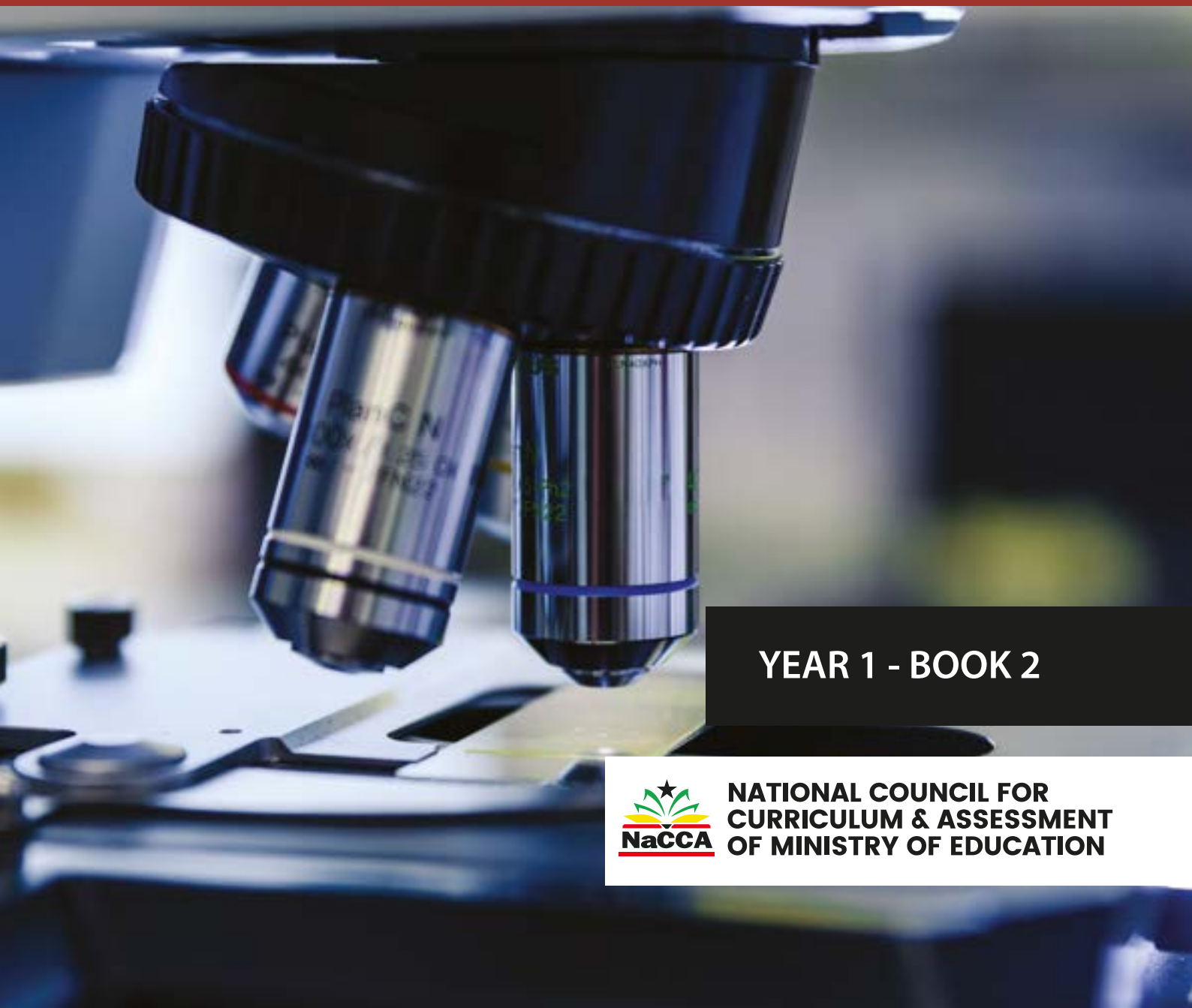
MINISTRY OF EDUCATION

GENERAL SCIENCE

For Senior High Schools

TEACHER MANUAL



YEAR 1 - BOOK 2

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

MINISTRY OF EDUCATION

REPUBLIC OF GHANA

General Science

For Senior High Schools

Teacher Manual

Year One - Book Two

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

GENERAL SCIENCE TEACHER MANUAL

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INTRODUCTION

The National Council for Curriculum and Assessment (NaCCA) has developed a new Senior High School (SHS), Senior High Technical School (SHTS) and Science, Technology, Engineering and Mathematics (STEM) Curriculum. It aims to ensure that all learners achieve their potential by equipping them with 21st Century skills, competencies, character qualities and shared Ghanaian values. This will prepare learners to live a responsible adult life, further their education and enter the world of work.

This is the first time that Ghana has developed an SHS Curriculum which focuses on national values, attempting to educate a generation of Ghanaian youth who are proud of our country and can contribute effectively to its development.

This Book Two of the Teacher Manual for General Science covers all aspects of the content, pedagogy, teaching and learning resources and assessment required to effectively teach Year One of the new curriculum. It contains information for the second 12 weeks of Year One. Teachers are therefore to use this Teacher Manual to develop their weekly Learning Plans as required by Ghana Education Service.

Some of the key features of the new curriculum are set out below.

Learner-Centred Curriculum

The SHS, SHTS, and STEM curriculum places the learner at the center of teaching and learning by building on their existing life experiences, knowledge and understanding. Learners are actively involved in the knowledge-creation process, with the teacher acting as a facilitator. This involves using interactive and practical teaching and learning methods, as well as the learner's environment to make learning exciting and relatable. As an example, the new curriculum focuses on Ghanaian culture, Ghanaian history, and Ghanaian geography so that learners first understand their home and surroundings before extending their knowledge globally.

Promoting Ghanaian Values

Shared Ghanaian values have been integrated into the curriculum to ensure that all young people understand what it means to be a responsible Ghanaian citizen. These values include truth, integrity, diversity, equity, self-directed learning, self-confidence, adaptability and resourcefulness, leadership and responsible citizenship.

Integrating 21st Century Skills and Competencies

The SHS, SHTS, and STEM curriculum integrates 21st Century skills and competencies. These are:

- **Foundational Knowledge:** Literacy, Numeracy, Scientific Literacy, Information Communication and Digital Literacy, Financial Literacy and Entrepreneurship, Cultural Identity, Civic Literacy and Global Citizenship
- **Competencies:** Critical Thinking and Problem Solving, Innovation and Creativity, Collaboration and Communication
- **Character Qualities:** Discipline and Integrity, Self-Directed Learning, Self-Confidence, Adaptability and Resourcefulness, Leadership and Responsible Citizenship

Balanced Approach to Assessment - not just Final External Examinations

The SHS, SHTS, and STEM curriculum promotes a balanced approach to assessment. It encourages varied and differentiated assessments such as project work, practical demonstration, performance assessment, skills-based assessment, class exercises, portfolios as well as end-of-term examinations and final external assessment examinations. Two levels of assessment are used. These are:

- **Internal Assessment (30%)** – Comprises formative (portfolios, performance and project work) and summative (end-of-term examinations) which will be recorded in a school-based transcript.

- **External Assessment (70%)** – Comprehensive summative assessment will be conducted by the West African Examinations Council (WAEC) through the WASSCE. The questions posed by WAEC will test critical thinking, communication and problem solving as well as knowledge, understanding and factual recall.

The split of external and internal assessment will remain at 70/30 as is currently the case. However, there will be far greater transparency and quality assurance of the 30% of marks which are school-based. This will be achieved through the introduction of a school-based transcript, setting out all marks which learners achieve from SHS 1 to SHS 3. This transcript will be presented to universities alongside the WASSCE certificate for tertiary admissions.

An Inclusive and Responsive Curriculum

The SHS, SHTS, and STEM curriculum ensures no learner is left behind, and this is achieved through the following:

- Addressing the needs of all learners, including those requiring additional support or with special needs. The SHS, SHTS, and STEM curriculum includes learners with disabilities by adapting teaching and learning materials into accessible formats through technology and other measures to meet the needs of learners with disabilities.
- Incorporating strategies and measures, such as differentiation and adaptative pedagogies ensuring equitable access to resources and opportunities for all learners.
- Challenging traditional gender, cultural, or social stereotypes and encouraging all learners to achieve their true potential.
- Making provision for the needs of gifted and talented learners in schools.

Social and Emotional Learning

Social and emotional learning skills have also been integrated into the curriculum to help learners to develop and acquire skills, attitudes, and knowledge essential for understanding and managing their emotions, building healthy relationships and making responsible decisions.

Philosophy and vision for each subject

Each subject now has its own philosophy and vision, which sets out why the subject is being taught and how it will contribute to national development. The Philosophy and Vision for General Science is:

Philosophy: The next generation of learners can be empowered to acquire scientific knowledge and develop science process skills in scientific concepts through 21**st** Century Skills and Competencies that create opportunities that leverage practical activities in a learner-centred environment to make Science functional, leading to Global relevance

Vision: A learner equipped with scientific knowledge through 21st Century Skills and Competencies who understands and applies scientific principles, solving daily scientific problems in an increasingly complex society.

SUMMARY SCOPE AND SEQUENCE

S/N	STRAND	SUB-STRAND	YEAR 1			YEAR 2			YEAR 3		
			CS	LO	LI	CS	LO	LI	CS	LO	LI
1.	Exploring Materials	Science and Materials in Nature	2	2	6	1	1	3	2	2	4
2.	Processes For Living	Essentials for Survival	2	3	5	2	2	6	2	2	6
3.	Vigour Behind Life	Powering the future with energy forms	1	1	2	1	1	2	1	1	2
		Forces acting on substances and mechanisms	1	1	2	1	1	1	1	1	2
		Consumer Electronics	1	1	1	1	1	2	1	1	2
4.	Relationships With The Environment	The Human Body and Health	3	3	3	1	1	2	2	2	4
		Technology in our Local Industries	2	2	3	1	1	2	1	1	1
TOTAL			12	13	22	8	8	18	10	10	21

Overall Totals (SHS 1 – 3)

Content Standards (CS)	**30**
Learning Outcomes (LO)	**31**
Learning Indicators (LI)	**61**

SECTION 5: SOLAR PANELS

Strand: **Vigour behind life**

Sub-Strand: Powering the future with energy forms.

Learning Outcome: *Relate forms of energy to their sources and their generation*

Content Standard: Demonstrate understanding of forms of energy, sources, their generation and effects on the environment.

INTRODUCTION AND SECTION SUMMARY

Harnessing solar energy to generate power through solar cells or panels is at the forefront of environmentally friendly energy options. The method entails absorbing sunlight and transforming it into electricity using photovoltaic technology. Individuals can play an important role in promoting renewable energy sources and environmental conservation by learning about the complexities of solar electricity generation and taking on the challenge of designing and building solar panels out of locally accessible materials.

This section comprehensively describes power generation using solar cells or panels. It dives into the fundamentals of solar energy conversion and emphasises the need to employ sustainable methods in the set-up of solar panels. This section hopes to promote creativity and innovation in renewable energy initiatives by understanding the principles underpinning solar panels. Individuals can learn about solar power's environmental and societal benefits through practical participation and hands-on learning experiences. By increasing people's understanding of solar energy technology, we enable them to contribute to a greener, more sustainable future.

The weeks covered by the section are:

Week 13: Describe the generation of electricity from solar cells/panels.

Week 14: Design and build Solar panels using locally available materials.

Week 15: Design and build Solar panels using locally available materials.

SUMMARY OF PEDAGOGICAL EXEMPLARS

Pedagogical Exemplars stress the role of teachers in providing dynamic learning experiences through individualised instruction. Teachers are encouraged to use a variety of instructional methods to meet the requirements of individual pupils, ensuring fair access to essential knowledge, understanding, and skills. The determination of core learning goals that serve as evaluation benchmarks is important to this example, which includes not just content mastery but also the development of critical cognitive and practical skills required for learners' overall growth and lifelong learning.

Furthermore, Pedagogical Exemplars advocate for the creation of supplementary curricula and opportunities tailored to the exceptional abilities of gifted and talented learners. Teachers can help high-achieving learners develop their unique abilities and potential by giving enriched challenges and extensions that go beyond the limits of the curriculum.

ASSESSMENT SUMMARY

This section's assessments can be formative, summative, or differentiated. Formative assessment will include activities such as laboratory work that demonstrates certain science features to improve

students' science process abilities. Short tests, class exercises, assignments, group debates, group projects, and group presentations are also available. Written exams, interviews, observations, or performance assignments based on assessment indicators are presented, along with graded results. Learners could be issued with a list of the learning outcomes for each section, and they could review their learning by coding each learning outcome in red (not understood). amber (understood but not yet secure) and green (securely understood). Summative assessments are due at the end of every lesson, section, and semester. However, both formative and summative exams contribute to learners' cumulative records.

To create a good assessment atmosphere, make sure learners are given clear instructions. Maintain consistency in administering the evaluation to all participants to ensure fairness. To create a good assessment atmosphere, make sure that learners are given clear instructions. Maintain uniformity when evaluating all participants to ensure fairness and impartiality. Assessment should focus on learners' ability to apply knowledge, think critically, solve problems, and communicate effectively. Differentiated assessments cater to individual learner needs and talents. Gifted and talented learners may require additional challenges, enrichment activities, or accelerated learning opportunities.

Transcript recording entails recording pertinent information such as the learner's characteristics, assessment date, assessment components, and scores. Include any extra observations or notes that may provide useful information about the evaluation outcomes.

Differentiated assessment considers each learner's unique learning needs, strengths, and interests. Teachers should tailor assessment questions to varied levels of readiness, learning styles, and preferences to ensure that all students have an equal opportunity to demonstrate their competencies.

