

ELEMENTS OF CONSTRUCT FOR PAPER ONE 545/1

1ST ELEMENT OF CONSTRUCT.

The learner appreciates contribution of chemistry our economy

This assesses a student's ability to recognize and articulate the economic impact of chemical industries and products.

The student should not only know the processes of production in industries but also the economic significance and its impact on the environment

Key areas of assessment

1. Raw materials
2. Process of production
3. Side effects of the process of production
4. Mitigations to the side effects
5. Benefits of the process

Activity

Item 1.

Air which is a mixture of different components contains 21% oxygen. Due to a wide spread of respiratory illnesses caused by COVID-19, there was an increased demand for oxygen by patients in hospitals. The government supply of oxygen is not enough and is planning to set up an oxygen production plant with minimal environmental impact. However, the science club members in your school would like to know how the process of production will be carried out.

Task: As chemistry student, make a write up you will use during the presentation.

Solution

Large scale manufacture of oxygen from air

Raw materials

Air

Steps followed in the production process.

Air is trapped from the atmosphere and fed into the tanks.

The trapped air is then passed through air filters to remove dust particles

The filtered air is passed over the adsorbent beads to remove the water vapor, carbon dioxide and pollutants. These are removed first as they can solidify easily and block the pipes during the process

Carbon dioxide is removed by sodium hydroxide in the one of the beds.



The water vapor is removed by cooling the air, water vapor condenses to liquid water. The liquid water is removed by silicon dioxide (silica gel) in one of the beds.

The pollutants are then removed in the next beds.

At this stage air is compressed by forcing it through a small jet at high pressure of about 200atm, the air in the jet becomes very hot. It then expands and becomes cold as it enters a large tank at the end of the small jet.

The process of cooling the air is repeated multiple times until it turns into the liquid at a temperature of -200°C .

The liquid air is then directed in the fractionating column for it to be distilled into different fractions.

Oxygen in the tower is collected at -183°C , and stored into cylinders for use

The cylinders can be transported to hospitals for use by the patients

The production process has some side effects to the environment though they can be mitigated and they include the following.

Noise pollution from the compressors which might cause damage of the ears, this can be minimized by use of personal protective equipment such as those that cover the ears

Air pollution by release of waste gases in the atmosphere, this can be mitigated by installing catalytic converters on waste gas chimneys as converters shall convert harmful gases into less harmful ones.

Too much exposure to oxygen may lead to skin and eye irritations, this can be mitigated by informing all workers to wear personal protective equipment covering their eyes and the whole body

The production process also has some benefits to the environment which include the following.

Oxygen is essential in healthcare for respiratory support and surgical procedures

Oxygen is used in metal processing, and welding

The plant brings employment opportunities leading to improved income thus better standards of living.

This leads to development of infrastructure such as electricity lines, roads, hospitals schools among others. Improved road network will facilitate trade hence improved income and better standards of living

Item 2

1. Kasengejje citizens are having a complaint about the water they use for washing as it wastes soap and still leaves the clothes with dirty marks. So, they need the government to help them provide clean water sources yet it has just dug boreholes for them. Now government water engineers have advised it to set up an industry manufacturing washing soda (sodium carbonate) as it shall help solve the problem of the members of the area.

Now the government has decided to set up the industry to manufacture the washing soda in the village though it wants to know how the production process shall be without severe damage of the environment as this shall help it make proper planning.

Task

As a chemistry student:

Make a write up you can use to help the government.

Solution

Large scale production of washing soda

Raw materials

Brine

Water

Ammonia gas

Calcium carbonate

The production process involves the following steps;

Very concentrated brine (28% sodium chloride) is saturated with ammonia gas in a tower to form ammoniacal brine.

The ammoniacal brine is run downwards from the top of the tower while carbon dioxide formed from decomposition of calcium carbonate, is forced to rise up the tower from the base of the tower.

The tower is fitted with perforated mushroom shaped baffles at intervals that delay the flow of ammoniacal brine and also offer surface for the reaction

The ammoniacal brine reacts with carbon dioxide to form sodium hydrogen carbonate as precipitates since it is not very soluble in water. Precipitation is assisted by cooling the lowest third of the chamber.



