SESSION 14: CHEMICAL SYSTEMS

Key Concepts
In this session we will focus on summarising what you need to know about:

- Exploiting the lithosphere
- Mining in South Africa
- Extracting metals from ores
- The cost of mining
- Effects of mining on the environment & society
- Gold mining
- Mining iron
- Phosphate mining
- Energy sources

X-planation

EXPLOITING THE LITHOSPHERE

- The lithosphere is the rocky outer layer of the earth’s crust and is full of minerals of all kinds.

- A mineral is any naturally occurring inorganic substance. Elements that occur naturally, such as gold and aluminium, are also considered as minerals.

- The minerals in the earth’s crust are found embedded in rocks. The rocks are a mixture of many different compounds, but some contain a large amount of single metal compound or a single metal.

- Rocks that contain a lot of one particular type of mineral, are called ores.

- Nearly three quarters of the earth’s crust is made up of only two non-metals: oxygen and silicon. These are mainly found in a compound called silicon dioxide commonly known as sand.

- The rest of the earth’s crust is made up of mainly six metals, one that occurs in the largest proportion being aluminium, followed by iron. All the other metals put together make up less than 1/50 of the earth’s crust.

MINING IN SOUTH AFRICA

Mining began in SA as far back as the early Iron Age (300 – 1000AD) and in those days copper and iron deposits were mined in Phalaborwa. Now 55 different minerals are produced from 707 mines and quarries in SA. The main mineral raw materials of SA are gold, diamonds, platinum, chromium, vanadium, manganese, uranium, iron ore and coal. These make up about 60% of SA’s entire export, and this makes the mining industry very important to the economy of the country.
EXTRACTING METALS FROM ORES

Extracting metals from ore is carried out in three stages:

A. Getting the ore from the rock
B. Getting the metal from the ore
C. Purifying the metal

A. GETTING THE ORE FROM THE ROCK

Often the ore must be separated from the soil and other impurities before it is processed. This may involve crushing the rocks and then separating the ore from the impurities.

B. GETTING THE METAL FROM THE ORE

Metal in ore is often in the form of compounds, and so the metal must be split off from the compound before it can be used. There are three main ways that metals can be extracted from ore. The method used depends on the reactivity of the metal. The table that follows illustrates the methods:

<table>
<thead>
<tr>
<th>Metal</th>
<th>Reactivity</th>
<th>Method Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium - K</td>
<td>Most reactive</td>
<td>1. Electrolysis</td>
</tr>
<tr>
<td>Sodium - Na</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium - Ca</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium – Mg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminium – Al</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc – Zn</td>
<td></td>
<td>2. Heating with carbon or carbon monoxide</td>
</tr>
<tr>
<td>Iron - Fe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead – Pb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver – Ag</td>
<td></td>
<td>3. No chemical reaction needed, only heating</td>
</tr>
<tr>
<td>Gold - Au</td>
<td>Least reactive</td>
<td></td>
</tr>
</tbody>
</table>

1. ELECTROLYSIS

Electrolysis is the splitting of a substance by running electric current through it, and it is the most powerful way of extracting a metal from its compounds. It is also the most expensive way. First the compound is melted or dissolved so that the ions in it are free to move. Then a current is applied to separate them. The positive ions move to the negative electrode and the negative ions move to the positive electrode.
2. **HEATING A METAL WITH CARBON (REDUCTION)**

Often a metal is found combined with oxygen to form an oxide. The process of removing oxygen is called reduction and to do it, reducing agents are used. Carbon and carbon monoxide are often used as reducing agents. Example:

\[
\text{Fe}_2\text{O}_3 (s) + 3\text{CO (g)} \rightarrow 2\text{Fe} + 3\text{CO}_2
\]

3. **HEATING THE ORE ALONE**

This is the cheapest way to extract a metal but it only works with compounds of metal at the bottom of the reactivity series. For example, mercury is extracted from mercury sulphide by heating it in air.