WEEK 13

Learning Indicator: *Describe the generation of electricity from solar cells/panels*

Theme or Focal Area: How Solar Panels Reduce the Reliance on Fossil Fuels in Ghana

Overview of fossil fuels

Fossil fuels, such as coal, oil, and natural gas, are nonrenewable resources derived from the remains of ancient plants and animals that have experienced geological processes over millions of years. For decades, these energy sources have served as the foundation of global energy production because of their high energy density and accessibility. However, the combustion of fossil fuels emits greenhouse gases and hazardous chemicals into the atmosphere, causing climate change, air pollution, and environmental degradation.

Ghana, like many other countries, is facing issues due to its reliance on fossil fuels for electricity generation, transportation, and industrial activities. Imported oil and locally mined coal are among the principal fossil fuels utilised in Ghana, fuelling economic growth while raising environmental and energy security issues.

The limited availability of fossil fuel supplies and their negative impact on the environment underscores the need for sustainable energy alternatives to lessen reliance on these nonrenewable resources.

Solar panels

Solar panels provide a clean, renewable energy source that can drastically reduce Ghana's reliance on fossil fuels. Solar panels, which harness sunlight and transform it into electricity, present a sustainable option that emits no greenhouse gases or air pollutants. Switching to solar power in Ghana can help minimise the environmental impact of burning fossil fuels, resulting in better air quality, lower carbon emissions, and increased environmental sustainability.

In Ghana, the adoption of solar panels can play a crucial role in diversifying the country's energy mix and reducing its carbon footprint. By investing in solar energy infrastructure, Ghana can tap into its abundant sunlight resources to generate electricity without relying heavily on fossil fuels. Solar panels can be deployed on rooftops, in solar farms, and in decentralised systems to provide clean energy for residential, commercial, and industrial applications, thereby reducing the demand for fossil fuels in various sectors.

Furthermore, the implementation of solar power in Ghana can contribute to energy security and resilience by reducing the country's dependence on imported oil and mitigating the impact of fluctuating fuel prices. Solar panels offer a stable and predictable source of energy that can complement existing energy sources and reduce the risk associated with supply chain disruptions or price volatility in the global fossil fuel market.

By embracing solar panels as a clean energy solution, Ghana can also stimulate economic growth, create job opportunities, and drive technological innovation in the renewable energy sector. The development of a local solar industry in Ghana can lead to investments in manufacturing, installation, maintenance, and research, fostering a sustainable transition towards a greener and more resilient energy system.

The use of solar panels gives Ghana a transformative opportunity to reduce its dependency on fossil fuels, combat climate change, improve air quality, increase energy security, and promote long-term economic development. Understanding the meaning of fossil fuels and their environmental impact

allows Ghana to use solar power as a key enabler of a cleaner, more sustainable energy future and contribute to global efforts to transition to a low-carbon economy.

Learning Tasks

1. Identify at least four (4) examples of fossil fuels.
2. In what way is solar energy different from energy from fossil fuels?
3. Explain ways solar panels can reduce reliance on fossil fuels in Ghana.

Pedagogical exemplars

Collaborative learning

- Engage learners in mixed groups for an organised discussion by revising various forms of electricity generation from the junior high school curriculum (B7.4.2.1.1) related to solar energy.
- Encourage active participation, question and answer sessions, and peer-to-peer explanations to consolidate understanding and enhance retention.
- Organize learners into mixed groups to research and deliver presentations on solar energy.
- Provide guidelines on content, format, and presentation skills to ensure clarity and engagement.
- In groups, learners research how solar panels can reduce reliance on fossil fuels in Ghana.
- Learners reflect and cross-share their findings for peer review and critique.
- Offer alternative presentation formats for learners with difficulties.

Key Assessment

Level 1: State three examples of fossil fuels.

Level 2: Explain the term fossil fuel.

Level 3: Describe how solar panels reduce the reliance on fossil fuels in Ghana.

Level 4: Analyse how the impact of the use of solar panels on Ghana's economy.

WEEK 14

Learning Indicator: *Design and build Solar panels*

Theme or Focal Area: How Solar Panels are Set Up in Ghana

Overview

In contrast to finite fossil fuels, solar energy is a clean and renewable energy source that is abundant and infinite. Using solar power decreases reliance on non-renewable resources, which helps mitigate climate change.

Installing solar panels in Ghana is based on worldwide best practices, with some local peculiarities. The following is an outline of how solar panels are generally erected in Ghana:

Solar panel installation in Ghana

Solar panel installation in Ghana starts with a thorough site assessment considering solar irradiation, shading, roof orientation, available space, and electrical infrastructure. These criteria are evaluated to determine the best location and design for the solar panel system.

Engineers install solar panel systems based on on-site evaluation to suit the energy needs of the property or facility. The design process involves establishing the number of solar panels, inverter capacity, battery storage (if applicable), mounting structure, and wiring arrangement.

Permits and approvals are essential in Ghana to follow local legislation, building norms, and electric grid connection guidelines. This process may include interacting with key authorities to get grid connection permissions and safety certificates.

Experiment: Installation of Solar Panel Using Solar Panel Kits for Senior High School

- **Aim:** To install a solar panel kit, understand its components, and measure the output voltage and current under different lighting conditions.
- **Apparatus:** Solar panel kit (designed for educational purposes), multimeter (to measure voltage and current), Connecting wires, Load (e.g., small motor or light bulb), Mounting stand (optional), Sunlight or artificial light source, Notebook and pen for recording data

Procedure

- Carefully unpack the solar panel kit and identify all components. Common components include the solar panel, connecting wires, a load (such as a small motor or light bulb), and a stand.
- If your kit includes a stand or frame, assemble it according to the instructions provided.
- Mount the solar panel onto the stand, ensuring it is secure.
- The connecting wires attach the load (motor or light bulb) to the solar panel terminals. Ensure correct polarity (positive to positive and negative to negative).
- Set the multimeter to measure voltage (V) and connect the probes to the output terminals of the solar panel.
- To measure current (I), you must set the multimeter to the current setting and connect it in series with the load.
- Outdoor in Sunlight: Place the solar panel in direct sunlight and record the voltage and current readings from the multimeter.
- Partial Shade: Move the panel to a shaded area and record the new readings.

- Artificial Light: Bring the panel indoors and use a strong artificial light source (e.g., a desk lamp). Record the readings.

Record Observations: For each lighting condition, note the following:

- Voltage (V)
- Current (A)
- Power (P = V × I)

Analyse Data: Compare the voltage and current outputs under different lighting conditions. Discuss how the intensity and type of light affect the solar panel's performance.

Example of Data

Table1.1:

Lighting Condition	Voltage (V)	Current (A)	Power (W) = V × I
Direct Sunlight	18.5	0.5	9.25
Partial Shade	10.2	0.3	3.06
Artificial Light	3.5	0.1	0.35

Roof Preparation and Mounting Structure: Rooftop installations may need strengthening or repair to accommodate the weight of solar panels. A strong mounting system is then placed on the roof to secure the solar panels and optimise sunlight exposure for optimal energy generation.

Install solar panels securely and at the right angle for the best sunlight throughout the day. The panels are wired correctly and safely to prevent shadowing and limit energy losses.

Inverter Installation: Solar panels are wired to an inverter, which converts DC electricity to AC for residential or commercial consumption. The proper installation of the inverter provides effective energy conversion. The AC electricity generated by the solar panels is routed through a meter and connected to the property's electrical infrastructure. In off-grid installations or systems with battery storage, the connection includes a battery bank and a charge controller for energy storage and management.

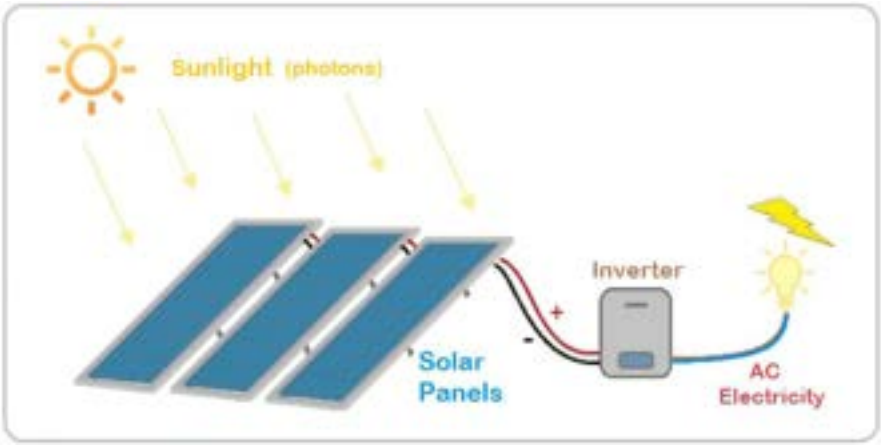

Fig. 1: *A labeled diagram of inverter installation*

Testing and commissioning: After installation, the solar panel system is thoroughly tested to ensure performance, safety, and operation. Testing entails inspecting electrical connections, measuring voltage output, and ensuring that the system works as intended. Maintaining and monitoring solar panel systems is crucial in Ghana for optimal performance and efficiency. Regular inspections,

cleaning of panels, and monitoring of energy production assist in optimising system output and quickly resolving any difficulties.

Caring for solar panels: Caring for solar panels in Ghana is essential to maintain optimal performance and longevity of the system, especially in the country's climate conditions. Here are some key tips on how to care for solar panels in Ghana:

Regular Cleaning: Dust, dirt, bird droppings, and other debris can accumulate on the surface of solar panels, reducing their efficiency. Regularly clean the panels with water and a non-abrasive cleaning solution to remove dirt and maintain maximum sunlight absorption.

Monitor Shading: Keep an eye on shading patterns on the solar panels, especially from nearby trees, buildings, or structures. Trim back vegetation or remove obstacles that cast shadows on the panels to ensure uninterrupted sunlight exposure throughout the day.

Check for Damage: Inspect the solar panels periodically for any signs of physical damage, such as cracks, scratches, or loose connections. Address any damage promptly to prevent further issues and ensure the panels continue to operate efficiently.

Test System Performance: Monitor the energy output of the solar panel system regularly to ensure it is producing the expected amount of electricity. Compare energy production figures with historical data to identify any anomalies that may indicate a problem with the system.

Maintain Electrical Components: Check the wiring, connections, and electrical components of the solar panel system for signs of wear, corrosion, or overheating. Ensure that all electrical connections are secure and functioning correctly to prevent breakdowns or safety hazards.

Protect Against Lightning: Ghana's climate can experience lightning storms, posing a risk to solar panel systems. Install surge protectors and grounding systems to safeguard the system from electrical surges and lightning strikes.

Schedule Professional Inspections: Consider scheduling regular maintenance checks by a qualified solar technician to inspect the system, perform detailed assessments, and address any issues proactively. Professional inspections can help identify potential problems early and optimise system performance.

Monitor Battery Health (if applicable): If your solar panel system includes battery storage, monitor the health of the batteries regularly. Check the charging levels, electrolyte levels (if applicable), and overall battery performance to ensure efficient energy storage.

Keep Records: Maintain detailed records of maintenance activities, energy production data, inspections, and any repairs done on the solar panel system. Keeping accurate records helps track system performance, troubleshoot issues, and plan for future maintenance.

Learning Tasks

1. Identify factors to be considered when setting up solar panels in Ghana.
2. Describe the Impact of environmental factors on solar panel installation.
3. Explain why regular cleaning of the solar panels is important.

Pedagogical exemplars

Demonstration

- Provide visual aids such as detailed maps showing the geographical distribution of solar panel installations across Ghana to learners.

- Use diagrams and concept maps illustrating the setup process of solar panels, including placement, orientation, and connection to the electrical system.
- Show pictures of existing solar projects in different regions of Ghana to demonstrate real-world applications and inspire visual learners.

Collaborative learning

- Put learners into mixed-ability groups to collaboratively analyse and interpret the detailed maps showcasing solar panel installations in Ghana, encouraging teamwork and information sharing.
- Provide opportunities for group discussions to create concept maps illustrating the setup process of solar panels, allowing for diverse perspectives and solutions.
- Provide criteria to help learners do group presentations where learners showcase pictures of existing solar projects in Ghana, fostering collaborative learning and collective insight into real-world solar applications

Research-based learning

- Learners explore the environmental factors unique to Ghana in mixed ability groups, such as weather patterns, sunlight intensity, and terrain, and how these impact the effectiveness of solar panel installations. Learners reflect and share their findings for peer review.
- Engage learners in group present where learners work in teams to design a solar panel installation plan for a hypothetical Ghanaian community.
- Assign specific roles within the group, such as project manager, technical expert, and financial analyst, to simulate a real-world collaborative environment.
- Encourage learners to consider sunlight exposure, energy demand, budget constraints, and community engagement when developing their solar panel installation proposal.
- Through hands-on activities, put learners in mixed-ability groups where learners clean and maintain a small-scale solar panel setup, simulating the conditions and challenges faced in Ghana.
- Assign projects to investigate the impact of Ghana's climate, dust levels, and maintenance practices on the longevity and efficiency of solar panels in the region. Task learners to develop and present educational materials on solar panel maintenance to raise awareness and promote sustainable energy practices in local communities.

Key Assessment

Level 1: Explain at least three routine maintenance tasks required to keep solar panels clean and functioning effectively.

Level 2: Describe the step-by-step procedures for installing solar panels.

Level 3: Create a visual diagram or flowchart illustrating the installation process of solar panels, highlighting key components and safety protocols.

