UNIT 1

THE EARTH IS IN DANGER

A. POLLUTION

1A *Which of the following do you think are most responsible for environmental pollution by metals? Read* Heavy metals in the environment *and check your predictions.*

- ☐ power stations
- ☐ by-products of industrial processes
- ☐ industrial waste
- ☐ petrol engines
- ☐ other .....
- ☐ diesel engines
- ☐ farm chemicals
- ☐ detergents
- ☐ human and animal waste

1B *What do you think should be done to prevent factories and farms from discharging chemicals into the environment?*

- ☐ impose strict rules
- ☐ impose heavy fines
- ☐ check factories and farms regularly
- ☐ other .....

HEAVY METALS IN THE ENVIRONMENT

Heavy metals are chemical elements many of which are poisonous to humans. Because of their extensive use, their toxicity, and their widespread distribution the most hazardous ones are mercury, lead, cadmium, and arsenic. Being totally non-degradable, that is, indestructible, they accumulate in the environment causing serious concern for human health.

Mercury is employed in many applications being a good liquid conductor of electricity. Liquid mercury is not highly toxic and most of that ingested is excreted but it is the most volatile of all metals and its vapour is very toxic. The main sources of atmospheric mercury are volcanoes, the burning of fossil fuels, the incineration of solid waste containing mercury. In air, most mercury is in the vapour (gaseous) state and it can travel long distances before being deposited on the Earth surface.

Lead is the most plentiful and the most widely used and dispersed of the four heavy metals of environ-mental concern. It is widely used in the building industry, in ammunition, and, combined with tin, it forms solder, used to make connections between solid metals. Lead becomes an environmental problem when it dissolves to yield the ionic form. Lead used in water pipes can dissolve in drinking water and therefore be absorbed by the body. Most environmental lead comes from vehicle exhausts and occurs mainly in inorganic form. It is either inhaled or ingested with food where it is incorporated. Most ingested lead is initially ▶

present in the blood, when it accumulates it enters the soft tissues, including the brain, and eventually it is deposited in bone, where it replaces calcium. Biochemically, lead interferes with the creation of haemoglobin and therefore it may cause anaemia. High lead levels also cause kidney dysfunction and permanent brain damage.
Most cadmium is produced as a by-product of zinc smelting. The main sources of cadmium in the environment are the burning of coal and the incineration of waste material containing cadmium.
Cadmium is very toxic and it can be absorbed by the body from drinking water, air and food. The amount of cadmium which cannot be eliminated in the urine is stored in the liver and kidneys where it may cause disease.
In the past, arsenic compounds were mainly used as a poison and as a pesticide. Today, most arsenic in the environment still derives from pesticides but also from the combustion of coal.
Even though a trace amount of arsenic is essential to good human health and people get it from drinking water and from many foods, this heavy metal is known to be carcinogenic to humans. Organic forms of arsenic are less toxic than some inorganic forms since they are water-soluble acids that can be excreted.

(from: Bair -Cann, *Environmental Chemistry*, Freeman & Co.)

2 *Answer these questions about* Heavy metals in the environment.

a. What are heavy metals? • **b.** Which of them are the most hazardous ones? Why? • **c.** What are the main sources of atmospheric mercury? • **d.** Where is lead used? • **e.** How can lead be absorbed by the body? • **f.** What are the effects of lead poisoning? • **g.** What are the main sources of cadmium in the environment? • **h.** How can cadmium be absorbed by the body? • **i.** Where does arsenic in the environment derive from? • **j.** How do we get the arsenic essential for our health?

3 *Among the adjectives underlined in* Heavy metals in the environment *choose those matching the synonyms or definitions below. Tip: copy adjectives and synonyms/definitions in your indexed book.*

a. ..... *means* abundant.
b. ..... *means* causing illness or death if taken into the body.
c. ..... *means* dangerous.
d. ..... *means* found over a large area.
e. ..... *means* important, grave.
f. ..... *means* necessary.
g. ..... *means* poisonous.
h. ..... *means* which is thrown away.

4 *Choose the correct alternative in the following sentences.*

a. Heavy metals accumulate in the environment *caused by / causing* serious concern for human health.
b. Most *ingested / ingesting* mercury is excreted.
c. Lead is *absorbed by / absorbing* the body from food and water.
d. Water *contaminated by / contaminating* chemicals includes heavy metals.
e. Water may be *contaminated by / contaminating* human and animal wastes.

B. GO GREEN!

ENERGY CHANGES

Energy is the most precious commodity we have. Without it there could be no life, no warmth, no movement. Energy gives us the power to do work, and in every country people's living standards are closely related to the availability of energy.