Sodium hydrogen carbonate is filtered from the white sludge at the base of the tower and washed to remove ammonium compounds. The sodium hydrogen carbonate is then heated to form sodium carbonate



The anhydrous solid is dissolved in hot water, crystallization takes place as the solution cools. The crystals are hydrated sodium hydrogen carbonate (washing soda) are removed and allowed to dry.



The production process has some side effects to the environment though they can be mitigated and they include the following.

Washing soda production can release harmful chemicals and heavy metals into the environment, this can be solved by implementing environmentally friendly manufacturing processes, use waste water treatment plants and conduct regular environmental impact assessments.

Exposure to washing soda can cause skin and eye irritation, respiratory problems, and other health risks, this can be mitigated by providing proper safety measures, provide personal protective equipment's to workers, and conduct regular health checks

Washing soda production can lead to contamination of nearby water sources and air, this can be solved by implementing waste water management, ensuring proper disposal of chemical byproducts, and conduct regular air and water quality monitoring

Washing soda production requires large amounts of energy and raw materials which leads to resource depletion, this can be mitigated by implementing energy efficient manufacturing processes, use of renewable energy and employ sustainable resource management practices among others

The production process has some benefits to the environment and they include the following;

Washing soda production provides employment opportunities for many people

Washing soda is used to produce soap, detergents, and other cleaning products, which help maintain personal and public hygiene

Washing soda is used in water treatment processes, ensuring access to clean drinking water for communities

Washing soda can also be used in food processing and preservation, contributing to food security

Washing soda industry contributes to national economy through revenue generation and tax payments

Washing soda can be exported to various countries, generating foreign exchange earnings

It leads to infrastructural development such as transportation networks and energy supply systems

It can also contribute to environmental sustainability through water treatment and pollution control applications.

General effects and solutions and benefits of industrial production processes

Effects:

- Environmental pollution (air, water, soil)
- Health risks (work safety, community exposure)
- Resource depletion
- Waste generation
- Climate change and its effects

Solutions

- Implement sustainable practices (reduce, reuse, recycle)
- Conduct regular environmental impact assessments
- Implement waste management and reduction programs
- Promote energy efficiency use of renewable energy sources
- Ensure worker safety and community engagements
- Implement pollution control measures

Social benefits

- Job creation and employment opportunities
- Improved public health (access to clean water, sanitation, healthcare)
- Education and skills development (worker training, community progress)
- Community development (infrastructure, social services)
- Increased standards of living (higher income)

Economic benefits

- Economic growth (revenue generation)
- Foreign exchange earnings(exports)
- Infrastructural development (transportation, energy, water)
- Innovation and competitiveness
- Increased productivity
- Economic diversification (reduced dependence on single industries)

2ND ELEMENT OF CONSTRUCT ACTIVITY

Appreciates application of chemistry in daily life

This assesses student understanding of how chemical principles or processes are applied in daily life situations

You may be required to:

1. provide examples of chemical reaction or products
2. functions of the products or processes
3. explain the chemistry behind them and how they improve life (importance of chemical reactions and products)
4. dangers of the chemical reactions and products
5. solutions to the dangers
6. evaluation of the product

Examples of where chemical processes are applied in everyday life (chemistry and society)

1. The working of batteries
2. Hard water soft water
3. Water purification
4. RUSTING
5. Nuclear processes

Examples of products:

1. Food additives like preservatives, baking powder
2. Drugs and medicines
3. Detergents

Activity

Item1

Onyera, living in an area where they use bore hole water, slid, fell and his white shirt became dirty. He decided to use a detergent to clean his shirt. The shirt remained with some brown spots yet he had rinsed it several times.

Task

As a chemistry learner;

- (a) point out the problem Onyera made when choosing a product.
- (b) help Onyera understand how the product works
- (c) advice Onyera on the challenges associated with the long-term use of the product.

Solution

Item 1

- a) Onyera used soap to wash or used a soapy detergent.

- b) The product works by lowering the surface tension of water enabling it to spread and wet the material to clean more effectively. This facilitates breaking and dispersing of the grease(dirt) particles.

