



CHEMICAL INDUSTRY

GRADE 12

Question 1

South Africa has a well developed chemical industry that consists of factories producing the following products: explosives, fertilisers, insecticides, petrochemical products, polymers, paper, glass, cotton products, soap and many other products.

As a result of the availability of coal, it is used in the making of petrol, oil and diesel. A committee, SASOL, has been set to administer this process.

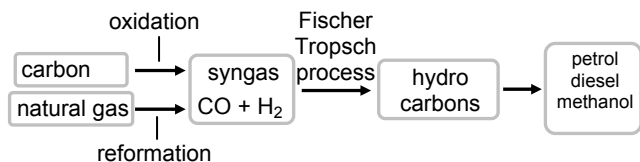
- 1.1 What does the abbreviation, SASOL, stand for?
- 1.2 Why is it advantageous for South Africa to use coal?
- 1.3 What impact has the development of the chemical industry had on man and the environment?

A balance should be maintained between man's activities and the environment. Sustainable development must be pursued, including the development of new industries.

- 1.4 What is meant by "sustainable development"?
- 1.5 Is South Africa seen as sustainable or not? Motivate.
- 1.6 What needs to happen to project a more favourable impression of the chemical industry of a country?

Question 2

Study the following diagram:



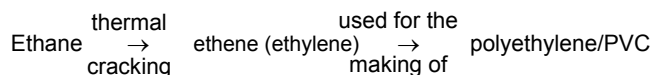
- 2.1 What are the raw materials in this process?
- 2.2 Name the main gas found in natural gas.
- 2.3 What is the full term for syngas?
- 2.4 Explain briefly what happens during the oxidation of carbon.
- 2.5 Supply the equation to show how natural gas reforms to CO and H₂.

During the Fischer-Tropsch process hydrocarbons are formed from CO and H₂.

- 2.6 Which metal is contained by the catalyst used in this reaction?
- The different hydrocarbons are separated from one another by means of fractional distillation.
- 2.7 On what principle does this process rest?
 - 2.8 What is meant by the term "hydrocarbon"?
 - 2.9 What does the process of cracking involve?

Question 3

Two of the hydrocarbon fuels formed during fractional distillation are ethane and propylene. These are used as raw materials for the polymer industry.



Two types of polyethylene are formed from the polymerisation-process, namely: HDPE and LDPE.

- 3.1 Write down an equation representing the cracking process of ethane.
 - 3.2 What type of reaction is this?
- Ethene molecules bond with one another to form long polymer chains.
- 3.3 What are these ethene units known as?
 - 3.4 What do the abbreviations HDPE and LDPE stand for?
 - 3.5 What is the difference between the two?
 - 3.6 What are these substances used for in the industry?

Question 4

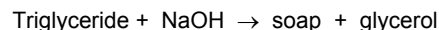
During the chloralkali process an electrical current is passed through a salt (NaCl) solution.

- 4.1 Name the product(s) that is/are formed during the oxidation half-reaction?
 - 4.2 What product(s) is/are formed during the reduction half-reaction?
 - 4.3 Give the equation for the net electrolysis process.
- Three different electrolytic cells can be used, namely: the mercury cell, the diaphragm cell and the membrane cell.
- 4.4 Which one is most commonly used? Why?
 - 4.5 For each of the products formed, write down an example where it is used in everyday life.
 - 4.6 Why must great care be exercised to prevent leakage of chlorine gas during the electrolysis process?

Question 5

One of the most important industrial uses of sodium hydroxide is in the making of a product that we have been using for nearly 5000 years, namely soap.

The following equation represents the process:



- 5.1 What is the common name for NaOH?
- 5.2 Triglyceride belongs to which homologous series?
- 5.3 What is the above reaction known as?
- 5.4 What is it in soap that makes it such a good cleansing agent?
- 5.5 Is soap and a purifier/cleanser the same thing? Explain.

Question 6

Because the world population is increasing so rapidly, the demand for food is incredibly high. The largest percentage of the world's soil is used for the cultivation of crops, but large shortages of nutrients and minerals to allow good crop growth exist.