From the earliest times, people worshipped the sun. This is not surprising, for through the process of photosynthesis, the sun provides us with most of our food and, over millions of years, it has created our supplies of the fossil fuels.

The transfer of energy to or from chemicals plays a crucial part in chemical processes in industry and in living things. Consequently, the study of these energy changes is very important to us.

Our present-day living conditions rely heavily on the availability of energy in its various forms. Chemical energy is converted to heat energy when fuels such as gas, oil and coal are burnt in our homes and in industry. Within our own bodies, energy changes are vital. Foods such as fats and carbohydrates are important biological fuels. During metabolism, the chemical energy in these foods can be converted to heat energy to keep us warm, to mechanical energy in our muscles and to electrical energy in the signals within our nerve fibres.

Chemical energy is also converted to electrical energy when the materials in cells and batteries are used to generate electricity. All these important processes involve energy changes.

Until the Industrial Revolution, civilizations depended for their supply of energy on the labour of people and animals or on the harnessing of wind and water. Then, in the early nineteenth century, people began to use coal as a source of heat and power in their homes.

Early in the XX century, oil began to make an impact. Discoveries multiplied fast and oil became plentiful, cheap and a source of many other products. Without oil, the internal combustion engine would have been impossible and the revolution in land, sea and air transport could never have taken place. Oil became the most convenient fuel for many industrial and domestic purposes and the basic raw material for the organic chemicals industry. In the 1970s, the first danger signals appeared as the rate of oil consumption increased faster than the discovery of new reserves. Unfortunately, there is only a finite amount of oil on the Earth. The situation with coal is much less alarming since its rate of consumption is lower and reserves are possibly twenty times greater than those of oil.

It is vital that we start to conserve our resources now, turning our thoughtless overconsumption to a more intelligent use of fuel and avoiding such frivolous wastes of energy as excessive heating and lighting in homes, offices, schools and factories. It has been shown that more than 20% of the energy used in heating buildings could be saved by better insulation of roofs and walls, double glazing at windows and the acceptance of slightly lower, but still comfortable temperatures.

One of the most wasteful users of fuel is the private car. Vast quantities of precious oil are also being squandered on industrial and domestic heating and on the generation of electric power. Oil is much too valuable for this purpose. It should be conserved as feedstock for essential chemicals.

(from: Hill-Hollman, *Chemistry in Context*, Nelson)

5 *Explain and comment these statements taken from* Energy changes.

a. Energy is the most precious commodity we have.

b. From the earliest times, people worshipped the sun.

c. The study of energy changes is very important to us.

d. Within our bodies, energy changes are vital.

e. Early in the XX century, oil began to make an impact.

f. In the 1970s, the first danger signals appeared.

g. There is only a finite amount of oil on the Earth.

h. The situation with coal is much less alarming... (*than with oil*).

i. It is vital that we start to conserve our resources now.

j. One of the most wasteful users of fuel is the private car.

k. Oil is much too valuable for the purpose... (*of heating and generating electric power*).

6 *Among the words underlined in* Energy changes*, choose those which complete the definitions below.*

a. ..... are animals, plants and microbes.

b. ..... are basic substances used in the production of goods.

c. ..... is the conversion of carbon dioxide, water and inorganic salts into carbohydrates.

d. ..... is a natural resource or a product of great value.

e. ..... are a people's level of wealth, comfort, material goods and essentials.

f. ..... are risk indicators.

g. ..... is the social, economic and technological change that took place during the late 1700s and 1800s.

h. ..... are the first eras of human life on Earth.

i. ..... are threadlike conductors of nerve impulses.

j. ..... are two layers of glass set in a window to reduce heat flow in either direction.