Soap molecule has two parts, the hydrophilic head (water loving) that is soluble (dissolves) in water and the hydrophobic tail (dirt loving) that is insoluble in water (it dissolves the oil/fat/grease). Dirt on a cloth is held by an oil film.

During washing, the soap molecules spread in water lowering the surface tension of water, the water penetrates the cloth (wetting) allowing soap molecules to reach the dirt particles in the cloth.

The hydrophobic tail (dirt loving part) surrounds the dirt particles forming micelles isolating the dirt particles from the cloth while the hydrophilic head (water loving) remains suspended in water, making the micelles soluble in water(emulsification). This disperses the dirt particles in water, creating an emulsion.

Due to repeated agitation, the micelles disperse into water leaving the cloth free from dirt. Agitation also breaks down larger dirt particles into smaller ones which are then surrounded by new soap molecules.

The cloth is then rinsed with clean water several times to remove the micelles from the cloth surface making it clean.

Bore hole water he is using is permanent hard water containing Mg^{2+} and Ca^{2+} dissolved in it since it passes through rocks underground. So, when soap a sodium stearate salt is added to water containing such ions during washing, the soap reacts with Mg^{2+} and Ca^{2+} forming the brown substance that remain in your cloth called scum.



This makes soap ineffective during washing hence leaving your cloth with brown spots on it even with several rinsing in clean water.

So Onyera should use a soap less detergent or a chemical like washing soda to remove the hardness in water. This shall enable him wash his clothes and they remain with no brown spots

- c) Soap contains chemicals that can cause skin burns and irritation and hence pain or cancer.
Eye redness and pain; hence loss of vision.
All the above effects can be prevented by thoroughly washing the affected areas like skin or eyes with fresh clean water.
Some soap less detergents
Soap less detergents contain phosphates which cause algae bloom/algal bloom and hence water pollution.

3RD ELEMENT OF CONSTRUCT.

The learner appreciates diversity and interactions of substances and their importance in life.

Key areas of assessment

1. Category of element, compound, substance or material with a reason (artificial or natural),(metal or non-metal) etc.
2. Properties or prediction of properties of element, compound, substance or material
3. Uses of element compound, substance or material
4. Impact of the element, compound, substance on the environment
5. Mitigations to the impacts

Activity

Item 1

Mr. John an investor in your village wants to construct a storied(flat) business house in the trading center, the contracted engineer has asked you to help him while choosing the materials he is to use to construct Mr. John's building.

Task:

As a student of chemistry;

- (a) help the engineer to choose five materials that should not miss on his list.
- (b) why do you think the materials in (a) should not miss on his list?
- (c) Advise the engineer on the choice of the materials

Solution

- (a) Essential Materials:

Concrete, for the foundation, floors, and structural support.

Steel, for reinforcement in concrete and structural framework.

Bricks or Blocks, for walls and partitions.

Glass, for windows and potential façade elements.

Wood, for doors, frames, and interior finishing.

- (b) **Reasons why the above materials should not miss on the list**

Concrete, is strong in compression, making it ideal for supporting the weight of the building. It's also fire-resistant and has good thermal mass.

Steel, has high tensile strength, which is necessary for withstanding forces like tension and shear. It also adds ductility to the structure, allowing it to flex under heavy loads.

Bricks or Blocks, provide good insulation, are durable, and have a high load-bearing capacity, which is crucial for the walls of a multi-storied building.

Glass, allows natural light to enter, reducing lighting costs, and can be treated for energy efficiency and aesthetics.

Wood, offers a combination of strength and aesthetics for non-structural elements and can be easily worked with for custom designs.

(c) Advice

(Choice of the material depends on many factors but in this case you shall focus on the use and sustainability of the material (environmental friendly))

Activity

Item

While investigating the reaction of period 3 elements with water, Juma first considered two elements A and B and the results of their reactions with water is summarized in the table below.

| Element | Observation |
|---------|---|
| A | Reacted violently while floating on surface of cold water forming an alkaline solution with evolution of hydrogen gas. |
| B | Reacted slowly with cold water forming an alkaline solution and hydrogen gas but when heated with steam formed a white solid and hydrogen gas |

Task:

As a chemistry learner:

- (a) Give the category of elements A and B
- (b) Predict the reaction of other elements in period 3 with water
- (c) Advise Juma about the dangers associated with the reaction of these elements with water.