WEEK 15

Learning Indicator: *Design and build Solar panels using locally available materials.*

Theme or Focal Area: Advantages and Disadvantages of Solar Energy to the Economy of Ghana

General advantages of solar energy/panel

Renewable and Sustainable: Solar energy is a renewable resource, meaning it is inexhaustible and can be harnessed for power generation without depleting natural reserves. This sustainability ensures a reliable energy source for current and future generations.

Environmentally Friendly: Solar energy production has minimal environmental impact compared to traditional fossil fuels. It reduces greenhouse gas emissions, lowers air and water pollution, and helps combat climate change, promoting a cleaner and healthier environment for all living beings.

Cost-Effective: Over time, solar energy systems prove to be cost-effective due to lower energy bills and minimal maintenance requirements. This affordability makes solar power accessible to a wider population, driving energy independence and economic growth.

Energy Independence: By utilising solar energy, individuals and communities can reduce their dependence on traditional energy sources, contributing to energy security and resilience in the face of disruptions or price fluctuations in the energy market.

Versatility and Accessibility: Solar energy can be harnessed in various forms, from small-scale residential installations to large-scale utility projects. Its accessibility makes it a versatile solution for powering homes, businesses, and even remote areas with limited access to traditional power grids.

Job Creation and Economic Growth: The solar energy industry creates job opportunities in manufacturing, installation, maintenance, and research sectors, stimulating economic growth and bolstering local economies.

General disadvantages of solar energy/ Panel: Solar energy availability depends on sunshine, making it sporadic and unpredictable, particularly on overcast days or at night. This fluctuation can make it difficult to supply continuous energy demands without storage options.

Energy Storage Limitations: Storing solar energy for use during periods of low sunlight can be expensive and technically difficult. Capacity and efficiency limits are common in solar battery storage systems.

The initial cost of installing solar panels and accompanying equipment might be prohibitive for many people and communities. The initial expenditure necessary for solar energy installations may discourage some people from using this renewable energy source.

Aesthetic Considerations: Some people may find solar panels physically unpleasant or detrimental to the aesthetics of a neighbourhood, raising issues about property values and community appearance.

System Integration issues: Integrating solar energy into existing power networks can bring issues relating to system stability, energy distribution, and balancing supply and demand, necessitating improvements and expenditures in grid infrastructure.

Advantages of solar panels to the environment

Reduced Greenhouse Gas Emissions: Solar energy systems provide electricity without emitting greenhouse gases such as carbon dioxide or methane, which are significant contributors to climate change. By utilising solar energy, we may considerably lower our carbon footprint and alleviate the effects of global warming.

Air Quality Improvement: Traditional energy sources, such as coal and natural gas, emit dangerous pollutants into the environment, contributing to air pollution and respiratory ailments. Solar energy generation is clean and does not release pollutants, which benefits general air quality and public health.

Water Conservation: Unlike fossil fuel power plants, which require a lot of water to cool and operate, solar energy systems use very little water. Water conservation is important for regions facing water scarcity or drought conditions, safeguarding this critical resource.

Solar energy generation has a limited environmental impact because it does not require the extraction, transportation, or combustion of fossil fuels. Solar electricity contributes to the conservation of biodiversity and natural landscapes by lowering environmental disturbances and habitat degradation.

Resource Conservation: Solar energy is derived from sunlight, a nearly infinite resource that does not deplete or require extraction from the planet. By using solar electricity, we lessen our reliance on scarce resources such as coal, oil, and natural gas, supporting resource conservation and sustainable energy practices.

Climate Resilience: Switching to solar energy decreases reliance on nonrenewable energy sources susceptible to supply disruptions, price volatility, and geopolitical conflicts. Solar power improves energy security and resilience to climatic hazards, resulting in a stable and sustainable energy future.

Energy Independence: By using solar energy, communities and nations can lessen their reliance on imported fossil fuels, thereby increasing energy independence and security. Localised solar power generation allows people to take control of their energy production, promoting self-sufficiency and autonomy.

Disadvantages of solar panel

Land Use: Large-scale solar energy projects require significant land area for installation, which can result in habitat disruption and land-use conflicts. Clearing land for solar farms may lead to biodiversity loss and natural ecosystems, particularly in sensitive or undeveloped areas.

Resource Extraction: Producing solar panels involves mining raw materials such as silicon, cadmium, and rare earth elements. Extracting these resources can have environmental consequences, including habitat destruction, water pollution, and energy consumption in the manufacturing process.

Waste Generation: When solar panels reach the end of their usable life span, they must be disposed of. Improper disposal of solar panels can lead to electronic waste, potentially releasing hazardous materials into the environment if not managed responsibly.

Transportation Impact: Solar energy systems and components are often manufactured in different locations and transported to installation sites. The transportation of solar panels and equipment can contribute to carbon emissions and environmental pollution if not optimised for energy efficiency.

Visual Impact: The visual appearance of solar panels, especially in residential or scenic areas, can be perceived as unsightly or intrusive. Concerns about the aesthetics of solar installations may arise, impacting community acceptance and willingness to adopt solar energy technologies.

Heat Island Effect: Solar panels can absorb and retain heat, leading to localised warming in urban or densely populated areas with high solar panel density. This heat island effect can alter microclimates, increase energy consumption for cooling, and affect thermal comfort near solar installations.

Learning Tasks

1. Identify three advantages of solar energy to life in Ghana.
2. Explain the advantages and disadvantages of solar energy/panels.
3. Analyse how the implementation of solar energy/panel initiatives impacts the country's economic growth and sustainability.

Pedagogical Exemplars

Collaborative learning

- Put the learners into small groups and assign each group a specific advantage of solar energy to the economy of Ghana, such as increased energy access or reduced reliance on fossil fuel imports. Have each group research and discuss their assigned advantage, then present their findings to the class. This activity encourages collaboration, critical thinking, and in-depth exploration of the economic benefits of solar energy.
- Engage learners in mixed-ability groups to focus on disadvantages such as high initial costs or intermittent sunlight exposure. Have learners become experts on their assigned topic, then reshuffle the groups so each new group has an expert from every initial expert group. This way, students can share their knowledge and insights on the disadvantages of solar energy before presenting a comprehensive overview to the class.

Case study

- Provide case studies showcasing the successful implementation of solar energy projects in Ghana, highlighting the economic benefits experienced by communities and businesses. Assign different case studies to individual learners or small groups based on their interests or learning styles. Students can analyse the economic impact, challenges faced, and lessons learned from each case study. This differentiated approach allows students to engage with real-world examples at their own pace and depth, catering to their diverse learning preferences.
- Present a variety of case studies on grid integration challenges or maintenance issues in solar energy adoption in Ghana, each with varying levels of complexity and allow learners to choose a case study based on their interest and familiarity with the topic.
- Let learners critically evaluate the economic drawbacks presented in their chosen case study and develop innovative solutions to address the challenges.
- Provide support materials, such as research articles, diagrams, or videos, tailored to each case study to help different learning abilities.
- Encourage learners to present their proposed solutions through written reports, presentations, or visual representations, allowing for individual expression and showcasing varied strengths among learners.

Key assessment

Level 2: Skills of conceptual understanding

Level 1: Identify at least four disadvantages of solar panels.

Level 2: Explain at least four advantages of solar panels.

Level 3: Investigate and describe the environmental benefits of utilising solar energy as a renewable alternative in Ghana.

Section review

Learning about power generation from solar cells/panels and understanding how solar panels are set up will provide learners numerous benefits beyond renewable energy technology. Understanding the basics of solar energy fosters an appreciation for sustainable practices and enables people to make informed decisions about their energy use and environmental impact. This knowledge gives learners the tools to advocate for clean energy initiatives and contribute meaningfully to reducing climate change and creating a greener future.

Solar energy has both advantages and downsides in Ghana's economy. Advantages include improved energy access and reliability, particularly in remote locations without grid connections. Solar power can help to stimulate economic growth, increase productivity, and reduce dependency on expensive fossil fuel imports, boosting energy security and conserving foreign exchange reserves. Despite initial constraints such as high costs and sporadic sunshine exposure, the long-term benefits of solar energy in terms of sustainability, affordability, and job creation surpass the initial barriers.

Learners can use their knowledge by investigating strategies to overcome obstacles and maximise the benefits of solar electricity in Ghana. Learners can contribute to sustainable development activities and positively impact Ghana's economy by conducting feasibility studies, making policy recommendations, or working on community projects. Understanding the economic implications of solar energy provides students with critical thinking skills for navigating energy difficulties and promoting sustainable practices in Ghana and elsewhere.

Additional activities

1. Create a visual presentation or poster board displaying various types of solar panels.
2. Overview of Solar Energy in Ghana: Examining the significance of solar energy as a renewable resource in Ghana's energy landscape.
3. Detailed steps and considerations for setting up solar panels in different regions of Ghana, including site assessment, mounting, wiring, and connection to the electrical grid.
4. Real-world examples of successful solar panel installations in Ghana, highlighting different approaches and outcomes. The critical role of regular care and maintenance in preserving the performance and lifespan of solar panels in Ghana's challenging environmental conditions.
5. Best practices for cleaning solar panels, conducting system inspections, and troubleshooting common issues to ensure optimal efficiency.
6. Strategies for sustainable solar panel maintenance, including water-saving cleaning methods, eco-friendly materials, and community engagement initiatives.
7. Explore locally available materials that can be used to design solar panels

Resources

- Projectors
- Charts/pictures/drawings showing different solar panels.
- Simulations/YouTube videos.
- Prototypes of solar panels
- Charts, pictures, and simulations of various forms of electricity generation.
- Internet resources such as (https://www.youtube.com/watch?v=9BgDt407uQc; https://www.youtube.com/watch?v=lxoHqV2fMK4)
- Different appropriate materials from the environment.

References

- Curriculum
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SECTION 6: **FORCE**

Strand: **Vigour behind life**

Sub-Strand: Forces acting on substances and mechanisms

Learning Outcome: *Apply various forces according to their effects on motions.*

Content Standard: Recognise the various forms of forces and their effects on motions.

INTRODUCTION AND SECTION SUMMARY

Forces play a pivotal role in shaping the behaviour of objects and explaining the phenomena we observe in our daily lives. In this immersive exploration, we will delve into the fundamental concepts associated with forces, from the foundational principles of Newtonian mechanics to the nuanced understanding of various force types such as friction, tension, and gravitational forces. We will uncover the underlying mechanisms that drive the physical world through engaging discussions and practical examples. Join us as we find the mysteries of forces and unveil the beauty of their influence on the world around us.

This section offers a comprehensive examination of the diverse forces-related concepts, providing participants with a deeper understanding of the fundamental principles governing object interactions. By exploring key theories such as Newton's laws of motion and gravitational forces, individuals will gain insights into how forces shape motion, equilibrium, and stability. The discussions encompass a broad spectrum of force types, illustrating their effects through real-world scenarios and interactive activities. Through this exploration, participants will enhance their knowledge of forces and develop a profound appreciation for the intricate mechanisms underlying the physical phenomena we meet daily. This section aims to empower individuals to recognise the pervasive influence of forces and leverage this understanding to navigate the complexities of the natural world with clarity and insight.

The week covered by the section is:

WEEK 16: Identify and explain concepts associated with forces.

SUMMARY OF PEDAGOGICAL EXEMPLARS

Pedagogical Exemplars emphasise instructors' critical role in providing personalised and dynamic learning experiences via individualised instruction. teachers can adjust their approaches to student's needs using various teaching strategies, ensuring fair access to critical knowledge, understanding, and skills. This approach is centred on establishing core learning objectives that serve as evaluative benchmarks, encompassing content proficiency and the cultivation of critical cognitive and practical competencies required for learners' holistic development and ongoing education.

Furthermore, Pedagogical Exemplars emphasise the significance of developing additional curricula and customised chances for extraordinarily brilliant and talented children. Teachers are urged to cultivate high-achieving students' unique abilities and potential by offering enriched challenges and extensions that go beyond the conventional curriculum. Teachers play an important role in meeting the different educational needs of their students and developing a culture of lifelong learning and sustainable development by creating an atmosphere that encourages individualised growth and enrichment.

ASSESSMENT SUMMARY

Assessments within this framework encompass formative, summative, and differentiated approaches to evaluate student learning comprehensively. Formative assessments encompass activities such as lab work, short tests, group projects, and presentations to enhance science process skills and gauge understanding. Conversely, summative assessments are conducted at the end of the lesson, section, or semester, contributing to cumulative records. Learners can self-assess learning outcomes by coding them red (not understood), amber (partially understood), or green (well understood). This system aids in tracking progress and addressing areas for improvement effectively.

Creating a conducive assessment environment entails providing clear instructions and maintaining consistency for all participants to uphold fairness. Emphasising the application of knowledge, critical thinking, problem-solving, and effective communication in assessments ensures a holistic evaluation of students' aptitudes. Differentiated assessments cater to individual learner needs, with gifted students receiving challenging tasks, enriching activities, or accelerated learning options. Transcript recording is vital to document learner characteristics, assessment details, and additional observations for a comprehensive evaluation overview.

Tailoring assessments to accommodate diverse learning needs, strengths, and interests ensures that all students can showcase their skills equally. By adapting assessment content to various readiness levels and preferences, teachers foster an inclusive learning environment that nurtures each student's capabilities to their fullest potential.

WEEK 16

Learning Indicator: *Identify and explain concepts associated with forces*

Theme or Focal Area: Identification and Explanation of Concepts Associated with Forces

Overview of forces

- Forces are fundamental concepts in physics that describe interactions between objects and can cause changes in their motion. Here are some key concepts associated with forces: Force is a push or pull that can change the state of motion or the shape of an object.
- Force is a vector quantity, which means it has both magnitude (size) and direction.
- Forces are measured in Newtons (N).