C. GREEN POWER: WHERE OUR ENERGY WILL COME FROM

C.1 WHERE MOST OF OUR ENERGY HAS COME FROM SO FAR

Most of the energy we use is produced by burning fossil fuels. These come from living things that died many millions of years ago. Their remains were buried in the Earth, and were formed into the fuels we use today by the high temperatures and pressures underground. Coal was formed mainly from giant fern-like plants that lived in prehistoric forests. Oil was formed mainly from marine organisms that lived in the shallow seas which covered large areas of the world. Natural gas was also formed from prehistoric remains and gas is often found above oil deposits.
The burning of a fuel to release energy can happen in one of two ways – with or without flames. Petrol burns with a flame to provide energy. Food is "burned" without flames during respiration. Three things are necessary for a fire – fuel, oxygen and heat. These three form the fire triangle. If any one of these is removed, the fire will go out.
Fossil fuels contain carbon and carbon compounds.
Coal is mainly carbon. A hydrocarbon is a compound of hydrogen and carbon. Natural gas is mainly the hydrocarbon methane. Oil is a rather complicated mixture of hydrocarbons.
When a compound burns the products are usually the oxides of the elements in the compounds. When a fuel reacts with the oxygen in the air, heat is given out. A reaction that produces heat energy is called an exothermic reaction.
There are three main types of coal: lignite, which is brown and soft, bituminous coal - much older than lignite - which is black and crumbly, and anthracite - the oldest form of coal - which is hard, black and shiny.
Crude oil, as it comes out of the ground, is not much use as a fuel. The oil is a complicated mixture of hydrocarbons. The work of an oil refinery is to separate the oil into simpler mixtures and to increase the proportion of the more useful hydrocarbons.
The separation of the oil is done by fractional distillation. This is a way of separating a mixture of liquids with different boiling points. The different hydrocarbons in the oil all have different boiling points.
Fractional distillation is one of the main processes that take place at an oil refinery. This is done using a special fractionating column. The second important job of an oil refinery is to try and break down some of the larger, not so useful compounds into the smaller, more useful ones. This process is called cracking. Sometimes an additional process called reforming is carried out. In this process the arrangement of the atoms in a molecule is altered in order to produce a more useful substance.
Fuels are burned to produce heat and light energy. At home we can also use electrical energy to produce both heat and light. It is also possible to produce electrical energy from chemical reactions.

7 *Answer these questions about* Where most of our energy has come from so far.

a. Where do fossil fuels come from?
b. How were they formed?
c. Where does coal come from?
d. Where does oil come from?
e. Where does natural gas come from?
f. What is necessary for a fire to burn?
g. How can a fire be put out?

h. What do fossil fuels contain?
i. What are the products of the burning of a compound?
j. What are the three main types of coal?
k. What is crude oil made up of?
l. What is fractional distillation?
m. What is cracking?
n. What is reforming?

8 *Use these words to complete the following concise summary of* Where most of our energy has come from so far: boiling points, carbon, carbon dioxide, carbon monoxide, cracking, fossil fuels, hydrocarbons, oil refinery, poisonous.

The three main (1) ..... are oil, natural gas and coal. These fuels all contain the element (2) ..... and so when they burn (3) ..... is formed. If there is not enough air some (4) ..... may be formed. This is dangerous because it is very (5) ..... Oil is a complex mixture of (6) ..... It can be separated into different fractions because the different compounds have different (7) ..... This separation is done at an (8) ..... Another process that takes place is (9) ..... which involves breaking larger molecules into smaller more useful ones.

C.2 BIOLOGICAL FUEL GENERATION

The continual depletion of global fossil fuel energy has generated an ever-increasing need to seek out alternative sources of energy. These have so far included the harnessing of hydro, tidal, wave and wind power, the capture of solar and geothermal energy supplies, and nuclear power. There is now a growing appreciation of biological energy systems. Biomass such as forest, agricultural and animal residues and industrial and domestic organic wastes can now be converted by physico-chemical and/or fermentation processes to clean fuels and petrochemical substitutes. Photosynthetically derived biomass that exists in many available forms in the environment could well be transformed into storable fuels and chemical feedstocks such as alcohols and methane gas. Biomass can be considered as a renewable energy source, and can be converted into either direct energy or energy-carrier compounds by direct combustion, anaerobic digestion systems, destructive distillation, gasification, chemical hydrolysis and biochemical hydrolysis.
There are three main directions that can be followed to achieve biomass supply:
1) cultivation of so-called energy crops,
2) harvesting of natural vegetation;
3) utilisation of agricultural and other organic wastes.
The conversion of the resulting biomass to usable fuels can be accomplished by biological or chemical means or by a combination of both. The two main end-products are methane or ethanol, although other products may arise depending on initial biomass and the process utilised, e.g. solid fuels, hydrogen, low-energy gases, methanol, and longer-chain hydrocarbons. ▶

9 *Read* Biological fuel generation *and make your own glossary choosing from the words underlined in the passage.*

a. ..... = always growing

b. ..... = cutting and gathering

c. ..... = raw materials

d. ..... = reduction in quantity

e. ..... = try to find

f. ..... = up to the present

g. ..... = utilization

10 *Answer these questions about* Biological fuel generation.

a. What does fossil fuel energy derive from?
b. What do alternative sources of energy include?
c. What does biomass consist of?
d. What methods may be used to convert biomass into an energy source?
e. How can an abundant supply of biomass be obtained?
f. What products may be derived from biomass?