CHEMISTRY DEPARTMENT

Senior four Topic: Chemicals for consumers.

Subtopic: Chemicals in medicine.

Lesson objective.

- ✓ Categories of medicines
- ✓ Suitability/functioning of medicines
- ✓ Advice (negative impact, mitigated)
- ✓ Evaluate/ compare (differences and similarities)

Categories of medicine.

Medicine is *any substance or chemical/compound used in treating a disease or give relief from pain.* Medicines are classified as,

(a) **Traditional medicines**, are medicines that utilize cultural and spiritual treatments mostly obtained locally as plant extracts, applied singularly or in combination to treat, and prevent illnesses or cure symptoms.

(b) **Modern medicine**, are medicines that utilize scientific knowledge, technology and evidence based practices to diagnose, treat and prevent illnesses and diseases.

(a) <u>Traditional medicines.</u>

	Traditional medicine	Use (function)
1.	Aloe Vera	Treats malaria, allergic reactions, treats diabetes, Skin disease. Treats burns.
2.	Guava leaf extract.	Treats malaria, ulcers, cough, diarrhea
3.	Paw paw leaf extract	Improves liver and kidney Functioning.
4.	Garlic extract	Controls cholesterol levels, regulates blood sugar, reduces cancer risks, and treats fungal and bacterial infection.
5	Momordica foetica (Bombo)	Used for fever, malaria infection, treating body Odour.
6	ginger	Treats digestive disorders, nausea.
7.	turmeric	has anti-inflammatory properties
8.	Neem	treats skin conditions and infections
9.	peppermint	treats digestive disorders and respiratory issues

<u>Suitability/ functioning/ working of traditional medicines</u>

Traditional medicines contain **active ingredients that provide relief from pain,** and others for bacterial infections work by **killing the bacteria thus preventing them from multiplying.**

<u>Side effects associated with uses of traditional medicines.</u>

These side effects include,

- Can trigger allergic reactions like mild skin rashes
- Lack standardized dosage, leading to over dose hence toxicity
- Prolonged use can delay treatment and worsen the condition instead.

- Trigger dependency and misuse especial those with addictive substances
- Headache.
- Stomachache.
- Diarrhea.
- Kidney and liver damage

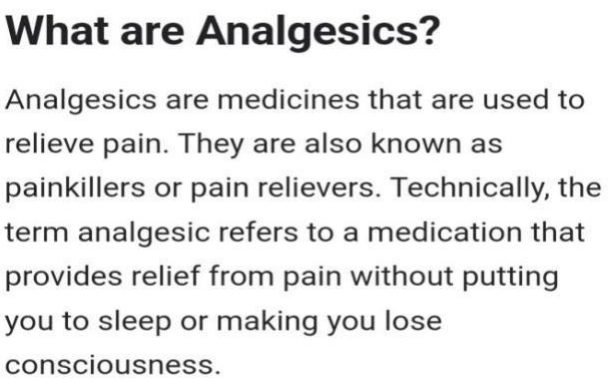
Mitigations to above side effects.