C. **PURIFYING THE METAL**

How much the metal is purified depends on what it is going to be used for. The purity of gold used in computers is different from that of the gold used for coins, for example. The more a metal is purified, the more expensive the process is, and the more costly the metal becomes.

**THE COST OF MINING**

Before a new mine is started, the various costs and issues must be considered to see if it will be an economic proposition. These include:

- How much ore there is in the site
- How much metal will be in the ore
- Special problems in getting ore out. For example, the presence of underground gas could complicate mining.
- How much it will cost to mine the ore and transport it to its final destination. Such costs include roads, buildings, mining equipment, the extraction of the metal, transport, fuel, chemicals, wages and housing for the miners.
- For how much profit the metal can be sold. (this is the hardest assessment to make as the price of metals changes daily)

Another important factor is that minerals are a non-renewable resource. This means that once the ore is dug from the ground, no new ore is formed. This is why it is important to recycle metals like cool drink cans or food cans. It is cheaper to recycle than to dig up and process ore, but it also maintains the total amount of metal that is available. It takes much less electrical and mechanical energy to recycle than to extract ores.
EFFECTS OF MINING ON THE ENVIRONMENT & SOCIETY

- To build a mine and its infrastructure (the public services of a region, like roads, lights, electricity and water, etc.) such as roads and harbours, sometimes people have to be moved from land that they have lived on for a long time, or precious and rare shrubs may be threatened by the digging. The natural ecosystem (a system in which a community and its living and non-living environment interact with each other) will be destroyed, animals will move away and the landscape will be spoiled.

- Deep digging can make the surrounding land unstable and it becomes unsafe to build on.

- Extracting the metal from the ore also requires some form of energy which may cause pollution.

- The destruction of the surrounding landscape may be against the wishes of the local population.

- On the other hand the local population y may welcome the job opportunities the mining brings.

GOLD MINING

Gold mining has played a big role in the economy of the country over the past 120 years, and SA has the largest reserves of gold in the world.

- Through gold mining, many towns and cities have developed, such as Johannesburg, Welkom, Springs, Benoni and Witbank.

THE TECHNICAL PROBLEMS OF MINING GOLD

- Although SA has so much gold, the gold-bearing rock lies very deep. The gold reefs where the metal is found, often lie several kilometres beneath the earth’s surface in large but thin layers. These layers usually slope through the ground at an angle of up to 20°.

- The Western Deep Level mine where digging goes as deep as 3900 metres, is one of the deepest mines in the world. Mining at such depths usually causes a lot of problems because temperature rises by 1°C every 33 metres.

- Immense machinery and air conditioning are required to make the working conditions underground bearable for the workers. The air is cooled down to 32°C, but the people underground have to cope with almost 100% humidity, making working conditions very difficult.

- The material, work and energy needed for gold production are enormous.
EXTRACTING THE GOLD FROM THE ORE

Only a very small part of every ton of ore mined is actually gold. More than 100 million tons of ore are mined in SA but a very small percentage is gold. The most common method of extracting gold is by using the cyanide process which takes place in steps as follows:

First, ore is hoisted up from the mines and broken up into smaller pieces by a primary crusher. Then secondary crushers break it down further. This is followed by a milling stage which turns the ore into a fine rock dust. At this point most of the tiny particles of gold contained in the ore will be exposed. The rock dust containing the gold particles is now combined with a diluted solution of sodium cyanide while at the same time, air is bubbled through it. This results in a solution called slime. The following reaction takes place:

\[ 4Au + 8NaCN + O_2 + H_2O \rightarrow 4NaAu(CN)_2 + 4NaOH \]

This reaction changes solid gold into a soluble solution, aurocyanide \((NaAu(CN)_2)\). This soluble solution is then separated from the ore dust by filtration. Zinc is then added to the gold solution, the gold gets displaced and it precipitates (Zn is more reactive than Au). There will be some unreacted zinc that will still be mixed up with the precipitate and also traces of silver. The precipitate is then purified by smelting to remove the zinc, and by treatment with nitric acid to dissolve the silver. After smelting, bullion gold bars containing about 85% gold are taken to the Rand Refinery near Johannesburg where they are purified further until they are either 99.5% (accepted standard for coins) or 99.9% pure.

