hydrogen and oxygen (formula  $H_2O$ ).

Water is needed by all living things. We can manage without food for several weeks, but we cannot last many days without water.

The water cycle describes the changes that happen to water in nature. Water is evaporated by the heat from the Sun. The water vapour rises into the atmosphere where it cools down and condenses into cloud formations. As the clouds get higher and colder the droplets of water get bigger and eventually fall out of the sky as rain. The rain either soaks into the ground or runs into streams and rivers. Eventually the water makes its way back to the sea and the cycle is repeated.

The water from reservoirs is first filtered to remove solid particles. The filtering is done by letting the water pass through filter beds of sand and gravel. Small amounts of chlorine or of other chemicals are then added to the water to kill bacteria.

In addition to domestic use, industry uses large amount of water. Nearly all of this water finds its way back into streams and rivers. Unfortunately it is not always very clean when it is discharged into them.

Water pollution is a serious problem. When we have finished using water we just let it go down the drain. If that unclean water was allowed to run into streams and rivers they would soon become unfit for life, dirty and smelly. In the past, untreated sewage was simply discharged into the sea. Nowadays there is much stricter control over the disposal of sewage which is processed before it is allowed to be discharged into the environment.

Wastewater from industry can contain all sorts of harmful chemicals. Some of those most dangerous to animal life contain metals such as mercury and lead.

Apart from nitrogen, another source of pollution from farms is the use of pesticides.

If large amounts of detergents are released into rivers, the river may become covered with foam. Some detergents are harmful to river life. It is possible now to obtain biodegradable detergents that are broken down by naturally occurring bacteria.

Hard water is caused by dissolved calcium and magnesium compounds in the water. There are two types of hard water, temporary hard water – which can be softened by boiling – and permanent hard water – which is not softened by boiling.

(from: Stone-Andrews-Williams, *Examining GCSE-Science*, Stanley Thornes Ltd.)

#### 8 Read Water and find words matching these definitions.

- **a.** white or grey mass of very small drops of water floating in the sky  $\_$   $\_$   $\_$   $\_$   $\_$
- **b.** very small drops <u>D</u>\_\_\_\_\_
- **c.** small rivers  $\underline{R}$  =  $\underline{R}$
- **d.** lakes used as sources or stores of water  $\_$  \_ \_ \_ V \_ \_ \_ \_
- **e.** mixture of small stones with sand  $\_$   $\_$   $\_$   $\_$   $\_$   $\_$   $\_$
- **f.** poisonous gas used to sterilize water  $\underline{H}$

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- g. waste material and water from houses and industries \_ \_ W \_ \_ \_
- **h.** throwing away  $\_$   $\_$   $\_$   $\_$   $\_$   $\_$
- i. pipe carrying wastewater away \_ \_ \_ l \_
- j. mass of small air bubbles in water <u>F</u> \_ \_ \_

Answer these questions about Water.

- a. How is wastewater filtered and disinfected?
- b. What would happen if untreated wastewater were allowed to run into lakes, rivers and seas?
- c. What are some of the most dangerous chemicals contained in wastewater from industries?
- d. What are the advantages of biodegradable detergents?
- e. What chemicals is hard water caused by?

#### 10 How much more do you know about water?

"It exists as a solid, liquid or gas over a relatively short range of temperature."

- a. What is the range of temperature over which water exists as a liquid?
  "Chemically, it is a compound of hydrogen and oxygen (formula H<sub>2</sub>O)."
- b. How many atoms of hydrogen and how many of oxygen are there in a molecule of water?"The water cycle describes the changes that happen to water in nature."
- c. Can you put these sentences in the right order to describe the water cycle?
  - 1. A portion of runoff enters rivers moving water towards the oceans.  $\Box$
  - 2. Cloud particles fall out of the sky as rain or snow.  $\Box$
  - 3. Most precipitation falls back into the oceans or onto land as runoff.  $\Box$
  - 4. Some water evaporates into the air.  $\Box$
  - 5. The sun heats water in the oceans.  $\Box$
  - 6. The vapour rises into the air where cooler temperatures cause it to condense into clouds.  $\Box$

"Small amounts of chlorine or of other chemicals are then added to the water to kill bacteria."