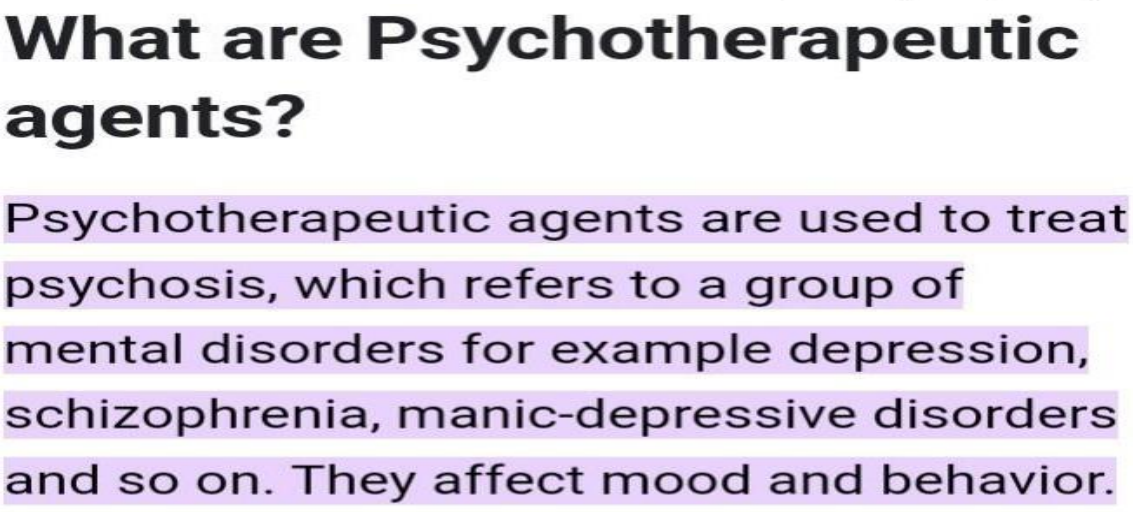
- Use of small amounts of traditional medicines other than excess.
- Use of modern medicine to counteract the effect of traditional medicine and avoid worsening the situation.
- Avoid self-medication
- Verify the source of the medicine
- Monitor and report any side effects

(b) Modern medicines.

These are classified into three types,

(I) Analgesics.
(II) Antibiotics.
(III) Psychotherapeutic medicine





1) Examples of analgesics (pain killers), their uses(functions) , their side effects and mitigations.

Medicine	Use of medicine	Side effects	Mitigations
1) Aspirin	Used to relieve pain from conditions of muscle aches and fever	Abdominal pain , chest pain	-Taking right prescription. - Seek immediate Medical attention. Switch to different medicine
2) Paracetamol	Used for pain relief and reducing high temperatures	Loss of appetite. Excessive sweating. Nausea Allergic reactions.	Follow recommended dose. Switch to different medicine. Seek immediate Medical attention
3) Codeine	Used for pain relief and cough suppression.	Nausea. Vomiting. Fatigue. Headache.	Taking enough rest. Seek immediate Medical attention. Switch to different medicine

How do analgesics work (**functioning**)

Analgesics work by inhibiting the sensation of pain, thus providing relief from pain. They achieve this by inhibiting production of prostaglandins from the brain that trigger pain and inflammation.

2) Examples of antibiotics.

Example of Antibiotics	Use (function)	Side effects	Mitigations.
1) Penicillin	Treat bacterial infections	Fatigue, dizziness, Nausea, vomiting, allergic reactions.	Seeking immediate Medical attention. Taking plenty of fluids. Taking enough rest.
2) Streptomycin	Treating bacterial infections for example tuberculosis	Chest pain, dizziness, Nausea, vomiting,	Seeking immediate Medical attention. Taking plenty of fluids. Taking Enough rest.
3) Amoxicillin	Treating chest infections for example Phenomenia.	Nausea, allergic reactions, fatigue, vomiting, dizziness.	Seeking immediate Medical attention. Taking plenty of fluids. Taking enough rest

How do antibiotics work (functioning)

Antibiotics work by **killing** the bacteria, thus preventing them from multiplying.
They interfere with formation of cell wall and cell membrane which are essential for the survival of bacteria

3. Examples of psychotherapeutic medicine, their uses, side effects and mitigations.

Example of psychotherapeutic medicines	Use (function)	Side effects.	Mitigations
1) Stimulants.	-Awakens alertness, confidence and energy. -Treats attention- deficit hyperactivity disorder (ADHD)	Loss of appetite. Headache. Nausea. Vomiting. Increased blood pressure.	Taking enough rest Seeking immediate Medical attention. Taking medicine in right amount as prescribed.
2) Antidepressants.	Treats generalized body anxiety disorder. Treats stress and depression.	Dizziness Loss of appetite. Feeling headache. Loss of libido. Erectile dysfunction	Seeking immediate Medical attention. Taking medicine in right amount as prescribed.
3) Antipsychotics.	Treating bipolar disorders such as extreme moods (stabilizing mood) and reducing anxiety	Dizziness. Weight gain. Headache. Sexual problems.	Taking medicine at different times of the day. Seeking immediate medical attention

Evaluate (similarities and differences between traditional medicines and modern medicines)

(a) Similarities.