THE ECONOMIC PROBLEMS OF GOLD MINING

SA is becoming a world leader in deep-level mining technology. This type of mining is, however, very expensive because of the massive amount of money required for labour, ventilation, cooling, hoisting and underground tunnelling. At the same time, the world price of gold has dropped owing to the state of the world economy. This means that when gold mines need to charge higher prices as mining becomes more expensive as levels go deeper, the mines are getting lower prices for their products.

SOCIAL ASPECTS OF GOLD MINING

Gold mining has had a huge impact on SA because it is the largest employer in the country and because it uses a system of migrant labour. Men from surrounding agricultural areas have come to cities to work in the mines in order to make more money, leaving their families at home. As a result children have grown up without their fathers and women have had to manage with only the help of older men. The lack of a stable family life among the men has led to many social problems and has probably contributed to the spread of HIV/AIDS.
MINING IRON

- Iron is the most widely used metal on earth and most of the iron that is produced, is used to make steel. This is then used to make machinery, tools, vehicles, buildings (where it is used as reinforcing inside concrete) and bridges.

- The ore from which the iron is obtained, is called haematite and it consists mainly of iron oxide (Fe₂O₃) and sand.

- SA is Africa’s leading iron-ore producer, producing about 33 million tons a year and the country’s reserves, mainly in the Northern Cape, store about 9 million tons of iron ore.

EXTRACTION OF IRON

The process of extracting iron from its ore is called smelting and takes place in a blast furnace, so called because hot air is blasted through small holes in the side of the furnace. The furnace itself is a tall structure, usually about 20m tall, made of heat resistant brick.

The process takes place as follows:

- At the top of the furnace a mixture of iron ore, coke and limestone is added. Coke is treated carbon and limestone is a common rock mainly containing calcium carbonate (CaCO₃). This mixture is called the charge. At the same time blasts of hot air are blown through small holes at the bottom of the furnace.

- The oxygen in the air combines with the coke to form carbon dioxide, then carbon monoxide according to the following equation

\[
2C \text{ (coke)} + O_2 \rightarrow 2CO
\]

The above reaction is exothermic (heat up the furnace to about 2000°C)

- As carbon monoxide forms, it rises up the furnace and reacts with the iron ore according to the equation

\[
Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2
\]

The high temperature inside the furnace keeps the iron liquid as it forms, and it drips to the bottom of the furnace from where it is tapped off at intervals.

THE ROLE OF LIMESTONE IN THE CHARGE MIXTURE

Limestone is used to remove impurities from the iron ore. Iron ore usually contains impurities like earth and sand (silicon dioxide - SiO₂).
The removal of the impurities takes place as follows:

The limestone gets decomposed in the very high temperatures inside the furnace to form calcium oxide and carbon dioxide according to this reaction:

\[ \text{CaCO}_3 \text{ (limestone)} \rightarrow \text{CaO} + \text{CO}_2 \]

The CaO reacts with the silicon dioxide and other substances to form slag, which is a mixture made mainly of CaSiO$_3$ (calcium silicate).

\[ \text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3 \text{ (slag)} \]

The slag also drops to the bottom of the furnace, like iron, but because it is less dense than iron, it floats on top of the iron and can also be removed at intervals. Waste gases (mainly oxides of carbon and nitrogen) are given off from gas outlets high up in the furnace. They are used to heat up the air being blasted into the bottom of the furnace to reduce energy costs.