Solution

(a) Category of elements A and B

Element A is **an alkali metal**, because it reacts violently with water, floats on the surface, forms an alkaline solution, and evolves hydrogen gas. This behavior is characteristic of alkali metals like sodium (Na) or potassium (K).

Element B is **an alkaline earth metal**, because it reacts slowly with water to form an alkaline solution and hydrogen gas, and when heated with steam, it forms a white solid.

This is typical of alkaline earth metals like magnesium (Mg) or calcium (Ca), which form oxides or hydroxides.

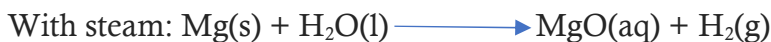
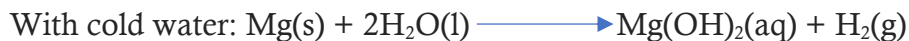
(b) Reaction of other elements in period 3 with water

Elements in period 3 of the periodic table include; Sodium (Na), Magnesium (Mg), Aluminum (Al), Silicon (Si), Phosphorus (P), Sulfur (S), Chlorine (Cl), and Argon (Ar).

Sodium (Na) would react similarly to Element A, violently with water forming an alkaline solution with evolution of hydrogen gas.



Magnesium (Mg) would react similarly to Element B, slowly with water and more vigorously with steam.



Aluminium (Al) reacts with water only when it is finely powdered at high temperatures, forming aluminium oxide and hydrogen gas.



Phosphorus (P) and Sulfur (S) do not react with water

Chlorine (Cl) do not react with water, but chlorine dissolves in water forming (chlorine water) a mixture of hypochlorous (chloric acid) acid and hydrochloric acid



Silicon does not react with water under normal conditions but reacts with steam to form silicon (IV) oxide and hydrogen



Argon (Ar) is a noble gas and does not react with water.

(c) Advising Juma about the dangers associated with these reactions:

Juma should be aware that reactions of metals with water can be highly exothermic, meaning they release a significant amount of heat so they can be explosive

The evolution of hydrogen gas can be dangerous as it is highly flammable and can lead to explosions if ignited.

Juma should conduct these experiments in a well-ventilated area and use proper safety equipment, such as gloves and goggles, to protect from splashes and the heat generated during the reactions.

It's also important to have a fire extinguisher nearby and to work under the supervision of a knowledgeable instructor.

4th ELEMENT OF CONSTRUCT

The learner appreciates the existence of natural resources in the environment and their importance in everyday life:

Students are assessed on their ability to identify natural resources in the environment, their importance, and how they can be conserved or be used sustainably

Key areas of assessment

1. Category of natural resources (renewable or non-renewable), reason and example
2. Composition of natural resources
3. Impact of natural resources on the environment, how it occurs and solutions
4. Impact of human activities on natural resources and mitigations
5. Benefits of natural resources

Activity

Item

Osukuru village in Tororo district is at the foot of Tororo rock. People of this village for a long time have practiced charcoal burning, animal husbandry, crop husbandry and stone quarrying, recently the animals have started dying and wells are drying up yet the little water available is not fresh. The locals are now wondering why all these are happening. A sensitization workshop is to be organized to explain the existing situation in the village. The theme of the work shop is MY ENVIRONMENT MY RESPONSIBILITY.

Task:

As chemistry student, write a message you will deliver upon invitation

Solution

MY ENVIRONMENT MY RESPONSIBILITY.

Greetings to every member of the village, our village, Osukuru has a various natural resource which can be categorized as renewable resources and non-renewable resources.

Renewable resources are resources that we use and are easily replenished easily, they do not get used up. Examples of renewable resources include, water, air, forests among others.