(I) Both aim to prevent and treat illnesses.

(II) Both use natural ingredients from plants and animals.

(b) Differences.

	Traditional medicine	Modern medicine.
1)	Less effective in healing illnesses.	More effective in healing illnesses.
2)	Increased risks of side effects.	Often less side effects.
3)	Has no dosage instructions i.e. lack prescription	Has required dosage instructions.

4)	Often lacks standardization in preparation.	Have strong standards in production.

Qn. Why would you prefer traditional medicines to modern medicines? And vice vasa

SOAPS AND DETERGENTS

What to know, what has not been given here, go and refer to your book three for soapy and soapless detergents

- Categories as soapy and soapless detergents
- Structure of soap and detergents, essentially, the structure is the same
- Cleansing action of soapy and soapless detergents (same)
- Compare the cleansing actions, why soapless are better than soapy
- Side effects of using each kind of detergent and mitigate the effect
- Compare the detergents

DANGERS OR SIDE EFFECT OF SOAP AND DETERGENTS.

(a) **Soap contains** chemicals that can cause:

- Skin burns / blisters / irritation and hence pain or cancer.
- Eye redness and pain; hence loss of vision.

- Mitigation can be done by thoroughly washing the affected areas (or irrigation of the affected areas) like skin or eyes with plenty clean water.

(b) **Soapless detergents** contain phosphates which cause growth of algae bloom/alagalbloom and hence eutrophication and water pollution. Death of aquatic life following eutrophication

Similarities:

- Both soapy detergents and soapless detergents are salts of Organic acids of long carbon chain.
- Both soapy detergents and soapless detergents are effective cleansing agents in soft water / rain water.

b) Differences;

Soapy detergents	Soapless detergents
Forms scum with hard water	does not form scum with any form of water.
Gentle on skin during cleansing.	not gentle on skin during washing
Sodium salts of carboxylic acid of long chains and cannot be used in strongly acidic solutions.	Sodium salts of long chain benzene sulphonic acids and can be used in strongly acidic solutions.
Biodegradable	Non-biodegradable

NUCLEAR PROCESSES

The atomic nucleus is composed of protons and neutrons, the total number of protons in an element gives its atomic number and the sum of protons and neutrons gives the mass number of a particular element.

Elements with unstable nuclei in their atoms can go through nuclear changes and turn into different elements. This process involves nucleus in atoms and it's therefore called **nuclear process.**

Nuclear process therefore is the process that involves fusing or splitting (fission) of the nucleus.

Atomic structure

Structure of an atom (read your S.2 notes)

Nuclear reactions A nuclear reaction is a process in which the nucleus of an atom changes either by splitting, combining or rearranging its protons and neutrons.

Examples of nuclear reactions include

- Radioactive decay
- Nuclear fusion
- Nuclear fission
- Radiations

Radiations

This is the energy that travels in space inform of particles, electromagnetic waves. The common radiation is the sunlight (infra-red, visible light, ultra violet). Other like television and radio waves, x rays gamma rays and alpha particles may not be seen.

There are 4 major radiations ie alpha, beta, neutrons and electromagnetic waves such as gamma rays which defer in mass, energy and penetrating power.

Classes of radiations

They are classified according to their energy and penetrating powers. These are

i. Ionizing radiations. These have enough energy to penetrate and alter the chemical structure of materials eg our bodies. They are able to remove electrons from atoms (to ionize) by breaking chemical bonds and for this reason ionizing radiations are potentially harmful to life. Ionizing radiations can't be seen, felt, smelt, tasted or heard.

ii. Non-ionising radiations. These are unable to directly alter the chemical structure of materials, they include radio, microwaves, infra-red and visible light.