**PHOSPHATE MINING**

**THE NEED FOR PHOSPHATE**

- One of the most essential fertilisers that plants need, is phosphorus because it is particularly important for the encouragement of root growth. It also helps plants to mature early, and speeds up the ripening of the crops.
- SA soils have a natural lack of this element, so adding phosphate fertilisers usually produces huge crop increases where it has not been applied before.
- Phosphorus is applied as a greyish white powder or as granules and is dug into the soil during seeding time. It can also be supplied to the soil by adding bone meal, a powder remaining after crushing and grinding bones.
- It is, however, usually applied in the form of superphosphates because this is the most efficient way of getting good quantities of phosphate into the soil.
- Most of the phosphate used for making fertilisers, comes from rock phosphate, and superphosphate is produced by treating naturally occurring rock phosphate with sulphuric acid. Triple superphosphate is made by treating the rock phosphate with phosphoric acid which contains almost 50% phosphorus.
- Pure phosphorus and phosphoric chemicals are also made from phosphate rock and are used in detergents, insecticides, matches, fireworks and many other products.

**WHERE PHOSPHATE IS OBTAINED**

- Phosphate was found by geologists at Phalaborwa in big enough quantities to supply the country for a thousand years, and this led to the establishment of Foskor in 1951. Foskor is the largest manufacturer of phosphoric acid-based products in the southern hemisphere with three million tons produced every year, a third of which is exported. They produce rock phosphate and other phosphate products in their factories at Phalaborwa and Richard’s Bay.
- Another source of phosphate in SA is near the town of Greenburg in the Western Cape.
MINING OF PHOSPHATE

- A compound called apatite is the main ore of phosphate and is a phosphate group \((\text{PO}_4^{3-})\) joined to calcium.
- The rock containing apatite also contains iron and copper which must be separated from the phosphate. The phosphate group is itself attached to chlorine or fluorine.
- It can, therefore, be a problem because when the ore is processed into water soluble phosphate by being treated with sulphuric acid, the fluoride or chloride is vaporised into the air and forms very poisonous gas compounds. If not dealt with, these compounds can cause pollution.

MINING

- Phosphate rock is found together with clay and sand, usually about 5-9m below the surface. The first step is, therefore, to remove the top layer of the soil.
- This clay, sand and phosphate mixture is then mixed with water. The clay sinks and the phosphate and sand mixture can be removed.
- A flotation process is then carried out. This involves using water, chemicals and physical force to separate the phosphate from the sand. The sand is then pumped back to the mine site to be used in reclamation (restoring land to its original state).
- The phosphate from the flotation process is transported to the chemical processing plant where it is reacted with sulphuric acid to make phosphoric acid which is then used to make fertilisers and other products.

ENERGY SOURCES

1. FOSSIL FUELS

- Fossil fuels are so called because they have formed from the remains of dead plants and animals that have been buried for millions of years. The bodies of plants and animals are mainly made of compounds that consist of carbon, nitrogen and oxygen (organic compound). Hundreds of millions of years ago, when the earth was in the process of cooling down, there were many more earthquakes, volcanoes and floods than there are today. This means that when some plants and animals died, instead of rotting away completely as they reacted with oxygen, they were covered with mud or lava from volcanoes and were sealed off from reacting with air in the usual way.
- Over millions of years, because of the action of bacteria and the pressure and heat of the earth on top of them, these dead creatures turned into coal (which formed from land plants and animals) or oil and gas (which formed from sea plants and animals). When they are burnt, the carbon, hydrogen and oxygen from which they were made, are released to combine with oxygen to form carbon dioxide, water and energy. This process, combustion, is exothermic and the reaction equation is as follows:

\[
\text{Organic compound (containing C, H, O)} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{energy}
\]
USES OF FOSSIL FUELS

- They are used to generate electricity
  - Coal is burned to produce heat and this heat is used to boil water and produce steam
  - The steam turns a turbine (a fan with blades that turn)
  - The turbine turns a large magnet inside a coil (magnet and coil make up a generator) to create electrical charge
- They are also used in the burning of petrol to drive vehicles