Experiment on frictional force

Title: Exploring the effects of different surfaces on the frictional forces they generate.

Aim: To investigate the effects of friction on the distance an object can slide along a surface

Materials:

- Wooden block or any object with a flat surface (e.g., a book, a toy car)
- Smooth surface (e.g., a glass table, a plastic tray)
- Rough surface (e.g., sandpaper, a carpet)
- Ruler or measuring tape
- Weighing scale (optional)

Procedure:

- Start by placing the smooth surface (e.g., glass table) on a flat, stable table or floor.
- Take the wooden block (or the object with a flat surface) and place it on a smooth surface.
- Push the block gently with a constant force and measure the distance it travels before coming to a stop. You can mark the block's motion's starting and ending points.
- Record the distance in a table.
- Repeat the above steps for the rough surface (e.g., sandpaper) and record the distance the block travels before stopping.

Observations and Analysis: Now that you have experimented, you can analyse the results. Compare the distance the block travelled on the smooth surface with the distance it travelled on the rough surface. You will likely notice that the block travelled a shorter distance on the rough surface than on the smooth surface.

Conclusion: The difference in the distances travelled is due to friction. Friction is a force that opposes the relative motion or tendency of such motion of two surfaces in contact. In this experiment, the rough surface created more friction between the block and the surface, which caused it to slow down and stop sooner. Frictional Forces: These forces arise when two objects physically touch each other. Examples include normal force (force exerted by a surface perpendicular to the object's surface). Frictional force resists motion between two surfaces in contact. Friction is a force that opposes the relative motion or attempts at motion between two surfaces in contact. It acts parallel to the

surfaces and can be beneficial (e.g., walking without slipping) and detrimental (e.g., slowing down a moving car).

Evaluation: Is there any aspect of the experiment that could be improved? Which variable is poorly controlled and could undermine the validity of the experiment and the quality of the conclusions?

Gravitational Force

This is the force of attraction between any two objects with mass. It is responsible for keeping planets in orbit around stars and objects anchored to the Earth's surface. The force is proportional to the product of the masses and inversely proportional to the square of the distance between their centres of mass.

Title: Investigating Gravitational Force

Aim: To understand the concept of gravitational force and explore its relationship with mass and distance.

Materials:

- Two objects of different masses (e.g., a small ball and a heavier object like a book)
- Spring scale
- Meterstick or measuring tape
- Stopwatch

Procedure:

- Set the spring scale on a flat surface and zero it.
- Using a string, attach a lighter object, such as a little ball, to the spring scale.
- Take note of the weight shown on the spring scale for this object.
- Repeat with a heavier object, such as a book, and record the weight.
- To calculate the gravitational force on an item, use the formula F = mg, where F represents the gravitational force, m represents the object's mass, and g represents the acceleration due to gravity (9.8 ms^2).
- Discuss any observed trends or variations between the computed gravitational forces of two objects.

Velocity

Velocity is a vector quantity that represents the rate of change of an object's position concerning time. It includes both magnitude (speed) and direction, making it different from speed, which is a scalar quantity. Scalar quantities have magnitude only.

The formula for calculating velocity is:

Velocity = (distance/time).

The word equation for velocity is:

$$\text{velocity} = \frac{\textit{displacement}}{\textit{(time taken)}}$$

Displacement is the distance travelled in a particular direction

Velocity is measured in units such as metres per second (m/s) or per hour (km/h).

Positive velocity indicates motion in the forward direction, while negative velocity indicates motion in the reverse direction.

Title: Exploring Velocity

Aim: The concept of velocity and how it relates to everyday life.

Materials: Stopwatch, measuring tape, toy cars, markers, chart paper

Procedure

- Explain the difference between speed and velocity.
- Watch a brief video to see velocity in action.
- Calculate the car's velocity by measuring its distance over a specific time.
- Experiment with various surfaces and angles to see how velocity changes.
- Note findings on a chart paper.
- Explain how variables such as distance and time affect velocity.
- Share real-world examples where velocity is important.
- Highlight the relevance of velocity in various industries, including sports, transportation, and technology.

Distance

Distance is a scalar quantity representing the total path length an object covers during its motion. It measures the total amount of ground covered, regardless of the direction taken. Distance is always positive or zero, as it only considers the magnitude of motion. It is measured in units such as metres (m), kilometres (km), miles (mi), etc.

Speed

Describes how fast an object is moving. Speed is a scalar quantity representing the rate of change of distance concerning time. It only considers the magnitude of motion and does not consider the direction. The formula for calculating speed is: speed = (distance travelled) / (time taken).

Speed is measured in units like metres per second (m/s), kilometres per hour (km/h), or miles per hour (mph). Unlike velocity, speed does not involve direction and can be positive or zero.

Worked examples

1. A runner covers a distance of 400 meters in 60 seconds. Calculate the average velocity of the runner.

   Solution:

   Velocity = Distance/Time Velocity

   = 400 m / 60 s

   Velocity = 6.67 m/s

   The average velocity of the runner is 6.67 meters per second.

2. A car covers a distance of 300 miles in 5 hours. Calculate the average speed of the car in miles per hour.

   Solution

   Given: Distance = 120 km, Time = 3 hours

Velocity = Distance / Time Velocity

= 120 km / 3 hours

= 40 km/h

Acceleration

- When something is accelerating, its velocity is changing.
- Acceleration = change in velocity/ time taken

$$a = \frac{(v - u)}{t}$$

- Where u is the initial velocity. v is the final velocity, and t is the time taken (in seconds).
- Acceleration (a) is measured in metres per second square (ms^2)
- A negative acceleration means deceleration. A uniform acceleration means a constant (steady) acceleration.

Calculating Force from Acceleration

Worked examples

1. PA car with a mass of 1500 kg accelerates from 0 to 20 m/s in 10 seconds. What is the net force acting on the car?

Solution:

Calculate the acceleration:

V = u + at

$$= \frac{(v - u)}{t}$$

$$\frac{20 - 0}{10} = 2.0 m/s^2$$

Use Newton's second law

F = ma:

$F=1500kg \times 2m/s^2$

=3000N

A car travels 200 kilometres in 2 hours. Calculate the speed of the car.

Solution:

Speed = Distance/Time

Speed = 200 km / 2 hours

Speed = 100 km/h

.: The speed of the car is 100 kilometres per hour.

2. A car accelerates from 0 m/s to 20 m/s in 5 seconds. Calculate the acceleration of the car.

Solution:

Acceleration = Change in Velocity/Time taken

Acceleration = (20 m/s - 0 m/s) / 5 s

Acceleration = 4 m/s2

The acceleration of the car is 4 meters per second squared.

Experiment on acceleration (Gravity)

Aim: To investigate the concept of acceleration using simple materials.

Materials: Toy car or small object that can roll**,** Smooth flat surface (such as a tabletop or floor)**,** Measuring tape or ruler**,** Stopwatch or timer**,** Notebook and pen.

Procedure:

- Set up the smooth, flat surface for the experiment. Ensure there is enough distance for the toy car to accelerate and come to a stop.
- Set the toy car at one end of the surface and indicate its starting point.
- Mark uniform distances along the surface with a measuring tape or ruler.
- Start the stopwatch when you release the toy car from its starting place.
- Measure the time it takes for the toy car to reach each marked spot on the surface.
- To calculate the average speed of the toy car between intervals, use the formula Speed = Distance / Time.
- Analyse speed data to determine if the toy car is accelerating, decelerating, or at a constant pace.
- To compute acceleration, apply the formula: Acceleration = (Final Velocity - Initial Velocity)/Time.
- Repeat the experiment and make adjustments to see how surface smoothness and inclination affect acceleration.
- Document your observations, measurements, and conclusions in the notebook.

Conclusion: Our experiment showed that the toy car exhibited consistent acceleration on a smooth surface. The acceleration varied when changes were made to the surface's smoothness and inclination. These findings highlight the importance of surface conditions in affecting acceleration

Overview of Cohesive and Adhesive Forces

Cohesive force is the attraction between molecules of the same substance that causes them to stick together. This force helps to keep molecules of a substance together, such as water molecules adhering together to create droplets.

Adhesive force refers to the attraction of molecules from dissimilar substances, which causes them to cling together. For example, the adhesive force causes water to adhere to surfaces such as glass or paper. Understanding these forces is useful in many domains, including chemistry, physics, and material science

Title: Understanding Cohesive and Adhesive Forces

Aim: To differentiate between cohesive and adhesive forces through a series of interactive experiments.

Materials: Small containers or cups**,** water**,** oil**, s**alt**, s**poon**, s**mall objects (e.g., paper clips, coins)**, d**roppers**, p**aper towels

Procedure:

Experiment 1: Cohesive Forces

- Fill 2 small containers with water.

- Stir a pinch of salt into one container until dissolved.
- Drop water from each container onto a clean, flat surface and compare the behaviour of plain and saltwater droplets.

Explain how saltwater's cohesive forces hold droplets together compared to ordinary water.

Cohesion is water's attraction to itself, caused by its polarity, which makes water molecules act like magnets and stick together. This force can be observed in experiments like dropping water onto a penny, where cohesion and surface tension allow multiple drops to accumulate before spilling over. Saltwater has lower cohesion than plain water, affecting the number of drops that can stay on the penny.

Experiment to demonstrate capillary action and water's adhesion to the surface of a capillary tube

Aim: To show how water molecules adhere to the surface of capillary tube

Materials:

- Capillary tubes (thin, borosilicate glass tubes), water, food coloring (optional), a tall glass or beaker

Procedure:

1. Fill the tall glass or beaker with water, adding a few drops of food coloring if desired.
2. Dip one end of the capillary tube into the water, making sure not to touch the sides of the glass.
3. Observe how the water rises up the capillary tube, seemingly defying gravity.
4. Measure the height of the water column in the capillary tube.

Explanation

- Water molecules are attracted to the glass surface (adhesion) and to each other (cohesion).
- The narrow diameter of the capillary tube increases the relative surface area, allowing the water molecules to spread out and climb up the tube.
- The combination of adhesion and cohesion creates a "capillary force" that pulls the water up the tube.

Precaution:

- Use a clean capillary tube to ensure proper adhesion.

Real-life applications of force

- *Gripping:* Friction allows us to hold objects.
- *Writing:* Force creates friction for ink transfer.
- *Opening doors:* Pushing/pulling on knob creates force to rotate door.
- *Transportation:*
- *Cars:* Engine force propels car forward, friction allows control.
- *Airplanes:* Wings generate lift (counteracts gravity), engines provide thrust.
- *Rockets:* Force from burning fuel propels through space.
- *Construction & Manufacturing:*
- *Lifting objects:* Cranes & forklifts use levers/hydraulics to exert large forces.
- *Building structures:* Beams/columns/trusses designed to withstand various forces.

- *Shaping materials:* Forces used in forging, pressing, cutting processes.
- *Sports & Recreation:*
- *Kicking a ball:* Force from foot transfers energy to the ball.
- *Jumping:* Pushing off ground propels you upwards.
- *Throwing a ball:* Force transfers from muscles to ball for movement.
- *Gravity:* Keeps us grounded, influences celestial bodies.
- *Buoyancy:* Upward force by fluid allows objects to float.
- *Wind:* Pressure variations in air create wind forces.

Learning Tasks

1. Create a Venn diagram comparing and contrasting acceleration and velocity. Label the similarities in the intersecting section and differences in the outer sections. Discuss examples of each concept and how they relate to motion.
2. What is the relationship between velocity, time, and acceleration?
3. Research and prepare a short presentation on two real-life applications of force.

Pedagogical exemplars

Collaborative learning

- Place learners in mixed-ability/mixed-sex groups to discuss concepts of distance, displacement, speed, velocity, and acceleration with contextual examples.
- Provide visual aids and real-world examples for visual or hands-on learners.
- Assign roles within each group to ensure equal participation and understanding among all learners. Allow for peer teaching and collaboration, where learners can explain concepts to each other in their own words.
- Guide learners in developing task sheets to explore real-life applications of the concepts of speed, displacement, velocity, and acceleration through hands-on activities in various experiments. Encourage learners to choose real-life scenarios that interest them, creating a personal connection to the concepts, such as cars on the road, athletes in a race, or objects in motion to make the concepts relatable.
- Provide support in researching and analysing the data for learners who may need additional help.

Key Assessment

Level 1: Differentiate between acceleration and velocity.

Level 2: If an object starts from rest (initial velocity = 0 m/s) and reaches a velocity of 20 m/s in 5 seconds, calculate the acceleration of the object.

Level 3: Explain two applications of force in real-life situations.

Section Review

Throughout this insightful investigation of forces, participants gained a thorough comprehension of the fundamental laws that govern motion and interactions in the physical world. By immersing themselves in the study of Newton's laws of motion, investigating the impacts of numerous force types such as friction and gravitational forces, and dissecting the dynamics of tension and normal forces, learners have established a firm foundation in appreciating the complexity of forces

The knowledge learned from this section transcends theoretical physics, having practical applications that can aid individuals in many ways in their real-world pursuits. Armed with the capacity to understand and interpret forces, participants are better equipped to manage everyday settings that entail motion, balance, and stability. From calculating the forces required to move items efficiently to maximising the performance of mechanical systems, the learned understanding of forces helps learners make educated decisions and solve complicated issues with precision and confidence.

The knowledge learned from this section transcends theoretical physics, having practical applications that can aid individuals in many ways in their real-world pursuits. Armed with the capacity to understand and interpret forces, participants are better equipped to manage everyday settings that entail motion, balance, and stability. From calculating the forces required to move items efficiently to maximising the performance of mechanical systems, the learned understanding of forces helps learners make educated decisions and solve complicated issues with precision and confidence.