Effect of radiations on atoms of elements

The main effect of radiations on atoms is ability to change atoms to ions (ionization).

Particles in radiation that have sufficient energy collide with atoms and knock off electrons from atoms. Such particles are called radioactive particles.

Elements such as Uranium and Thorium are naturally found on earth and slowly change to produce decay products such as radium and radon upon exposure to radiations. These elements that able to decay are called radioactive elements and the process that causes effect on atoms of radioactive elements as a result of radiation is called radioactivity.

Radiations mainly affect nucleus and when exposed to radiations, nucleus may either split to form other atoms (nuclear fission) or fuse with other nuclei of atoms (nuclear fusion)

Nuclear fission is a process in which a heavy nucleus of an atom splits into two smaller nuclei with the release of energy. It is typically induced by absorption of a neutron.

Fission occurs in heavy elements like Uranium, Plutonium.

How nuclear fission occurs.

A heavy nucleus e.g. Uraniun-235 absorbs a slow moving neutron making the nucleus unstable. The unstable nucleus splits into two smaller nuclei, releasing additional neutrons and energy. The released neutrons may trigger fission in other nearby nuclei leading to a chain of reactions.

There are some naturally occurring isotopes which will split spontaneously and release energy, such as Uranium 235 and 238. These isotopes are called **fissile.**

Illustration of fission using Uranium

Nuclear fusion is a process in which two light nuclei combine to form a heavier nucleus with the release of energy (radiations). This is induced by extremely high temperatures and pressures.

How fusion occurs

Nuclei are positively charged and repel each other. For fusion to occur, the repulsion forces must be overcome which requires very high temperatures to provide the two nuclei with enough kinetic energy to collide with sufficient force. This strong collision overcomes repulsion and the two nuclei and bound together forming a new heavier nucleus. The mass of the resulting nucleus is slightly less than the sum of the original masses. The lost mass is converted into energy.

Example of fusion, using hydrogen nuclei (protons) in the sun.

Nuclear decay/Radioactivity/radioactive/nuclear disintegration

This is the spontaneous disintegration of an unstable nucleus into stable nuclei with emission of energy in form of radiations. As a result, the nucleus changes into the nucleus of one or more other elements. The daughter nuclei have a lower mass and are more stable (lower in energy) than the parent nucleus.

There are majorly three forms of decay, these are;

- ✓ Alpha decay
- ✓ Beta decal
- ✓ Gama decay

They emission of radiations or particles that include

- Alpha radiation
- Beta radiation
- Gamma ray

These radiations differ in properties

Alpha decay.

This is the nuclear disintegration that emits alpha particles,

Equation

Properties of alpha particles

- When an alpha particle is emitted, the mass number decreases by four and the atomic number decreases by two.

- They are positively charged with a charge of +2.
- Alpha particles are deflected towards the negative electric plate and repelled by the positive plate.
- Alpha particles are deflected by both electric and magnetic fields.

- The penetrating power of alpha particles is very poor (low) since they are large particles (large mass). Because of this, it can be stopped or absorbed by a thin sheet of paper.
- Because of the high charge, alpha particles have a great ionizing power and greatest ability to damage tissues (the ability to change atoms into ions due to radiation effect).
- Has a low range in air

Beta decay

Beta decay is a type of radioactive decay in which an atomic nucleus emits a beta particle.

The neutron in the nucleus splits into a proton and an electron, the proton stays in the nucleus increasing the atomic number of the atom by one. The electron is ejected from the nucleus and is the particle of radiation called beta. Hence, a beta particle is a high energy (fast moving) electron emitted from the nucleus.

When an atomic nucleus emits a beta particle, the atomic mass remains the same while the atomic number increases by 1.