DISADVANTAGES OF FOSSIL FUELS

- Pollution – fossil fuels release gases that affect the atmosphere and that will have far-reaching effects on health and stability of the planet earth
- Fossil fuels are not a renewable resource and the supply of fossil fuels is running out (every time fossil fuels are burnt, a substance that has taken millions of years to form, is being used). It is, therefore, important to conserve them and to avoid wasting. This can be done by:
  - Trying to use fuels more economically and efficiently
  - Using alternative sources of energy that are renewable

POLLUTION

Coal, oil and gas cause pollution. Coal is the most plentiful, the one used the most and the one which pollutes the most.

When these fossil fuels are burnt, they release pollutants like carbon dioxide, sulphur dioxide, nitrogen oxides and particulate matter (particles of soot and other solids) into the atmosphere.

Sulphur is present in small amounts in coal, oil and gas and when it burns in oxygen, it forms sulphur dioxide (SO\textsubscript{2}). This gas escapes into the atmosphere where it combines with water vapour to form sulphurous acid according to the following equation:

\[
\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3
\]

This is one of the main sources of acid rain.

When acid rain falls

- it lowers the pH of the soil, which stunts the growth of plants
- the run-off of this rain from the land can also poison lakes and streams and this in turn affects the animals that live in the lake, and the animals that live off them, i.e. the ecosystem gets thrown off balance
- Acid rain also attacks concrete and cement causing damage to building, bridges, statues, etc.
Nitrogen oxides (NO, NO\textsubscript{2}, N\textsubscript{2}O\textsubscript{4}) are other gases produced by the burning of fossil fuels. They also contribute to acid rain by forming nitric acid, and the gas itself causes irritation to lungs and mucous membranes when it is breathed in, causing respiratory diseases. One of the most dangerous pollutants is carbon dioxide. It is one of the greenhouse gases that is leading to global warming.

2. NUCLEAR POWER

- Nuclear power plants provide another way to heat water and to turn it to steam with which to turn turbines that generate electricity. They already supply 11% of the world’s energy and produce huge amounts of energy from very little fuel
- How it works – In a reactor, a controlled nuclear reaction is allowed to take place and the heat energy produced is used to change water to steam. The steam turns a turbine which turns a generator. Nuclear reactors are usually situated near the sea so that a large amount of water is available to keep the reactor cool enough to be safe
- SA has one of its nuclear reactors in Koeberg near Cape Town

ADVANTAGES

- SA already has the technology and suitable land
- This energy source is clean – does not really pollute the atmosphere
- Uranium (the fuel required) is plentiful in the country

DISADVANTAGES

- Any accidental leak in a nuclear plant can have consequences as terrible as death, cancer, birth defects, etc.
- Nuclear waste products stay radioactive for up to a thousand years. Presently, this nuclear waste is buried in an uninhabited part of the country in very strong and leak-proof containers

3. WIND POWER

Windmills are used to turn turbines that generate electricity. This energy source is being considered in the windier parts of SA like the Western Cape.

ADVANTAGES

- Wind is free and will always be available
- No pollution
- No waste

DISADVANTAGES

- Objections to the placing of giant wind turbines near houses and nature reserves where birds might be caught in them
- Not all parts of the country have sufficient wind
- The technology is expensive (but with greater numbers of them, they will become cheaper.)
4. WAVE POWER

An energy collector that has an opening at one end big enough to let sea water enter and leave a central space or chamber, is used. The waves arriving and leaving make the water in the chamber rise and fall and this causes air to be forced in and out of the hole at the top of the chamber. The turbine in this hole is turned by the movement of the air. The turbine in turn turns a generator which produces electricity.