Additional reading

- The relevance of force, pressure and momentum in technology.
- How acceleration, velocity and speed are used in preventing accidents in cars

Resources

- Projectors
- Charts/pictures/drawings showing different concepts associated with forces.
- Simulations/YouTube videos.
- Stopwatch,
- measuring tape,
- toy cars,
- chart paper
- Toy car or small object that can roll
- Smooth, flat surface (such as a tabletop or floor)
- Measuring tape or ruler
- Stopwatch or timer

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SECTION 7: **BASIC ELECTRONICS**

Strand: **Vigour Behind**

Sub-Strand: Consumer Electronics

Learning Outcome: *Identify selected electronic components and their uses in household electronic gadgets and amplifiers.*

Content Standard: Demonstrate knowledge and recognition of selected electronic components and their uses in Household Electronic devices.

INTRODUCTION AND SECTION SUMMARY

This section aims to develop learners' understanding of household electronic devices, their electronic component composition, the uses of these components, and their ability to design a basic amplifier. Learners will be introduced to household electronic devices such as old/spoilt/abandoned televisions, radios, microwaves, and refrigerators where appropriate or watch videos about their internal electronic components. They will explore the internal electronic components of these devices where appropriate, including resistors, capacitors, transistors, diodes, and integrated circuits. Additionally, learners will research the functions and applications of these electronic components within different devices using the internet/books.

Furthermore, learners will be guided through designing a basic amplifier using electronic components. This hands-on exercise will enhance their knowledge of circuit design principles and deepen their practical skills in electronics. By the end of this section, learners will have gained a comprehensive understanding of household electronic devices, their constituent components, their functions, and the ability to apply this knowledge in designing simple electronic circuits.

The week covered by the section is:

Week 17: Explain the uses of electronic components in household electronic devices and amplifiers.

SUMMARY OF PEDAGOGICAL EXEMPLARS

Pedagogical exemplars should include a comprehensive approach that incorporates differentiated instruction to help learners gain a comprehensive understanding of household electronic devices, their constituent components, their functions, and the ability to apply this knowledge in designing simple electronic circuits and building a simple amplifier. Teachers should use a variety of teaching strategies and techniques to meet learners' diverse learning abilities and skills in the classroom. Differentiated instruction is essential for addressing individual needs and ensuring that all learners have effective access to the focus area of study. Clearly define the learning outcomes and expectations for all learners, including the fundamental knowledge, understanding, and application of the knowledge they must acquire during the learning process.

Assessments should be aligned with the learning outcomes to appropriately evaluate learning progress. Give gifted and talented learners more challenges, extensions, and enrichment opportunities to help them learn more effectively. This could include more challenging classwork, independent research projects, or opportunities for creative expression outside of the traditional curriculum.

By employing these strategies, teachers can foster a supportive learning environment that encourages academic improvement for all learners while giving advanced chances for gifted and talented learners to attain their full potential.

ASSESSMENT SUMMARY

This section's assessments may be formative, summative, or differentiated. Formative assessment will involve laboratory work demonstrating certain science aspects to improve learners' science process abilities. Short exams, class exercises, assignments, group discussions, group projects, and group presentations also exist. Written examinations, interviews, observations, or performance assignments based on assessment indicators are delivered, along with graded outcomes. Summative assessments are due at the end of every lesson, section, and semester.

To foster a positive assessment environment, ensure learners are given clear instructions. Maintain consistency in administering the evaluation across all participants to ensure fairness.

Transcript recording requires relevant information such as the learner's characteristics, assessment date, components, and scores. Include any additional observations or notes that may provide valuable insights into the evaluation results.

Differentiated assessment focuses on each learner's learning abilities. Teachers should adjust assessment questions to different levels of assessment and learning abilities so that all students have an equal opportunity to demonstrate their competencies.

WEEK 17

Learning Indicator: *Explain the uses of electronic components in household electronic devices and amplifiers.*

Theme or Focal Area: Uses of Electronic Components in Household Electronic Devices

Overview of electronics

Electronics deals with the behaviour and control of electrical currents and the flow of electrons through various components.

In simple terms, electronics involves manipulating electrical signals to perform specific functions or tasks. It covers many areas, including designing, developing, and manufacturing electronic devices and systems. Electronics has revolutionised the world, enabling the creation of devices and technologies that have transformed our lives. Electronics is present in almost every aspect of modern life, from smartphones and computers to televisions, kitchen appliances, and medical equipment. The core elements of electronics include electronic components, such as resistors, capacitors, transistors, and integrated circuits, which are combined to create complex electronic systems. These systems can perform amplification, signal processing, data storage, communication, and control tasks. Furthermore, electronics is closely related to digital circuits, analogue circuits, microelectronics, telecommunications, power electronics, and embedded systems. It is a continuously evolving field with regular advancements and innovations.

Electronic components and their uses

Resistors: These components restrict the flow of electric current in a circuit, helping to control voltage levels and protect sensitive parts.

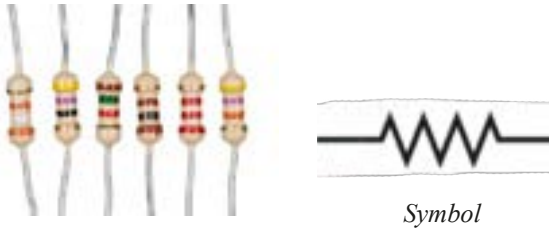


Fig. 1: *A resistors*

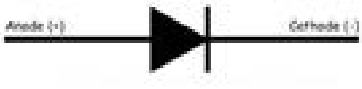
Capacitors: These store electrical energy and release it when needed. They are commonly used for smoothing voltage fluctuations and filtering noise in power supplies. Noise as used in a power supply refers to unwanted electrical signals or fluctuations superimposed on the DC output voltage.

Fig. 2: *Diagram of a capacitors*

Diodes: These allow electric current to flow in only one direction and are often used to convert AC (alternating current) to DC (direct current) in power supplies. Alternating current (AC) is an

electric current that periodically reverses direction, unlike direct current (DC) which flows in only one direction. AC is the type of electricity commonly used in homes and businesses because it can be easily transmitted over long distances and can be converted to different voltages with transformers. It is generated by power plants and delivered to consumers through power lines.

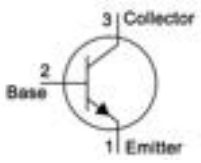
Direct current (DC) is an electric current that flows in one direction only, typically from a positive to a negative terminal. It is commonly produced by batteries, solar cells, and rectifiers, and is used in various applications such as electronics, transportation, and power distribution.



Symbol

Fig. 3: *A Diode*

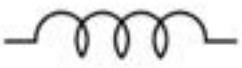
Transistors: These amplify or switch electronic signals. They are crucial in amplifiers, computers, and various digital devices.



Symbol

Fig. 4: *Transistors*

Inductors: These store energy in a magnetic field and are commonly used in filters, transformers, and power supplies. In electronics, a filter is a circuit or device designed to selectively pass or block certain frequencies while allowing others to pass through. Filters are used to remove unwanted noise or signals from a desired signal or to isolate specific frequency components. They are commonly used in audio systems, communication systems, and signal-processing applications.



Symbol

Fig. 5: *Inductors*

LEDs: LEDs (Light-Emitting Diodes): They that convert electrical energy into light energy. They are extensively used in household electronics for indicators.

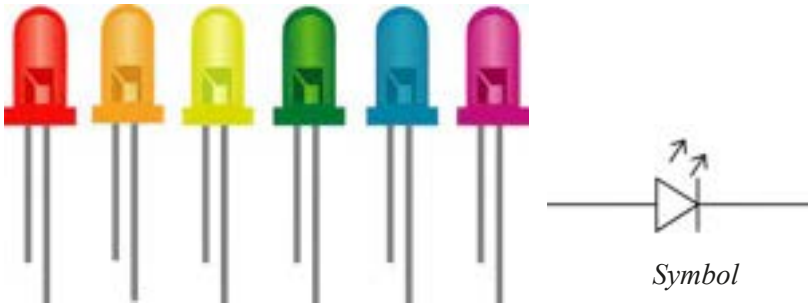


Fig. 6: *Diagram of a LEDs*

Some common examples of Household electronic devices

Examples are televisions, refrigerators, washing machines, microwave ovens, air conditioners, vacuum cleaners, gaming consoles, etc.

Designing circuits involving transistors and switches

A circuit is a closed loop or pathway through which electric current flows. It typically consists of components like resistors, capacitors, inductors, and power sources connected by conductive wires or traces on a circuit board.

Experiment on how to build an electrical circuit

Aim: To build a light-dependent resistor circuit

Apparatus: Breadboard, LDR (light-dependent resistor,10k ohm resistor, LED, 330 ohm resistor, 9V battery and battery clip, Jumper wires

Procedures:

- Connect one end of the LDR to the battery's positive terminal.
- Connect the other end of the LDR to one end of the 10k ohm resistor.
- Connect the other end of the 10k ohm resistor to the battery's negative terminal.
- Connect the junction of the LDR and the 10k ohm resistor to the base of an NPN transistor (if using).
- Connect the transistor emitter to the battery's negative terminal.
- Connect the collector of the transistor to one end of the 330 ohm resistor.
- Connect the other end of the 330-ohm resistor to the anode of the LED.
- Connect the cathode of the LED to the negative terminal of the battery.
- The LED should light up when the ambient light levels fall below a certain threshold

Experiment on LED circuit

Aim: To build LED circuit

Apparatus: Breadboard, LED (Light Emitting Diode), resistor (330 ohms or appropriate value for the LED), 9V battery and battery clip (or a suitable power supply, connecting wires (jumper wires), multimeter (optional, for testing), switch (optional, to control the LED)

Procedures:

- Place the breadboard on a flat surface for easy component insertion.

- Place the LED on the breadboard with the anode (longer leg) in one row and the cathode (shorter leg) in another row.
- Connect one end of the resistor to the same row as the anode of the LED.
- Connect the other end of the resistor to an empty row.
- Attach the battery clip to the 9V battery.
- Connect the red wire (positive) from the battery clip to the row with the free end of the resistor.
- Connect the black wire (negative) from the battery clip to the row with the cathode of the LED.
- Insert the switch into the breadboard.
- Connect one terminal of the switch to the row with the free end of the resistor.
- Connect the other terminal of the switch to the row with the red wire from the battery clip.
- Double-check all connections.
- Connect the battery clip to the 9V battery.
- If using a switch, toggle it to the "on" position.
- Observe the LED lighting up, indicating a successful circuit.

NB: *if the LED doesn't light up*:

Check all connections for loose wires.
Ensure the LED is correctly oriented (anode to positive, cathode to negative).

Verify the resistor value is appropriate for the LED and power supply.

Use a multimeter to check for continuity and correct voltage levels.

Designing circuits involving transistors and switches typically involves several steps. The following is the general outline of the process:

Define the Objective: Clearly define the purpose of your circuit Eg. **LED circuit**. Determine what functionality or task you want the circuit to accomplish. This will guide your design decisions.

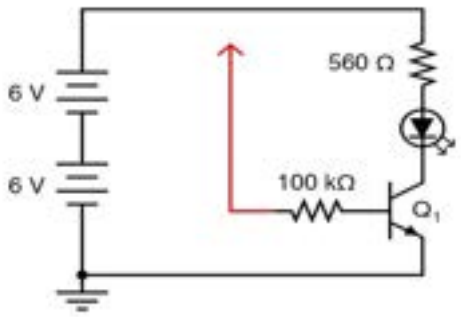


Fig. 7: *circuit diagram of transistor as a switch*

Circuit Analysis: Analyse the requirements of your circuit and identify the components and their connections needed to achieve the desired functionality. Consider the input and output requirements, power supply, voltage levels, and specific constraints.

Transistor Selection: Select the appropriate transistor type (s) for your design based on your circuit analysis. Common types include bipolar junction transistors (BJTs) and field-effect transistors (FETs). Consider factors such as current handling capacity, voltage ratings, speed, and other specifications relevant to your circuit.

Component Sizing: Determine the values of resistors, capacitors, and other components required to bias and drive the transistors properly. Calculate or choose appropriate component values based on the desired performance and the transistor's datasheet specifications.

Circuit Simulation: Utilise circuit simulation software such as Linear Technology Spice (LTspice) or Proteus to simulate and validate your circuit's performance. This can help identify potential issues, optimise component values, and achieve the desired functionality.

Printed circuit board (PCB) Layout: If you plan to create a (PCB) for your design, create a layout incorporating the components, their connections, and proper trace routing. Consider factors such as component placement, signal integrity, and thermal considerations.

Prototype and Testing: Build a physical prototype of your circuit using the designed PCB or a breadboard. Test the circuit's functionality, performance, and reliability. Make any necessary adjustments or modifications based on the test results.

Documentation: Document your circuit design, including schematics, component values, and any specific design considerations. This documentation will be useful for future reference, troubleshooting, or sharing your design with others.

Method of building an amplifier

An amplifier is a device that increases the strength (amplitude) of a signal. It takes a weak input signal and produces a stronger output signal, usually with the same waveform but a larger amplitude. Amplifiers are essential in various electronic devices such as audio systems, radios, televisions, and telecommunications equipment to boost signals for better transmission.

Building an amplifier involves the following process:

Determine the Amplifier Type: Decide on the type of amplifier you want to build, such as a class A, class AB, class D, or a specific audio amplifier design. Each type has its characteristics and applications.

Select Components: Choose the necessary components for your amplifier design. This typically includes transistors (bipolar junction transistors or MOSFETs), resistors, capacitors, and possibly transformers or inductors, depending on the amplifier type. Refer to an amplifier circuit diagram or schematic for component values and specifications.