Equation

Properties of beta particles.

➢ They are negatively charged with a charge of -1.

➢ Beta particles are deflected towards the positive electric plate and repelled by the negative plate.

➢ Beta particles are deflected by both electric and magnetic fields.

➢ They have a low mass hence a higher penetrating power and due to this, they can be stopped or absorbed by a block of wood or aluminum foil.

➢ Because of the low charge, beta particles have a low ionizing power

Sample question

Gamma decay.

Is a type of radioactivity in which unstable nucleus releases high energy inform of electromagnetic radiation without any particle being ejected.

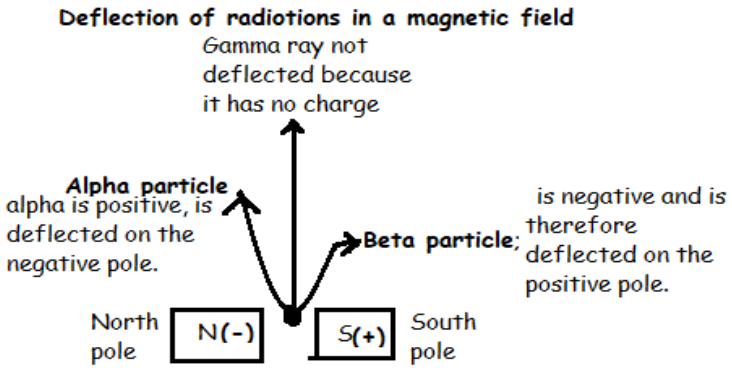
Gamma rays are not particles but electromagnetic waves with very short wavelength. When an atomic nucleus emits gamma rays, there is no change in the atomic number or mass number but the energy associated with gamma emission leads to an extra stability of the atomic nucleus. The composition or structure of an atom doesn't change.

Properties of gamma rays.

➢ They are not charged, hence are not deflected by magnetic or electric field.

➢ Their penetrating power is very high.

➢ Their ionizing power is very low



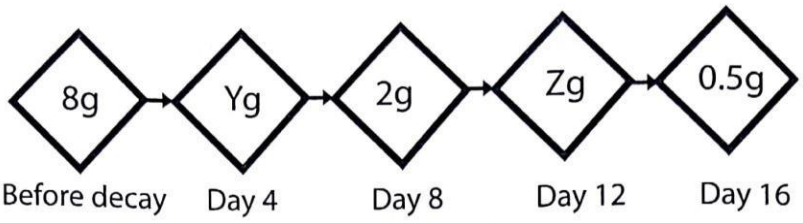
Sample qn

Half-life

Half-life is the time taken for a given mass of a radioactive substance to reduce or decay to half of its initial mass. Only unstable radioactive isotopes decay and as decay occurs, the level of radioactivity decreases.

The concept of half-life

Study and interpret the figure below.



a) What was the half-life of the radioactive material?
   - Four days

b) Work out the masses Y and Z obtained at day 4 and day 12, respectively.
   - Y = 4g
   - Z = 1g

c) What percentage of the radioactive material had been lost at day 8?