ADVANTAGES

- This energy source is free
- No waste
- No pollution
- Wave generators, once built, are inexpensive to maintain (but they must be strong enough to withstand strong waves)

5. SOLAR POWER

Three main systems have been developed:

- **Solar Panels** are put onto the roofs of houses or buildings. These are large black panels that contain pipes through which water runs. The sun heats up the water which then runs into a storage tank. This means that people do not need to use electricity for hot water.
- **Solar powered plant** – the heat contained in solar rays is concentrated by reflecting mirrors until it reaches 4000°C. This heat is then used to produce steam that could run a normal power generator.
- **Photovoltaic (PV) cells** (a type of electric cell in which sunlight energy is converted into electrical energy) – can convert sunlight into electrical energy. Example: in calculators.

ADVANTAGES

- Sun is free and will always be available
- No pollution
- No waste

DISADVANTAGES

- Not always sunny
- The technology would be expensive
6. BIOMASS
- This is energy produced by burning plant and animal substances. For example, in South America sugar cane is allowed to ferment and is turned into alcohol which can then be used as fuels
- Sometimes the sugar cane pulp is burned directly to make steam to turn turbines
- Animal waste can be treated to produce methane gas and other fuels

ADVANTAGES
- These are renewable sources because more plants can be grown

DISADVANTAGES
- Burning a source that has other uses as well, must be done carefully because although it can be grown again, it takes a long time to reach maturity
- If it comes from burning plant material, it uses up a lot of land for the plant material to grow
- Can never really be used to supply big cities

7. HYDROELECTRICITY
- It involves using the power of falling water to turn turbines. A dam has to be built to trap the water, usually where there is already a lake. The water flows through tunnels in the dam, driving the turbines in the process.

ADVANTAGES
- No pollution
- Once built, it provides cheap energy

DISADVANTAGES
- Too much pressure on water as a resource that is not only used for electricity
- SA is fairly dry, does not receive enough water as it is

X-ample Questions

Question 1
A man’s wealth has been measured by the amount of gold he possesses. South Africa’s economy used to rely heavily on gold mining. The following flow diagram illustrates some of the most important steps in the recovery of gold:

```
Gold → A → NaAu(C) → B → Gold → C → Pure
```

1.1 Name the process indicated by A (1)
1.2 What type of reaction takes place during the process in 1.1 – precipitation, acid-base or redox? (1)
1.3 Write the equation for the reaction indicated by A and use oxidation numbers to explain your answer in question 1.1 (6)
1.4 Is the pH of the solution after this process in 1.1, greater than, less than, or equal to 7? (1)
1.5 Name the chemical process used in process B and give the chemical equation (5)
1.6 Name the process represented by C (2)

The recovery of gold has positive and negative effects.
1.7 Give one positive effect for the economy of the country (2)
1.8 Name one negative effect on our water sources (2)

Gold can be used in each of the following situations – state the property/(ies) of gold that is illustrated in each case.
1.9 It is used to make jewellery. (2)
1.10 Gold can be made into thin sheets that are used for decoration. (1)
1.11 It can be used as heating elements in aircraft windows. (1)
1.12 Gold is used to cover objects that carry corrosive chemicals. (1)
1.13 When making jewellery, the gold is alloyed with, for example, copper, silver or nickel. (2)
1.14 Electronic components and medical implants. (1)

(1)

QUESTION 2

Phosphate mining is propelled by the world’s growing demand for fertilisers. Open pit mines in Phalaborwa are used for rock phosphate mining.

The following two reactions are used to transform rock phosphate into soluble phosphates:

\[ \text{A: } \text{Ca}_{10}(\text{PO}_4)_6\text{F}_2 + 7 \ X + 3 \ H_2\text{O} \rightarrow 3 \text{Ca} (\text{H}_2\text{PO}_4)_2\text{H}_2\text{O} + 2 \text{HF} + 7 \text{CaSO}_4 \]
\[ \text{B: } \text{Ca}_{10}(\text{PO}_4)_6\text{F}_2 + 14 \ Y + 10 \ H_2\text{O} \rightarrow 10 \text{Ca} (\text{H}_2\text{PO}_4)_2\text{H}_2\text{O} + 2 \text{HF} \]