Design the Amplifier Circuit: Create a circuit diagram or schematic based on the selected amplifier type and component choices. This diagram will illustrate how the components are connected and the flow of signals through the amplifier.

Calculate Component Values: Determine the values of resistors, capacitors, and other components based on the desired performance and the amplifier design specifications. This may involve biasing, gain, stability, and frequency response calculations.

PCB Layout: If you plan to create a printed circuit board (PCB) for your amplifier, design the layout incorporating the components and their connections. Pay attention to proper trace routing, ground planes, and thermal considerations to ensure optimal performance and reliability.

Audio frequency (AF) Amplifiers

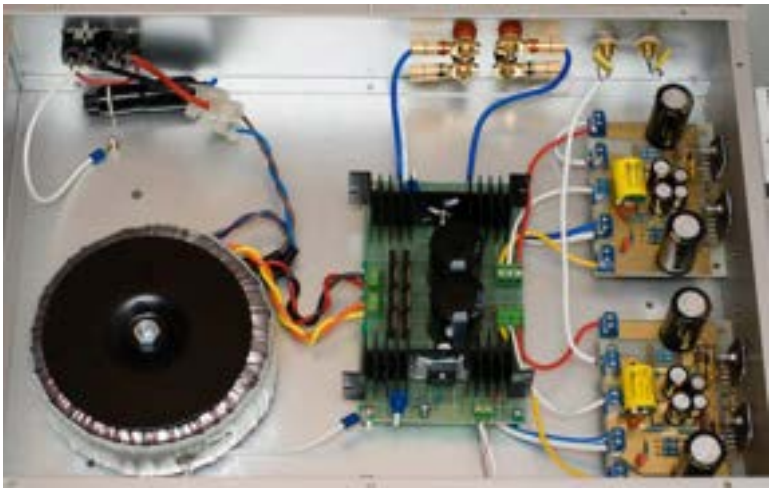


Fig. 8: *Diagram of Audio Frequency Amplifier*

Experiment on how to Build a Simple Audio Amplifier

Apparatus: LM386, 10 µF electrolytic capacitor (2 pieces), 0.047 µF ceramic capacitor (1 piece), 10 ohm resistor (1 piece), 1k ohm resistor (1 piece), Potentiometer (10k ohm, for volume control), Speaker (8 ohms, small size), Audio Input Jack (3.5mm stereo jack), Battery (9V battery with battery clip), Breadboard or PCB (Printed Circuit Board), Connecting Wires, Soldering Kit (if using PCB)

Procedure:

- Place the LM386 IC in the middle of the breadboard or PCB for easy wiring.
- Connect the 9V battery clip to the breadboard or PCB.
- Connect the positive terminal of the battery clip to pin 6 of the LM386.
- Connect the negative terminal of the battery clip to the ground rail on the breadboard or PCB.
- Connect the audio input jack's ground (sleeve) to the ground rail on the breadboard.
- Connect the audio input jack's left or right channel (tip or ring) to one terminal of the 10k ohm potentiometer.
- Connect the wiper (middle terminal) of the potentiometer to pin 3 of the LM386.
- Connect a 10 µF electrolytic capacitor between pin 7 and the ground. Ensure the negative leg of the capacitor goes to the ground.
- Connect a 10 µF electrolytic capacitor between pin 1 and pin 8 of the LM386 to set the gain to 200. Ensure the negative leg is on pin 1.
- Connect a 0.047 µF capacitor between pin 5 of the LM386 and one terminal of the 10 ohms resistor.
- Connect the other terminal of the 10-ohm resistor to the speaker's positive terminal.
- Connect the negative terminal of the speaker to the ground rail on the breadboard or PCB.
- Connect a 220 µF capacitor's positive leg to pin 5 of the LM386 and its negative leg to the junction between the 0.047 µF capacitor and the 10-ohm resistor.
- Double-check all connections to ensure they are correct.
- Attach the 9V battery to the battery clip.
- Plug an audio source into the input jack and adjust the potentiometer to control the volume.

- You should hear the amplified audio through the speaker.

NB: *The concentration should be on the audio amplifier.*

Learning Tasks

1. Identify electronic components in household devices
2. Explain the uses of electronic components in household devices
3. Design circuits involving transistors and switches.
4. Build an amplifier using electronic components.

Pedagogical exemplars

Talk-for-learning:

- Guide learners to revise the basic electronics components from the JHS curriculum using talk-for-learning approaches and internet resources.
- Guide the learners in mixed groups through the process of building amplifiers using transistors and other components using talk-for-learning.

Activity-based learning/Demonstration:

- Let learners in mixed-ability groups watch simulations from websites such as CircuitLab or Tinkercad to visually demonstrate how circuits use components. Let each group do a whole-class discussion based on the group findings.
- Provide materials such as breadboards, resistors, capacitors, transistors, and switches to each group where available.
- Organise hands-on demonstrations where students can observe the functionality of electronic components and devices in action. For example, demonstrate how a transistor can be used as a switch or an amplifier, and allow learners to interact with the circuit to see the results firsthand.
- Divide the learners into mixed-sex and differentiated groups. Asks learners to share ideas in their mixed groups, research using online resources/books for guidance, and sketch out their circuit designs on paper before moving to build them.
- Let learners cross-share and reflect their findings to their peers and present for a whole class discussion. Encourage constructive feedback and discussions on their findings.
- Provide each group with a task to design a specific circuit involving transistors and switches. For example, designing a simple amplifier circuit.
- Provide assistance and guidance as needed but allow learners to take ownership of their designs and problem-solving process.
- Encourage all learners to actively participate in hands-on activities and discussions, emphasising the value of diverse perspectives in problem-solving. This fosters an inclusive learning environment by addressing stereotypes related to electronics that anyone can excel in electronics regardless of gender or background.
- Allow learners to reflect and cross-share their work and present their simple circuit built to their peers. Encourage constructive feedback and whole class discussions on the results.

Project-based learning:

- Assign tasks that require learners in mixed-ability groups to apply their knowledge of electronic components to solve real-world problems or design innovative solutions. For instance,

challenge them to design and build a simple electronic device, such as a simple amplifier using the components they have learned about.

- Encourage learners to apply their knowledge by designing and building electronic devices outside the classroom, perhaps as a homework assignment or a long-term project.
- Provide opportunities for learners to present their projects to the class for peer review and presentation. This fosters confidence and public speaking skills.

Key Assessment

Level 1: Identify at least four (4) electronic components and draw their circuit symbols.

Level 2: Explain the function of at least five electronic components in electrical household appliances.

Level 3: Design simple electrical circuits involving transistors and switches.

Level 4: Design and build a simple amplifier.

Section Review

These lessons were structured to provide a holistic learning experience. It focuses on helping learners gain a comprehensive understanding of household electronic devices, their constituent components, their functions, and the ability to apply this knowledge in designing simple electronic circuits and building a simple amplifier. The aim is for each learner to gain theoretical knowledge and develop practical skills that can be applied to design and build their own electronic devices outside of the classroom for the world of work.

Additional Reading

1. Encourage learners to explore their homes for electronic devices and identify the components within them.
2. Search internet resources such as Khan Academy, All About Circuits, or Electronics Hub for self-study and exploration.
3. Draw different circuit diagrams involving LEDs, capacitors, connecting wires, dry cells, diodes, and resistors.

Resources

1. Breadboards, resistors, LEDs, capacitors, transistors, switches, diodes, inductors, etc.
2. Internet, simulations/videos on electronic components.
3. Pictures/charts/videos of simple amplifiers.

References

- Curriculum
- https://www.instructables.com/Simple-Audio-Amplifier-Using-Single-Transistor/
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SECTION 8: PROMOTING HEALTH AND SAFETY

Strand: **Relationships with the Environment**

Sub-Strand: The Human Body and Health

Learning Outcomes:

1. *Discuss everyday hazards and how to manage them in the environment.*
2. *Distinguish various types of lifestyle diseases.*
3. *Clarify the concept of drugs and reflect on their effects on humans*

Content Standards:

1. Demonstrate an understanding of hazards in everyday life and how to manage them.
2. Show understanding of lifestyle diseases, their causes, symptoms and prevention.
3. Exhibit understanding of the concept of drugs and reflect on their effects on humans and their control

INTRODUCTION AND SECTION SUMMARY

This section delves into various aspects of health and safety, aiming to equip learners with the knowledge necessary to navigate common environmental risks and hazards. It begins by examining prevalent risks and hazards, providing insights into their identification and mitigation strategies. Learners are encouraged to develop an awareness of potential dangers in their surroundings and learn how to address them effectively.

Additionally, the section explores lifestyle diseases, offering a comprehensive understanding of their causes, effects, and preventive measures. This helps learners to gain insight into the importance of healthy habits and lifestyle choices in disease prevention.

Furthermore, the attributes of recreational are analysed in depth, offering learners an understanding of their effects on the human body and mind. Moreover, the section emphasises the importance of responsible drug usage and the potential consequences of substance abuse.

Overall, this section provides an all-inclusive approach to health and safety education, equipping learners with the knowledge and skills necessary to identify and address risks in their environment, adopt healthy lifestyle practices, and make informed decisions regarding drug usage. Through acquiring this knowledge, learners are empowered to prioritise their well-being and make positive choices for themselves and their communities.

The weeks covered by the section are:

Week 18: Explore common risks and hazards in the environment and how to address them.

Week 19: Describe lifestyle diseases, their causes, effects and prevention

Week 20: Analyse the attributes of drugs

SUMMARY OF PEDAGOGICAL EXEMPLARS

When designing pedagogical exemplars, teachers should use a comprehensive approach that integrates differentiated instruction to help learners identify and manage common risks and hazards present in

their environment, offering learners insight into potential dangers and strategies to mitigate them effectively. Furthermore, emphasises the importance of understanding lifestyle diseases, their origins, impacts, and preventive measures to promote healthier living. Finally, it provides a comprehensive analysis of drugs, exploring their attributes and effects to foster informed decision-making regarding their use.

Teachers should use various teaching strategies and techniques to meet learners' diverse learning abilities and skills in the classroom. Differentiated instruction is essential for addressing individual needs and ensuring that all learners have effective access to the focus area of study. Clearly define the learning outcomes and expectations for all learners, including the fundamental knowledge, understanding, and application of the knowledge they must acquire during the learning process.

Assessments should be aligned with the learning outcomes to appropriately evaluate learning progress. Give gifted and talented learners more challenges, extensions, and enrichment opportunities to help them learn more effectively. This could include more challenging classwork, independent research projects, or opportunities for creative expression outside of the traditional curriculum.

ASSESSMENT SUMMARY

This section's assessments may be formative, summative, or differentiated. Formative assessment will involve activities such as laboratory work that demonstrate certain aspects of science to improve learners' science process abilities. There are also short exams, class exercises, assignments, group discussions, group projects, and group presentations. Written examinations, interviews, observations, or performance assignments based on assessment indicators are delivered, along with graded outcomes. Summative assessments are due at the end of every lesson, section, and semester.

To foster a positive assessment environment, ensure that learners are given clear instructions. Maintain consistency in administering the evaluation across all participants to ensure fairness.

Transcript recording requires recording relevant information such as the learner's characteristics, assessment date, assessment components, and scores. Include any additional observations or notes that may provide valuable insights into the evaluation results.

Differentiated assessment focuses on each learner's learning abilities. Teachers should adjust assessment questions to different levels of assessment as well as learning abilities so that all students have an equal opportunity to demonstrate their competencies.

WEEK 18

Learning Indicator: *Explore common risks and hazards in the environment and how to address them.*

Theme or Focal Area: Hazards and How to Manage them in the Environment

Overview of hazard

A hazard is an activity, action, inaction or any dangerous situation that is likely to cause damage or accidents. Hazards can occur in the school, workplace and home environment. Environmental hazards refer to any physical, chemical, or biological agents in the environment that can harm human health. These hazards can be natural or synthetic and occur in various settings, including the workplace, school, home and community. Examples of environmental hazards include exposure to hazardous chemicals such as lead or asbestos; biological hazards such as infectious diseases or mould; physical hazards such as noise or radiation; and psychosocial hazards such as job stress or workplace violence. Other environmental hazards include natural disasters such as floods, earthquakes, hurricanes, and wildfires. Environmental hazards can have short-term and long-term effects on human health, ranging from minor injuries to chronic illnesses and even death. To protect individuals from environmental hazards, it is essential to identify and manage potential hazards, implement safety protocols and regulations, and provide education and training to help individuals minimise their exposure to these hazards. Common hazards/accidents in science classes and during science lessons include heat burns, scalds, chemical burns, cuts, fire outbreaks, shock, electrical shock, and poisoning.

Causes of Hazards during Science Lessons/Classes

- Water poured on a polished floor.
- Explosion (gas or chemical).
- Chemicals being poured above eye level.
- Flammable solvents being heated with a naked flame.
- Placing heavy apparatus on a weak support.
- Using tools such as chisels, knives, saws, etc. during lessons without wearing appropriate protective clothes.
- Leaving sharp and pointed tools on the floor.
- long/overgrown fingernails.
- Keeping long hair.
- Overcrowding materials on a bench or floor.
- Playing and running in the laboratory.
- Ignorance of safety rules in the laboratory.

Types of hazard causes and prevention

Chemical Hazards

Many workplaces use chemicals such as solvents, acids, and pesticides that can harm human health. These chemicals can be found in manufacturing, laboratories, and cleaning services. Those exposed to chemicals may develop respiratory problems, skin irritation, or even cancer if exposed for prolonged periods.

Chemical hazards can occur in various forms, including airborne particles, spills, and leaks. Exposure can happen through inhalation, skin contact, or ingestion.