Lost mass= (8-2) g

= 6g

Total mass = 8g

$$\text{Percentage loss} = \left(\frac{6}{8} X 100\right)\%$$

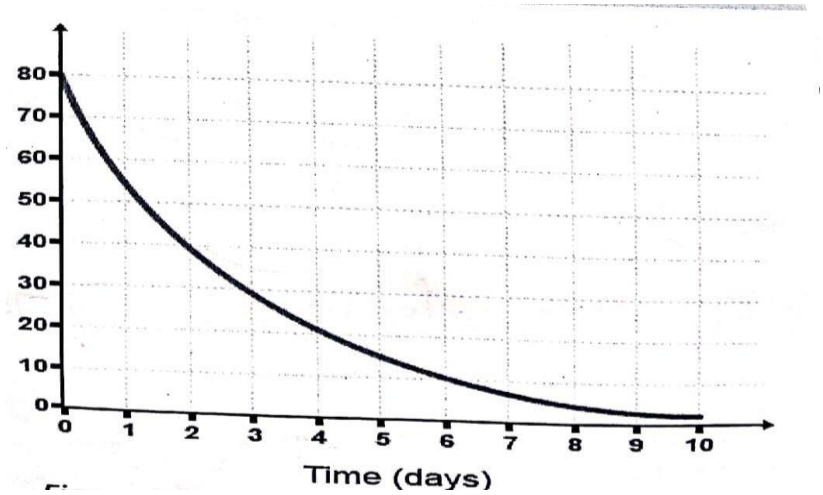
$$= 75\%$$

So what percentage had remained at day 8?

d) Predict the mass of the radioactive substance that will remain at day 20.
   - Since the half-life is four after every four days, we consider our initial mass at day 16 which 0.5g and will reduce to **0.25g**

Finding the time taken for an element to reduce to half of its original amount using a graph.

Study the graph below showing count rate of a radioactive substance H against time.



How long did it take for the count rate to reduce from;

a) 80 to 40
b) 40 to 20
c) 20 to 10
d) 10 to 5

Trial 2

8grams of substance D were initially present in a sample. The mass of D in the sample reduced to half in 8 days. Find the mass remaining after 24 days.

After 8 days, 4 grams remained

After 16 days, 2 grams remained

After 24 days, 1 gram remained. Therefore
1 gram remained after 24 days.

Calculating Half life

After one half-life, one half-life of the original amount of a radioactive substance remains. After two half-lives, one half of the previous half remains or one quarter and so on.

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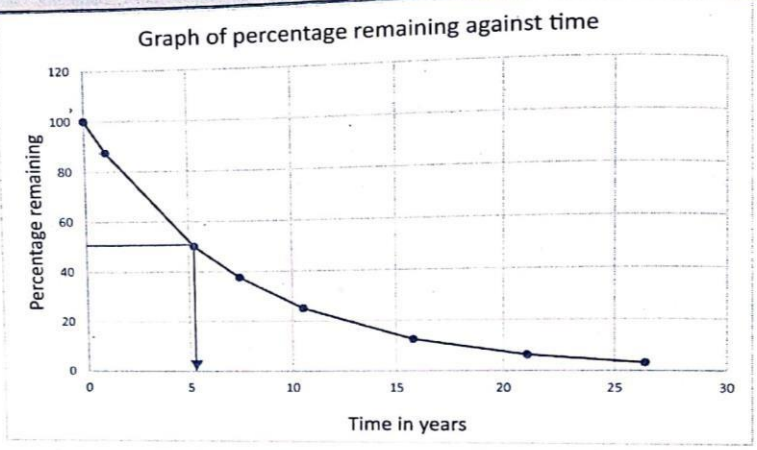
Table 6.2: Time taken for a substance to decay and the remaining percentages.

Time (years)	Percentage remaining	Time (years)	Percentage remaining
0	100	1.02	87.5
5.27	50	7.46	37.5
10.54	25	15.81	12.5
21.08	6.25	26.35	3.13

2. Plot an appropriate graph of the data in the above table.
3. From the graph they have drawn, let them determine the half-life of the substance.

Suggested responses



2. From the graph, the half-life of the substance is 5 years.

Exercise 6.1

The half-life of a certain radioactive isotope is 24 days. If the initial mass is 0.64 g, find;

a) the mass remaining after 120 days

b) how long it will take to have only 0.04 g remaining undecayed

Suggested responses

a) Number of half lives = $\frac{120}{24} = 5$

From the first principles:

Mass of the isotope remaining after 24 days = $\frac{0.64}{2} = 0.32g$;

Mass of the isotope remaining after 48 days = $\frac{0.32}{2} = 0.16g$;

Mass of the isotope remaining after 72 days = $\frac{0.16}{2} = 0.08g$;

Mass of the isotope remaining after 96 days = $\frac{0.08}{2} = 0.4g$;

Mass of the isotope remaining after 120 days = $\frac{0.04}{2} = 0.02g$.