- d. What are the other chemicals which may be added to water to kill bacteria?"Apart from nitrogen, another source of pollution from farms is the use of pesticides."
- e. What are pesticides used for?

### E. SEWAGE TREATMENT



Read A gold mine in a water treatment plant and decide which of the expressions below mean the same as those underlined in the passage.

a. "Why didn't we think of this?" • b. clever administration • c. expensive load • d. leading position of great advancement • e. source of wealth • f. trigger an improvement

#### A GOLD MINE IN A WATER TREATMENT PLANT

San Antonio's wastewater treatment plant *is* <u>cutting edge</u>. 
It doesn't look any different from most other plants but what has changed in San Antonio is in the way people think about water there.

They don't, for instance, think of their Dos Rios wastewater treatment plant as a costly burden LL. The San Antonio Water System (SAWS) sees Dos Rios as a resource mine  $\Box$  and recycles everything the city's residents pipe in. And it makes money doing it.

The Dos Rios plant cleans the dirty water and sends it back into a water distribution system to customers. Not only does Dos Rios charge for the water, it sells every gallon of water it can recycle! The muddy-coloured sediment that remains is called sludge, and most cities separate it from their water stream, dry it, and send it to landfills. This is the "waste" in wastewater.

The folks at Dos Rios wring as much water as possible out of the sludge. Then they spread it out on the Texas turf and let it dry under the Texas sun. The sludge – what remains after bacteria eat everything harmful in the water - is rich organic material. It's trucked to a commercial compost supplier, where it's processed, bagged, and sold. By recycling the sludge – Dos Rios recycles as much as 98 %t of it - SAWS cut the cost of disposal by more than half.

Smart water management  $\Box$  has a kind of spiralling quality  $\Box$ : once you're turning the sludge into a commercial product and selling the clean water, you start thinking, What else could we be selling? Dos Rios has five enormous gas burners – the same kind you see flaring off the natural gas on oil fields. At wastewater plants, the bio-solids digesters that process and stabilize the sludge produce natural gas as a by-product. Until September 2010, the five gas flares at Dos Rios sent enormous flames into the sky 24 hours a day, disposing of that bio-gas by burning it. Then it occurred to the people at SAWS how silly it was to waste the natural gas. The Dos Rios plant now markets the gas it generates.

SAWS gets about \$20,000 a month for the natural gas it used to burn. That might seem foreheadslappingly obvious , but San Antonio is the first – and, as far as the folks there know, the only - municipal wastewater plant in the United States to sell its bio-gas commercially.

In San Antonio, they don't call Dos Rios a wastewater treatment facility - they call it a recycling plant.

(from Charles Fishman - The Rotarian)

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Which of these verbs can be used instead of those below from A gold mine in a water treatment plant: appear dissimilar, come to mind, consider, debit, discharge, distribute over, eliminate, move to, reduce by more than 50%, squeeze from, transform into.

a.	look different	g.	truck to
b.	think about	h.	cut by more than half
c.	pipe in	i.	turn into
d.	charge for	j.	dispose of
e.	wring out of	k.	occur to
f.	spread out		

### F. SAMPLING AND ANALYSIS OF SOIL G. SOIL MICROBIOLOGY: THE ECOSYSTEM\_

3 *Read* Soil microbiology *and decide which of these adjectives could be used instead of those underlined in the passage:* abundant, available, better, big, dangerous, entire, minute, productive, several, supreme, useful, vital.

#### SOIL MICROBIOLOGY

Inorganic constituents (minerals, water, air), dead organic matter and soil life are the components that make up the <u>total</u> soil environment. The living portion of the soil can be divided into macro- and micro-organisms. Macro-organisms play an <u>important</u> role in organic decomposition by **chewing** plant and animal residues into <u>fine</u> particles. Though the micro-organic portion represents considerably less than 1% of the soil mass, it is on this **tiny** fraction that the continued re-cycling of nutrients mainly depends.