2.1 Identify the acids represented by X and Y. (4)
2.2 Despite the similar molecular formulae, the products Ca(H₂PO₄)₂ formed in the two reactions have different common names. Write down the names for each of these products in reactions A and B. (2)
2.3 Explain why rock phosphate is unsuitable for fertiliser (1)
2.4 Give a reason why phosphates used in animal feed must be absolutely pure (1)
2.5 What is the biggest pollution problem that the phosphate industry in South Africa is currently facing? Give a reason for your answer and give a possible solution to this problem. (3)
2.6 State one advantage of phosphate mining. (2)
2.7 Name two other uses of phosphates, other than fertilisers. (2)
2.8 Name the main phosphate ore. (2)
2.9 Write the chemical formula for ammonium phosphate and calculate the percentage phosphorous in the fertiliser. (5)
Question 3

Iron is removed from its ore by the following reaction:

\[ \text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2 \]

3.1 Give the name of the iron oxide that is commonly found

3.2 In the above reaction aluminium can be used instead of CO. Explain why CO is preferred to aluminium

The above reaction takes place in a blast furnace at a very high temperature.

3.3 Write down two chemical equations that will lead to the formation of carbon monoxide in the blast furnace.

3.4 What is the function of the carbon monoxide in a blast furnace?

3.5 What is the function of the limestone in the blast furnace?

3.6 Briefly describe the economical and environmental impact of iron mining in our country.

Question 4

4.1 What is a pollutant?

4.2 Name three pollutants produced by burning fossil fuels.

4.3 What is acid rain and explain how it is formed.

4.4 Explain how acid rain can disturb the environment.

4.5 Name the most important greenhouse gas and explain how it contributes to the greenhouse effect.

4.6 Define global warming.

Coal is South Africa’s main energy source for electricity production.

4.7 Why do we mainly use coal?

4.8 Write the general equation for the combustion of fuel.

4.9 Write an equation to show why the combustion of coal contributes to acid rain pollution.

Question 5

5.1 Explain in general how electricity is generated.

Nuclear power is generated when a controlled nuclear reaction takes place in a nuclear reactor, producing heat used to convert water to steam which drives turbines.

5.2 Where are nuclear reactors usually situated and why?

5.3 Where is SA’s nuclear reactor located?

5.3.1 One of the disadvantages of nuclear reactors is leaking. Name three consequences of nuclear radiation.
5.4 What happens to nuclear waste? (1)
5.6 Describe the chemical property of nuclear waste that makes it harmful. (1)
5.7 Give the name and symbol of the element that is commonly used in the generation of nuclear power. (1)

**X-ercise**

**Question 1**

1.1. List the three stages involved in extracting metal from its ore. (3)
1.2. How does the reactivity of the metal influence the method of extraction? (2)
1.3.1 Suggest a method of extracting the following and in each case provide a reason for your answer.
   - a. silver from silver sulphide (2)
   - b. zinc from zinc sulphide (2)
   - c. magnesium from magnesium chloride (2)

**Question 2**

Consider the extraction of iron from its ore in a blast furnace.

2.1 What is the name given to this process? (1)
2.2 Name the three substances that are added at the top of the furnace. (3)
2.3 What is the name given to the above mixture of substances? (1)

**Question 3**

Consider the following energy sources:

A. Fossil fuels
B. Nuclear power
C. Solar power
D. Wave energy
E. Biomass
F. Wind energy
G. Hydropower
Which of the above:

3.1. can have disastrous consequences if great safety precautions are not taken?  

3.2. makes use of PV cells to make electricity?  

3.3. is commonly used in generating SA’s electricity?  

3.4. makes use of windmills instead of steam to drive turbines?  

3.5. is produced by burning plant and animal substances?  

3.6. makes use of a radioactive element?  

3.7. is a major contributor to air pollution and ultimately global warming?