What is the solution? Fertilisers.

- 6.1 Supply the names of the three primary macronutrients in fertilisers.
- 6.2 Where do plants get the elements carbon, hydrogen and oxygen from?
- 6.3 What is meant by the term, "autotrophic" organisms? (Plants fall in this category.)
- 6.4 The fertiliser: NPK is sold as NPK 14-24-16. What does this mean?
- 6.5 Why are liquid fertilisers used more and more in agriculture?
- 6.6 Write a paragraph or two in which you address the impact of fertilisers on the environment.

Question 7

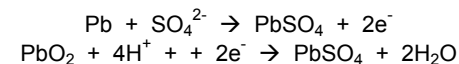
Ammonia is used during the Ostwald process in the production of nitric acid.

- 7.1 Which process is used by SASOL to produce ammonia?
- 7.2 Write down the three steps (in the form of chemical equations) of the Ostwald process.
- 7.3 What is most of the nitric acid, formed during this process, used for?

Question 8

The lead-acid battery is an example of a secondary battery, and is also known as an accumulator battery.

- 8.1 What is a secondary battery?
 - 8.2 Which solution acts as the electrolyte in a car battery?
- The following reactions take place in a car battery:



- 8.3 What happens to the lead during this process?
- 8.4 Which energy conversion takes place when a current flows?
- 8.5 Why does a car battery not go flat after being used once or twice?

Question 9

Why is it necessary to recycle batteries and not simply throw them away?



CHEMICAL INDUSTRIES

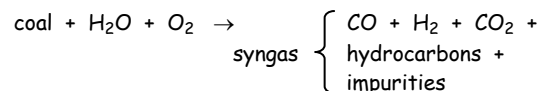
GRADE 12

QUESTION 1

- 1.1 Originally Afrikaans for: Suid-Afrikaanse Steenkool-, Olie- en Gaskorporasie (no English name)
- 1.2
- creates job opportunities
 - reduces importation of goods
 - saving of foreign exchange
 - improves the economy
- 1.3
- Pollution of the air and soil.
 - Followed by pollution of rivers, lakes and the sea.
 - Dumping of waste near residential areas.
 - Disturbing the balance in the environment because of the withdrawal of certain substances from the soil.
- 1.4 To provide for current needs, without endangering the ability of our descendants to provide for their needs.
- 1.5 Unsustainable; because of poverty it is basically impossible to have sustainable development. A lot of people don't even have access to clean water, enough food, housing, health services and sanitary services.
- 1.6 Systems must be established:
- must be cared for the health and safety of people
 - chemicals must be used according to instruction
 - waste must be thrown away carefully
 - clear policies and legislations drawn up by the government

QUESTION 2

- 2.1 coal; crude gas (natural gas)
- 2.2 methane (CH_4)
- 2.3 synthesis gas
- 2.4 During the combustion of coal, steam and oxygen are the reactants of the reaction.



This process takes place inside the gasifier at high temperatures.

- 2.5 $\text{CH}_4 + \text{H}_2\text{O} \rightarrow \text{CO} + 3\text{H}_2$
- 2.6 iron
- 2.7 Different boiling points of different substances makes it possible to separate them by means of fractional distillation.

- 2.8 Organic molecule consisting of the elements: carbon and hydrogen.
- 2.9 Process through which organic molecules are broken down into simpler molecules, for example:
- saturated hydrocarbons converted to unsaturated hydrocarbons
 - long chain structures converted to shorter chain structures

QUESTION 3

- 3.1 $\text{C}_2\text{H}_6 \rightarrow \text{C}_2\text{H}_4 + \text{H}_2$
- 3.2 elimination reaction
- 3.3 monomers
- 3.4 HDPE \rightarrow high-density polyethylene
LDPE \rightarrow low-density polyethylene
- 3.5 The methods through which they are produced differ:
- HDPE: produced under high pressure (15 - 30 atm) in the presence of an organo-metal catalyst.
- LDPE: produced under high pressure and temperature in the presence of an organic-peroxide catalyst
- 3.6 HDPE - buckets
- crates
- motor-oil containers
- LDPE - frozen vegetable bags
- garbage bags