Normal, <u>fertile</u> soils **teem with** soil microbes. The most <u>numerous</u> microbes in soil are the bacteria followed by the actinomycetes, the fungi, soil algae and cyanobacteria ("blue-green algae") and soil protozoa. In addition to the microbes, there are <u>numerous</u> species of soil animals that **inhabit** soils. These larger organisms can **exert** <u>beneficial</u> effects through <u>improved</u> soil structure and improved aeration and **drainage due to** their channelling activities in the soil. Soil microbes produce lots of **gummy** substances that help to **cement** soil aggregates. Fungal filaments, called hyphae, also stabilize soil structure. Moreover, soil microbes are of <u>paramount</u> importance in cycling nutrients such as carbon, nitrogen, phosphorus, and sulphur and they can regulate the quantities of N available to plants. It is only through the actions of soil microbes that the nutrients in organic fertilizers are liberated for plants and use by other microbes. Soil microbiologists call this process mineralization. It is through such process that crop residues, grass **clippings**, leaves, organic **wastes**, etc., are decomposed and converted to forms useable for plant growth as well as converted to stable soil organic matter called 'humus'.

The <u>large</u> organisms function as **grinders** in that they reduce the particle size of organic residues making them more <u>accessible</u> and decomposable by the soil microbes. The soil microbial population also **further** decomposes the waste products of the

larger animals. Thus, the activities of different groups of soil organisms are linked in complex "food webs".

One beneficial process **carried out** exclusively by soil microbes is called nitrogen fixation, the capture of inert N<sub>2</sub> gas (dinitrogen)

from the air for incorporation into the bodies of microbial cells. Another benefit of soil microbes is their ability to degrade pest control chemicals and other <u>hazardous</u> materials **reaching** the soil. **Thus** through the actions of the soil microflora, pesticides may be degraded or rendered nontoxic **lowering** their potential to cause environmental problems such as ground and surface water contamination.

Some soil bacteria (the anaerobes) do not need air to grow and some are "poisoned" by exposure to oxygen. Generally, soil microbes grow best in soils of near neutral pH (7.0) having adequate **supplies** of inorganic nutrients (N and P, etc.), a **balance** of air- and water-filled pore space and abundant organic substrates (carbon and energy sources). Most soil microbes grow best at temperatures between 15-30°C.

(By David A. Zuberer)



**balance**: equilibrium carried out: performed, made to cement: to reinforce to chew: to masticate clipping: cut off piece drainage: removal of water due to: caused by to exert: to have further: in addition grinder: something that crushes into small pieces gummy: sticky to inhabit: to live in lowering: reducing reaching: arriving in supply: provision to teem with: to be full of thus: so tiny: very small wastes: residues

#### 14 Put the phrases in brackets in the suitable place to complete the passage below:

(bacteria, actinomycetes, fungi, algae, and protozoa) - (e.g. addition of manure) - (e.g. floods) - (leaves, plants, and remains of animal bodies) - (mainly carbon dioxide, oxygen and nitrogen) -(rodents, insects, worms, etc.) - (mineral particles) - (organic and inorganic) - (water)

Soil is made up of solid (	), liquid (	)
and gaseous (	.) constituents and is the habitat c	of a great and varied
population of microorganisms. The organization	anic residue (	) in the last
stages of decomposition forms the humus	s. The biological systems in fertile	soil include the root
systems of higher plants, many animal for	rms ()	and microorganisms
(). The condi	tions influencing the microbial cor	ntent of soil include:
amount and type of nutrients (	), available	moisture, degree of
aeration, temperature, pH, some agricult	ural practices (	) and some
natural occurrences (	).	

### 15 All the verbs have been removed from the passage below related to Soil microbiology. Put them back in the correct place.

are (4), break down, do, fertilize, grow, helps ensure, is, is filled, make up, need, release, see, use

### Student A: Use these hints to ask questions about the reading passage. Student B: answer Student A's questions.

- a. What / constituents / soil?
- b. What / main microorganisms / soil?
- c. What / main functions / microorganisms / soil?
- d. What / 'mineralization'?
- e. What / function / larger organisms?
- f. What / 'nitrogen fixation'?
- g. How / soil microorganisms / help the environment / reduce water contamination?
- h. What conditions / soil microorganisms / require / growth?

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