Non renewable resources are resources that are not replenished easily once they are used up; they take millions of years to be formed. Examples of non-renewable resources include fossil fuels and rocks

All renewable and non-renewable resources have different compositions for example;

Air is a mixture of gasses found in the atmosphere, it's made up of nitrogen, oxygen, carbon dioxide dust, rare gases like argon and pollutants like carbon monoxide, Sulphur dioxide among others.

Water is made up of hydrogen and oxygen.

Forests consist different plant species and, in their structure, they are also made up of carbon, hydrogen and oxygen like their cellulose cell walls.

The fossil fuels are formed from decomposition of animal and plant remains like coal and petroleum, they are also made up of hydrogen, and carbon.

The rocks are aggregates of minerals like iron, calcium, magnesium among others

Recently, your animals have started dying, wells are drying and the available water is not safe for use.

All that must have resulted from the activities you do carry out irresponsibly in this village which include, charcoal burning, animal husbandry, crop husbandry and stone quarrying.

These activities impact negatively on natural resources for example charcoal burning involves cutting down of trees which is deforestation leading to shortage of grazing grounds for all animals and loss of habitat for wild animals. It also leads to increased amount of carbon dioxide in the atmosphere which contributes to climate change and global warming hence the wells dry up due to increased temperatures.

Stone quarrying involves breaking of rocks into small stones and gravel for construction purposes. This disrupts the underground water cycle and sources hence reduced water quality make the water in the village unsafe for use, air pollution from dust, destruction of vegetation cover reducing the grazing grounds for the animals causing their death.

Farming, crop and animal husbandry, involves the use of fertilizers and manure which pollutes water bodies and makes the water unsafe for use. Fertilizers also cause eutrophication in water bodies leading to growth of algae on water bodies, this contaminates the water and also kills aquatic animals.

All the above impacts caused by our activities have mitigations to help us conserve our resources because they are so important to us. The mitigations to avoid the above impacts include the following;

Ensure sustainable fuel production using soft wood which is renewable through planting more trees. The trees also help to reduce the amount of carbon dioxide from the atmosphere thus preventing global warming that leads to climatic changes.

The planted trees also help in rain formation thereby filling the dried up water sources.

The planted trees also restore the grazing grounds and habitats for animals, this reduces on their death

Use charcoal briquettes made from waste organic materials like banana peelings and cassava flour instead of using charcoal that requires cutting down of trees that are important in keeping a fresh environment.

Strict government policies and laws to minimize stone quarrying. This reduces on destruction of rock beds that are important in water purification hence having clean and safe water in wells.

Filling up holes made during the process of quarrying, encourage population to use alternative construction materials like tiles and clay bricks. This enables growth of vegetation cover favoring rain formation and restoring grazing grounds for animals.

Sensitise farmers to use controlled doses of fertilisers and manure in gardens, this helps to reduce the effects of water pollution in the village

People should ensure proper disposal of animal excreta and also convert it into other useful products for example biogas, organic fertilisers and briquettes. This also reduces effects of water pollution, hence clean water sources.

Farmers should be encouraged to use organic fertilizers in the gardens such as compost manure

The natural resources in the village are very useful, that's why we should conserve them

Air is used for respiration, during respiration carbohydrate combine with oxygen in air to release energy and carbon dioxide used for proper body functioning.

Air facilitates photosynthesis, during photosynthesis carbon dioxide from air combines with water in presence of sunlight trapped by chlorophyll to form glucose and oxygen.

Fossil fuels are used as fuels, fossil fuels when burnt produce heat energy used to run engines and machines, even for cooking

Criteria for attempting items correctly.

1. Read the scenario described more than once to ensure understanding
2. Identify the problem in the scenario because it's the one you must address (solve in your response) if the problem is not solved, know your response is lacking and you may not get all the score
3. Always be precise, avoid using a lot of words to address the problem, science needs only facts, so many words with not fact, no score shall be attained.
4. Ensure that you cater for all areas of assessment as required in each element of construct most especially for section B items. For section A the areas might be distributed in the different parts of the task, so take note on that in order not to misplace or mis out in your responses
5. Always respond to the tasks as you are educating the examiner. So, mind the context in which the item has been asked and respond accordingly to that.

STAY WELL