Causes of Chemical Hazards

- Mishandling of chemicals or improper storage of chemicals can leak or spill.
- Accidents during transportation, such as crashes or leaks, can spread hazardous chemicals.
- Some chemicals react unexpectedly, causing explosions or fires.
- Chemicals can contaminate the air, water, soil, or food, harming people and nature.
- Accidental exposure to chemicals by breathing them in or swallowing them can cause harm.

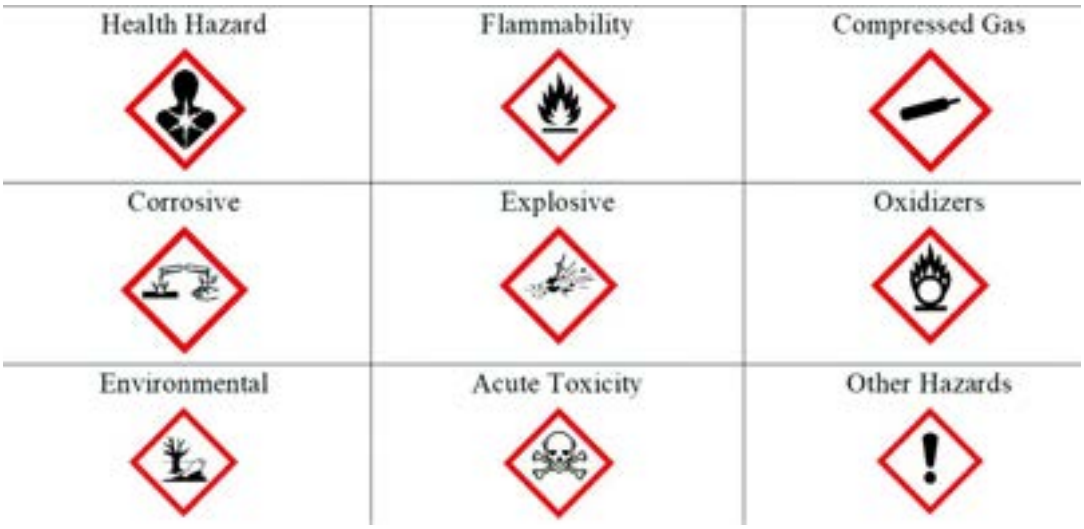

Fig. 9: *Diagram of some hazard symbols*

Prevention of chemical hazard

- Proper safety protocols must be implemented, such as providing protective equipment and training workers on handling and disposing of hazardous chemicals.
- Store hazardous chemicals in a designated, well-ventilated area.
- Clearly label all containers with their contents.
- Use personal protective equipment (PPE) when handling chemicals.
- Follow manufacturer instructions and safety guidelines.

Biological Hazards

Biological hazards include bacteria, viruses, fungi, and other microorganisms that can cause infections and illnesses. We call these disease-causing organisms pathogens. These hazards are commonly found in workplaces such as healthcare facilities, laboratories, and farms, where workers are exposed to infectious diseases or contaminated materials. Workers exposed to biological hazards may experience symptoms such as fever, coughing, and skin irritation.

Fig. 10: *A symbol of biological hazard*

Causes of Biological Hazard

- Exposure to biological hazards such as bloodborne pathogens, airborne diseases and waste contaminated with pathogens.
- Handling of infectious specimens or experiments with biological materials.

- Exposure to animal-borne diseases or contaminated soil in farms and other agricultural settings.
- Bodily fluids carry pathogens that can infect workers.
- Poor sanitation can lead to the spread of diseases
- Exposure to bacteria, viruses, fungi, parasites, or biological toxins increases the risk of infection

Prevention of Biological Hazard

- Practice good hand hygiene with regular handwashing.
- Follow strict protocols for disposal of contaminated waste and specimens.
- Implement regular training programs on infection control and biohazard safety procedures.
- Maintain a clean and sanitised work environment to minimise the risk of contamination.
- Monitor and enforce proper hand hygiene practices among workers.
- Provide vaccinations and immunisations against relevant diseases where applicable.
- Implement engineering controls such as ventilation systems to minimise airborne exposure.
- Regularly inspect and maintain equipment to ensure proper functioning and safety.
- Establish emergency response protocols in case of accidental exposure or spills.

Fire Hazard

These hazards can result from faulty wiring, flammable liquids, and combustible materials. Fires can cause serious injuries and even death.

Flammable liquids, such as gasoline or cleaning solvents, can be found in many places, including manufacturing facilities, homes, schools and auto repair shops. In addition, combustible materials, such as paper or wood, can be found in offices or construction sites. Faulty wiring can also pose a significant fire hazard in any workplace.

Fig. 11: *Some hazard*

Causes of Fire hazard

- Electrical faulty wiring can lead to fires.
- Open flames pose a risk of ignition.
- Overheating equipment may trigger fires.

- Combustible materials increase the severity of fires.
- Smoking in prohibited areas can start fires.
- Improper storage of flammable substances heightens fire risk

Prevention of fire hazard

- Install smoke detectors and regularly check their functionality.
- Keep flammable materials away from heat sources.
- Have fire extinguishers in easily accessible areas.
- Develop and practice a fire escape plan with all occupants.
- By implementing safety protocols such as fire safety training, proper storage and handling of flammable liquids, regular inspections of electrical equipment, and working fire extinguishers and smoke detectors in the workplace.

Electrical Hazards

An electrical hazard is where a person can contact'" live" electrical components, wires, or objects that may have become "live" due to some failure.

An electrical hazard can be defined as a serious workplace hazard that exposes workers to burns, electrocution, shock, arc flash/arc blast, fire, or explosions.

Fig. 12 : *Sign of electrical hazards*

Causes of Electrical Hazard

- Faulty wiring can cause electric shocks or fires.
- Overloaded circuits may lead to overheating and electrical fires.
- Damaged electrical equipment increases the risk of electric shock.
- Exposure to live wires poses a direct threat of electrocution.
- Improper use of electrical devices can result in accidents

Preventing electrical hazards involves several measures

- Educate personnel on electrical safety procedures, including proper use of equipment and awareness of hazards.
- Regularly inspect and maintain electrical equipment to ensure it is in safe working condition.
- Install Ground Fault Circuit Interrupters (GFCIs) in areas where water and electricity may come into contact to prevent electric shocks.
- Ensure wiring is installed correctly and meets safety standards to prevent electrical fires and shocks.
- Implement procedures to de-energise and lock out machinery during maintenance to prevent accidental startup.
- Provide appropriate PPE such as insulated gloves and mats for workers handling electrical equipment.
- Maintain adequate clearance around electrical panels and equipment to allow for safe operation and maintenance.
- Clearly label hazardous areas and equipment with warning signs to alert personnel of potential dangers.
- Conduct routine inspections of electrical systems to identify and address any potential hazards promptly.

Transportation Hazard

Transportation hazards include accidents, mechanical failures, adverse weather conditions, and human error. It is essential to follow safety protocols, maintain vehicles properly, and stay informed about road conditions to mitigate risks.

Fig. 13: *Sign of transportation hazard*

Causes of Transportation Hazards

- Vehicle collisions occur due to factors such as speeding and reckless driving.
- Poor road conditions, such as potholes, contribute to accidents.
- Driver fatigue leads to reduced reaction times.
- Impaired driving from alcohol or drugs increases the likelihood of accidents.
- Mechanical failures in vehicles can lead to unexpected breakdowns.
- Hazardous cargo can spill or leak, posing environmental and health risks.
- Adverse weather conditions.

Prevention of transportation hazards

- Ensure vehicles undergo regular maintenance checks to identify and address any potential issues before they become hazards.
- Provide comprehensive training for drivers, including defensive driving techniques, handling adverse weather conditions, and proper vehicle operation.
- Equip vehicles with safety features such as seat belts, airbags, anti-lock braking systems (ABS), and electronic stability control (ESC).
- Train drivers on emergency procedures and equip vehicles with emergency kits, including first aid supplies, reflective vests, and warning triangles.
- Stay informed about weather conditions along planned routes and adjust travel plans to avoid hazardous conditions.
- Ensure cargo is properly secured to prevent shifting during transit, affecting vehicle stability and leading to accidents.
- Stay up-to-date with transportation regulations and industry standards to ensure compliance and promote safety in all operations.

Hazardous Air Pollution

Air hazards can arise from various pollutants or contaminants present in the atmosphere, both indoors and outdoors.

Fig. 14: *Hazardous Air Pollution*

Causes of Hazardous Air Pollution

- Industrial processes emitting pollutants during manufacturing and production.
- Vehicle exhaust releases harmful gases and particulate matter into the air.
- Burning of fossil fuels for energy production, heating, and transportation.
- Agricultural activities, such as livestock farming and crop burning, release pollutants.
- Improper waste management practices lead to the release of pollutants into the air.
- Natural events such as wildfires and volcanic eruptions also contribute to air pollution.

Prevention of hazardous air pollutants

- Preventive measures of hazardous air pollutants
- Implement and enforce regulations to limit emissions from industrial sources and vehicles.

- Promote using cleaner energy sources such as renewable energy (solar, wind, hydro) and natural gas to reduce reliance on fossil fuels.
- Enforce strict vehicle emission standards and promote the use of electric vehicles.
- Encourage public transportation and carpooling to reduce the number of vehicles on the road.
- Educate the public about the health risks associated with air pollutants and promote behaviours that reduce emissions, such as reducing idling and proper waste disposal.

Invest in research and developing new technologies and strategies for effectively reducing air pollution.

Physical hazards

Physical hazards are one of the most common environmental hazards in the workplace. These hazards can be found in various industries, such as manufacturing, construction, and transportation. Exposure to physical hazards can cause various health problems, including hearing loss, eye damage, burns, and other injuries. Examples of physical hazards include noise, which can harm workers' hearing if exposed to high decibel levels for extended periods. Vibration from equipment can cause musculoskeletal disorders such as carpal tunnel syndrome or hand-arm vibration syndrome. Extreme temperatures can cause heat stress or hypothermia, and radiation exposure can cause skin damage or increase the risk of cancer.

Fig. 15: *some example of health hazards*

Causes of Physical Hazards

- Failure to provide adequate safety equipment exposes workers to unnecessary risks.
- Insufficient training leaves workers unable to recognise and mitigate physical hazards.
- Neglecting to implement safety protocols increases the likelihood of exposure to dangerous situations.

- Disregarding the importance of wearing appropriate PPE compromises worker safety during tasks.
- Poorly stored objects pose a threat of falling and causing injury to workers.
- Ignoring safe distances from moving machinery and equipment increases the risk of accidents.
- Non-compliance with safety protocols and procedures when operating machinery increases the probability of accidents.

Prevention of Physical Hazards (e.g., Falling Objects, Moving Machinery):

- Provision of proper safety equipment.
- Training workers to identify physical hazards.
- Implementing safety protocols to reduce exposure.
- Wear appropriate personal protective equipment (PPE) for the task.
- Securely store objects to prevent them from falling.
- Keep a safe distance from moving machinery and equipment.
- Follow safety protocols and procedures when operating machinery.

Wildlife and Pest Hazards

Wildlife and pest hazards involve risks and dangers from animals, including threats to human safety, property damage, and disease transmission. These hazards can arise from encounters with wildlife in natural environments or from infestations of pests such as insects and rodents in urban or rural areas.

Causes of Wildlife and Pest Hazards

- Animal attacks.
- Venomous bites or stings.
- Transmission of diseases.
- Collisions with vehicles.

Preventive measures

- Implementing integrated pest management techniques, including traps, baits, and eco-friendly pesticides, effectively managing pest populations.
- Installing barriers, fencing, or repellents to discourage wildlife from entering human habitats or agricultural areas.
- Ensuring proper disposal of food waste and garbage to prevent attracting pests such as rodents and insects.
- Providing information to communities about wildlife behaviour, pest prevention, and proper waste management practices to encourage proactive measures.
- Implementing vaccination programmes for pets and livestock to prevent the spread of diseases carried by wildlife or pests.
- Conduct routine inspections of properties and agricultural fields to promptly detect and address pest or wildlife infestations.

Construction and Renovation Hazards

Construction and renovation hazards refer to risks or dangers present during the building or remodelling of structures.

Causes of Construction and Renovation Hazards

- Lack of proper training, inadequate supervision, and failure to follow safety procedures.
- Exposure to toxic substances such as asbestos, lead, or mould can pose serious health risks to workers and occupants.
- Working at heights without proper fall protection measures is a common cause of injuries in construction and renovation projects.
- Improper wiring, overloaded circuits, and damaged electrical equipment can lead to electrical shocks, fires, and other accidents.
- Heavy Machinery and Equipment: Mishaps involving construction machinery such as cranes, forklifts, and power tools can result in severe injuries or fatalities.
- Weak or unstable structures may collapse during construction or renovation, endangering workers and nearby individuals.
- Welding, hot work, and flammable materials can increase the risk of fires on construction sites.
- Exposure to chemicals used in construction, such as solvents, paints, and adhesives can cause respiratory problems, skin irritation, and other health issues.
- Prolonged exposure to high levels of noise and vibrations from construction activities can lead to hearing loss and other health problems.

Preventive Measures of Construction and Renovation Hazards

- Implement comprehensive safety training programs for all workers, emphasising proper procedures and hazard awareness.
- Conduct regular inspections to identify and address potential hazards, including those related to hazardous materials.
- Provide adequate personal protective equipment (PPE) such as respirators, gloves, and safety harnesses, and ensure they are used correctly.
- Follow proper handling, storage, and disposal protocols for hazardous materials to minimise exposure risks.
- Install and maintain appropriate fall protection systems, such as guardrails, safety nets, and personal fall arrest systems.
- Inspect and maintain electrical systems and equipment regularly to prevent malfunctions and hazards.
- Ensure proper training and certification for heavy machinery and equipment operators, and enforce safety protocols.
- Conduct structural assessments and reinforcement to prevent collapses and ensure stability.
- Implement fire prevention measures, including properly storing flammable materials, using fire-resistant materials, and adhering to hot work procedures.
- Substitute hazardous chemicals with safer alternatives whenever possible and provide adequate ventilation in work areas.
- Implement noise control measures and provide hearing protection to workers exposed to high noise levels.