Applications of radioactivity

Yes radiations have harmful effects but at the same time they have peaceful and beneficial effects,

Advantageous application of radioactivity/nuclear reactions

- ***Gama rays are used in radiotherapy to treat cancer and detecting breakages in bones.***
- ***Gama rays are used in sterilizing food, medical and industrial instruments***
- ***Radioisotopes are used to determine the age of fossils and rocks***
- ***Radioactive iodine is used to image the thyroid gland for diagnostic purposes.***
- ***Used to study the uptake of fertilizers by plants***
- ***Sterilizing insects and eliminate pests***

In industries, radioactive particles are used to

- ✓ ***Investigate flow of liquids in chemical plants***
- ✓ ***Detect smoke***
- ✓ ***Produce energy***
- ✓ ***Detect faults***
- ✓ ***Manufacture weapons of mass destruction such as nuclear and atomic bombs***

Activity

Sort out applications of radioactivity in

a) ***Archaeology***
b) ***Geology***
c) ***Crop production (biological)***
d) ***In defense***

Disadvantages of nuclear reactions.

Note; alpha particles are less dangerous unless the source enters the body. Beta and gama radiations are very dangerous as they damage body cells and tissues. They cause;

- ***Negative impact on the environment during mining of uranium***
- ***Skin burns***
- ***Leukemia (blood cancer)***
- ***Sterility***
- ***Blindness***
- ***Low body resistance to normal diseases***
- ***Mutation that may be lethal/fetal***
- ***Security threats***

Precautions to be taken while carrying out nuclear reactions/radioactive sources.

- *Use gloves always when working with radioactive materials*
- *They should be held with forceps or a pair of togs but not bare hands*
- *In radioactive labs, do not eat, drink, smoke, or use cosmetics*
- *Radioactive sources should be kept in lead boxes when not in use*
- *Wash hands thoroughly after exposure*
- *Any cut on the body should be covered before dealing with radioactive sources*
- *Do not pipette orally*
- *The radiations should not be directed to people during experiments*
- *Wear disposable clothes if there is substantial contamination risk*
- *Keep your lab coat separate from your everyday attire.*

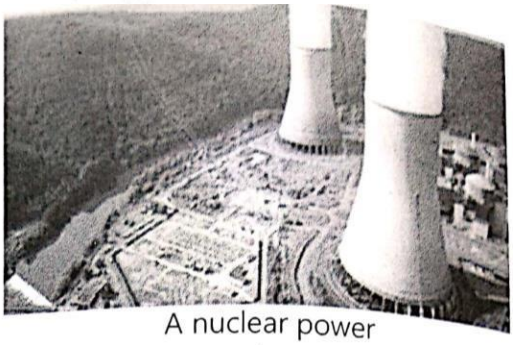
Activity

Point out social, political and environmental effects of nuclear power

Sample Activity of Integration

Due to increasing demand for power, agencies predict that East Africa could soon adopt the use of nuclear power for the smooth running of the increasing number of industries. Discussions among East African countries are underway to build nuclear power plants. However, there is little known about use of nuclear power by most people in East Africa and others have fears of its dangers.

Ugandans officials on a visit to the nuclear power plant in Fuqing, China



A nuclear power plant

Task

Write an article to be published in newspapers informing the concerned agencies and entire community about where the nuclear plant should be built, citing reasons why, impact to the surrounding area and population, advantages and disadvantages of nuclear plants and how they can me managed.

FOSSIL FUELS

What you need to know

- ✓ Why all fuels contain carbon
- ✓ How they were formed
- ✓ How they can be used as sources of energy
- ✓ Why they are described as non-renewable resources and their use is unsustainable

A fuel is a substance consumed to provide energy through combustion or chemical reaction or nuclear reaction.