QUESTION 4

- 4.1 Cl_2 (chlorine gas)
- 4.2 H_2 (hydrogen)
 OH^- (hydroxide-ion)
- 4.3 $2\text{NaCl}_{(\text{aq})} + 2\text{H}_2\text{O}_{(\text{l})} \rightarrow 2\text{NaOH}_{(\text{aq})} + \text{H}_2(\text{g}) + \text{Cl}_2(\text{g})$
- 4.4 Membrane cell
- produces a purer product
 - does not cause poisoning like in the case of the mercury cell
 - does not make use of as much energy as the diaphragm cell
- 4.5 Cl_2 - PVC
- paints / dyes
 - bleaching agents
 - pesticides
 - hydrochloric acid
 - medicine

- H_2 - margarine
- nylon
- hydrochloric acid
- NaOH - soap
- detergents
- paper
- weaving material



- 4.6 Cl_2 is a poisonous gas. Can cause damage to the lungs during inhalation. Can lead to death. Also a harmful pollutant.

QUESTION 5

- 5.1 caustic soda
- 5.2 fats or lipids
- 5.3 saponification
- 5.4 It acts as a wetting agent which decreases the surface tension of the water. It converts greasy and oily dirt into droplets that become suspended in the soapy water, forming an emulsion. These droplets can be removed from the material by being rinsed away.
- 5.5 No; soaps are manufactured from a renewable resource and are biodegradable. Detergents are synthetic - made in a laboratory and not found in nature, are less biodegradable than soaps.

QUESTION 6

- 6.1 nitrogen (N)
phosphorus (P)
potassium (K)
- 6.2 From the CO_2 and H_2O absorbed through their leaves and roots, from the air and soil.
- 6.3 They use the inorganic elements (C, H and O) to manufacture glucose, through the process of photosynthesis.
- 6.4 N = nitrogen
P = phosphorus
K = potassium
- The numbers indicate the percentage per mass of the substance.
- 6.5
- They cause the least environmental problems.
 - Substances are wasted minimally.
 - Insecticides can be added.
 - Nutrients are spread evenly.

6.6 The leaching of too many nitrates and phosphates (in fertilisers) into natural water resources may lead to eutrophication. This can take place during heavy rains or when too much fertilisers are administered. When there is an excess of nutrients in the water, blue-green algae thrive and multiply.

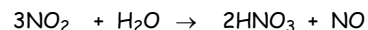
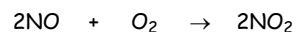
The algae contain waste products, which taint the water and make it unsuitable for drinking. When the algae die, the excessive decomposing matter uses up oxygen in the water. Lack of oxygen then leads to the death of animals living in the water.

Diseases spread through use of the water due to the contamination. Excess nitrates can decrease the ability of blood to carry oxygen.

The wind can carry fertilisers (administered by aeroplanes) to nearby dams or lakes.

QUESTION 7

7.1 Haber process



7.3 Is used in the manufacturing of ammonium nitrate (NH_4NO_3), which is used in fertilisers.

QUESTION 8

8.1 Charging can take place in these batteries. This is achieved by passing electricity through the battery. Now the battery can be re-used.

8.2 sulphuric acid

8.3 Lead is oxidised (loses e^-) to lead-ions.

8.4 chemical energy \rightarrow electrical energy

8.5 The alternator, driven by the engine, recharges the battery constantly. In this way electrical energy is converted to chemical energy.

QUESTION 9

Some batteries (dry cells) contain harmful substances like mercury chloride and cadmium, which can be dangerous to man and the environment. Pollution and diseases, like cancer, can be caused.

This practise is inherently wasteful and ecologically unsound. By recycling, our economy can benefit - it is less expensive to recycle metals than to exploit more.