Fossil fuels are natural energy resources that were formed as a result of a gradual decomposition/ decay of the remains of ancient plants and animals.

Or these are natural substances formed from anaerobic decay of dead plants and animals that lived millions of years ago and are used as a source of fuel.

Types of Fossil Fuels

There are mainly three types of fossil fuels, namely:

1) Coal; it is a solid at room temperature.

2) Crude oil; thick dark brown or black liquid.
3) Natural gas; colourless gas.

Fossil fuels are carbon based because they formed from organic matter of dead plants and animals whose bodies are primarily composed of carbon, this occurs under conditions of high temperatures and pressure. These fuels are known as fossil fuels because they were formed from fossils which were formed millions of years ago which were decomposed under high pressure and temperature

Formation of fossil fuels,
These fossil fuels differ in the way they were formed. However, they have many physical and chemical properties in common. All are
(1) Natural resources
(2) Sources of energy
(3) Non-renewable.

Uganda has large deposits of fossil fuels especially crude oil and natural gas. Coal is not found in Uganda.

How Was Each of These Fuels Formed?

(1) Coal

Coal was formed by the action of heat and pressure on the remains of mainly terrestrial /land plants over millions of years. Coal is formed by slow decomposition of dead plant materials. This process is called carbonisation. As plants died, they accumulated in layers and buried under sediment and the increasing temperature and pressure transformed plant material into coal. Plants contain a high amount of carbon; this is why coal also contain high amounts of carbon.
Summary

- ✓ Accumulation of plant debris
- ✓ Burial under sediment
- ✓ Compression and heat effect
- ✓ Coal formation

(2) Crude oil and natural gas

Crude oil and natural gas were formed by the action of heat and pressure on the remains of sea plants such as planktons and animals over millions of years. As these organisms died, they sank at the bottom of oceans and mixed with mud and other sediments and later transformed into oil or natural gas mainly methane.
Summary

- ✓ Marine organisms die and settle at the bottom

- ✓ Burial under layers of sediments
- ✓ Compression and heat over millions of years
- ✓ Formation of oil and natural gas

Activity; Assess the ability of these fuels to pollute our environment and how.

How Are Fossil Fuels Extracted?

There are two main methods for extracting fossil fuels from the ground. These are (1) mining

(2) drilling. Fossil fuels are obtained from the earth by mining and drilling.

Mining is the extraction of solid fossil fuels from the earth. For example, coal is extracted by digging underground or scrapping from the surface.

Drilling is a cutting process in which a drill bit is used to cut or enlarge a circular hole in a solid material. Crude oil and natural gas can easily be forced to flow to the surface using drilling method.

Why Are Fossil Fuels Used as Sources of Energy?

- This is because of their ability to release a lot of energy when burned.
- Fossil fuels are cheap and easy to use.

Uses of fossil fuels

- Generation of electricity.
- Oils gives us gasoline, diesel and other petroleum products.
- For cooking in gas stoves.
- Heating homes and buildings.
- Natural gas is used for cooking, heating.

Other Uses of Fossil Fuels

By-products of crude oil are used to produce various chemicals like;

- Plastics.
- Paint.
- Lubricants for vehicles and machines.

- Tar for tarmacking roads.
- Soap and dyes.
- Medicines like aspirin.
- Fertilizers and pesticides.

Why Are Fossil Fuels Described as Non-Renewable?

The formation of fossil fuels happened millions of year ago and such process may not happen again in the near future. In other words, fossil fuels are described as non-renewable natural resources because they cannot easily be replaced. Fossil fuels take a long time to be formed or renewed. The rate at which they are consumed far exceeds the rate at which they are naturally replenished. This makes their use unsustainable.
There is need for sustainable use of these fuels. Sustainability means using a resource to meet our own current needs without compromising the ability of future generations to meet their own needs.

Success dear students