Lifting and Manual Handling Hazards

Manual hazard refers to any situation or condition in the workplace that poses a risk of injury or harm due to manual labour or physical exertion.

Causes of Lifting and Manual Handling Hazard

- Lack of proper training in lifting techniques.
- Absence of mechanical aids or equipment to assist with lifting heavy objects.
- Failure to assess the worksite regularly for potential hazards.
- Inadequate rotation of tasks and insufficient rest breaks.
- Lack of an open reporting environment for employees to communicate hazards or discomfort.
- Insufficient supervision and monitoring to ensure compliance with safe lifting practices

Preventive measures

- Provide comprehensive training on proper lifting techniques, including knee bending, keeping the back straight, and using leg muscles to lift.
- Encourage using mechanical aids such as dollies, carts, forklifts, or conveyor belts to assist with lifting heavy objects whenever possible.
- Conduct regular worksite assessments to identify potential hazards and implement appropriate control measures, such as rearranging storage areas to reduce the need for heavy lifting.
- Rotate tasks and provide opportunities for rest breaks to reduce the cumulative strain on employees' muscles and joints.
- Create an open environment where employees feel comfortable reporting hazards, near misses, or discomfort related to manual tasks, allowing for timely intervention and corrective action.
- Implement regular supervision and monitoring to ensure that safe lifting practices are being followed and to identify any emerging hazards or issues.

Psychosocial Hazards (e.g., Stress, Workplace Violence)

Psychological hazards in society can stem from various sources, including:

Causes of Psychological Hazards

- Natural disasters, accidents, or violent incidents can lead to trauma and psychological distress among individuals and communities.
- Loneliness, lack of social support, and disconnectedness can contribute to mental health issues such as depression and anxiety.
- Systemic discrimination based on factors such as race, ethnicity, gender, sexual orientation, or religion can have profound psychological impacts, including feelings of inferiority, stress, and low self-esteem.
- Financial insecurity, poverty, and unemployment can lead to chronic stress, anxiety, and depression.
- Physical, emotional, or sexual abuse, whether experienced directly or witnessed, can cause long-term psychological harm.
- Substance misuse and addiction can lead to various mental health disorders and worsen existing psychological issues.
- Exposure to graphic or distressing content in media, including social media, can contribute to anxiety, fear, and desensitisation.

- Political instability, oppressive regimes, or civil unrest can create an atmosphere of fear, mistrust, and anxiety among the population.
- Negative attitudes and misconceptions about mental illness can discourage individuals from seeking help and lead to feelings of shame and isolation.

Preventive Measures of Psychological Hazards

- Educate the public about mental health issues, reduce stigma and encourage help-seeking behaviours.
- Foster social connections, support networks, and community resilience to mitigate the effects of isolation and loneliness.
- Implement anti-discrimination policies, promote diversity and inclusion, and provide training to combat prejudice and bias.
- Implement policies that promote job security, fair wages, and access to resources to alleviate financial stress and poverty.
- Enforce laws against violence and abuse, provide support services for victims, and promote healthy relationship dynamics.
- Offer education on substance misuse, provide accessible treatment programmes, and implement harm reduction strategies.
- Teach critical thinking skills and media literacy to help individuals navigate and interpret media content responsibly.
- Advocate for peaceful conflict resolution, promote democratic values, and support initiatives that foster political stability and social cohesion.
- Ensure access to affordable mental health services, including counselling, therapy, and crisis intervention.

Natural Disasters (e.g., Earthquakes, Floods, Hurricanes)

Natural hazards are a type of environmental hazard that can pose a serious risk to lone workers. These hazards, such as earthquakes, hurricanes, floods, tsunamis, and avalanches can cause injury or trap lone workers in confined spaces. While many natural hazards can be impossible to predict, it is the employer's responsibility to ensure that lone workers can communicate their location and status in the case of a natural disaster or emergency.

Causes of Natural Hazards

- Insufficient awareness or preparation for potential disasters.
- Failure to anchor heavy items, leading to hazards during earthquakes.
- Electrical gear at ground level is vulnerable to flood damage.
- Failure to monitor weather updates and heed evacuation notices.
- Insufficient means tracking lone workers' locations in real-time increases risk.

Prevention of natural disasters

- Develop and practice emergency plans for different types of disasters.
- Secure heavy furniture and objects to prevent injury during earthquakes.
- Elevate electrical equipment and utilities above flood levels.
- Stay informed about weather conditions and evacuate if necessary.

- Personal safety devices, such as GPS-enabled devices or mobile apps, can allow employers or other team members to monitor the location of lone workers in real-time.

Radiation and EMF Hazards

Radiation is the emission or transmission of energy through waves or particles through space or a material medium. It can be categorised into ionising radiation (X-rays and gamma rays) and non-ionizing radiation (radio waves, microwaves, and visible light).

EMF (Electromagnetic Field) hazard refers to potential health risks associated with exposure to electromagnetic fields, particularly from devices such as mobile phones, Wi-Fi routers, and power lines. While research is ongoing, some studies suggest that prolonged exposure to high levels of EMF may have adverse health effects, including increased risk of cancer, neurological disorders, and reproductive issues.

Causes of Radiation and EMF Hazards

- Proliferation of radiation-emitting devices such as mobile phones and laptops.
- Increased dependence on wireless technologies leading to prolonged exposure.
- Potential health concerns associated with prolonged exposure to electromagnetic radiation.
- Lack of widespread awareness of the risks of radiation and EMF exposure.
- Absence of universally adopted safety standards for the use of radiation-emitting devices.
- Limited understanding of the long-term effects of EMF exposure on human health.
- Rapid technological advancements leading to increased use of devices emitting radiation.
- Environmental factors contributing to the generation and propagation of electromagnetic fields.

Preventive measures for minimising radiation and EMF hazards

1. Maintain a safe distance from radiation-emitting devices whenever possible. For example, hold your mobile phone away from your body when making calls.
2. Limit the time spent using devices emitting radiation, such as mobile phones and laptops.
3. Use shields or cases designed to reduce exposure to radiation from devices such as mobile phones and laptops.
4. Use wired connections whenever feasible instead of relying solely on wireless technologies, such as wired internet connections instead of Wi-Fi.
5. Minimise exposure by avoiding unnecessary use of radiation-emitting devices and keeping them away from your body while sleeping.
6. Consider using EMF protection devices, such as specialised cases or shields, to reduce exposure to electromagnetic fields.
7. Adhere to safety guidelines provided by regulatory bodies and manufacturers for using radiation-emitting devices safely.
8. Stay informed about the potential risks associated with radiation and EMF exposure and take appropriate precautions to mitigate them.

Water Contamination

Water contamination refers to harmful substances or pollutants in water sources, making them unfit for their intended use, such as drinking, irrigation, or recreation. Contaminants can include chemicals, microorganisms, heavy metals, and other pollutants that threaten human health and the environment.

Causes of Water Contamination

- Inadequate wastewater treatment leading to water body contamination.
- Improper disposal of hazardous materials such as chemicals and oils contaminating water sources.
- Unregulated agricultural practices cause runoff of pollutants into water bodies.
- Insufficient monitoring and testing, allowing contamination to go unnoticed.
- Lack of public awareness of water conservation and pollution prevention.
- Weak enforcement of regulations against industrial and agricultural pollution.
- Neglecting proper disposal of hazardous waste, leading to water contamination.
- Failure to maintain plumbing, increasing the risk of leaks and contamination.
- Inadequate testing of drinking water for contaminants.
- Improper disposal practices, such as pouring harmful substances down drains, contributing to pollution.

Preventive measures to mitigate water contamination

1. Ensuring proper wastewater treatment before it is discharged into water bodies, including sewage treatment plants and industrial effluent treatment.
2. Implementing safe disposal practices for hazardous materials, including chemicals, oils, and other pollutants, to prevent them from contaminating water sources.
3. Promoting sustainable agricultural practices to reduce runoff of fertilisers, pesticides, and animal waste into water bodies.
4. Conduct regular monitoring and testing of water quality to detect contamination early and take corrective actions promptly.
5. Educating the public about the importance of water conservation and pollution prevention and providing information on safe water usage and disposal practices.
6. Enforcing strict regulations and policies to control pollution from industrial activities, agriculture, and other sources, including penalties for non-compliance.
7. Ensure proper disposal of chemicals and hazardous waste.
8. Regularly check and maintain plumbing to prevent leaks.
9. Test drinking water for contaminants regularly.
10. Be cautious about what you put down the drain or flush.

Factors of hazard management

- **Risk Assessment**: Identifying and evaluating potential hazards and their associated risks.
- **Hazard Identification:** Recognising and understanding the hazards present in a given environment or situation.
- **Mitigation Strategies:**Developing and implementing measures to reduce or eliminate hazards and their associated risks.
- **Preparedness Planning:** Creating plans and procedures to respond effectively to hazards, including emergency response and evacuation plans.
- **Training and Education:** Providing training and education to individuals involved in hazard management to ensure they understand their roles and responsibilities.

- **Communication:** Establishing effective communication channels to disseminate information about hazards and emergency procedures to relevant stakeholders.
- **Monitoring and Review:** Continuously monitoring hazards and evaluating the effectiveness of hazard management strategies to make necessary adjustments and improvements over time.

Learning Tasks

1. Explain and identify hazards in the environment.
2. Describe the causes of Hazards in the environment
3. Describe three (3) ways each how to manage hazards in school laboratories and construction sites etc.

Pedagogical Exemplars

Think-Pair-Share Activity:

- Let learners research using books/internet to analyse the root causes of hazards, and types and explore possible preventive measures. Facilitate a whole-class discussion based on the pairs' findings.
- Divide the class into pairs/ mixed-ability groups and provide each group with a list of common areas in the home and workplace (e.g., laboratory, kitchen, construction site).
- Encourage critical thinking by asking questions such as "How can these hazards be minimised or eliminated?" and "What role do regulations and safety protocols play in managing risks?"
- Ask learners to write down potential hazards and risks associated with each area. Encourage them to consider physical, chemical, biological, and ergonomic hazards.
- Ask each group to share their findings with the class to foster discussion and presentation.
- Provide scaffolding for learners with difficulties.

Field Trip:

- Choose a local industry that is accessible and relevant to the students, such as a sawmill, palm kernel oil production facility, or gari processing plant.
- Before the visit, provide learners with background information about the industry and its potential hazards.
- Ask learners to observe the activities taking place and identify potential hazards and risks.
- Engage with industry workers or managers to gain insights into their safety practices and measures in place to mitigate risks.
- Encourage learners to actively observe their surroundings and identify potential hazards, such as moving machinery, chemicals, noise, and ergonomic risks.
- Provide them with a checklist or worksheet to document their observations and assessments.
- After the visit, reconvene as a class to discuss their findings and reflections on the risks and hazards present in the industry.

Project-based Learning:

- Assign individual or mixed-ability group projects where students develop safety plans or hazard assessments for specific home or workplace scenarios such as school laboratory, construction site etc. using the Internet/videos/books. Provide support for learners who have difficulties.

- Facilitate cross-sharing sessions where learners present their findings to their peers. Encourage constructive feedback and discussions on their findings.

Collaborative Learning:

- Divide the learners into mixed-ability groups and invite a resource person from relevant industries or safety organisations to share their expertise and experiences. Provide the resource person with guidelines on the key points to cover, including risks and hazard management.
- After the talk, encourage learners to discuss and share their understanding of the key points with their group members. This discussion allows for peer learning and comprehension reinforcement.
- Assign each group the task of preparing a group presentation summarising what they learned from the talk. Emphasise that each member should contribute according to their abilities, and provide support and guidance as needed.

Key Assessment

Level 1: Explain the term hazard and identify at least four (4) types of hazards in our environment.

Level 2: Describe five (5) possible causes of hazards in the science laboratory in the school.

Level 3: Describe three (3) ways each how to manage hazards in school laboratories and construction sites etc.

Level 4: Analyse the differences among the differences among physical and psychological hazards.

Level 5: Design a comprehensive hazard management plan for a proposed local industry facing multiple hazards.

Week 19

Learning Indicator: *Describe lifestyle diseases, their causes, effects and prevention*

Theme or Focal Area: Causes, Effects and Prevention of Lifestyle Diseases

Overview of lifestyle

Lifestyle diseases are non-communicable diseases and resulted from lifestyle choices that individuals make. Examples are lung cancer from smoking, heart disease from lack of exercise and poor diet, and type 2 diabetes from poor diet, etc.

Causes of lifestyle disease/ Non-Communicable disease

The causes of lifestyle diseases are lack of physical activity, unhealthy eating, alcohol, substance use disorders and smoking tobacco, which can lead to heart disease, stroke, obesity, type II diabetes and lung cancer.

- **Fatigue:** Sleep is a fundamental component of a healthy lifestyle. Sleep disturbances have several negative effects on one's health, finances, society, and psychology. Sleep directly impacts one's physical and emotional well-being, and lifestyle choices can influence sleep quality. Serious medical conditions such as high blood pressure, heart disease, stroke, obesity, and mental impairment are linked to sleep deprivation.
- **Diet and Body Mass Index (BMI):** The most important lifestyle component is that diet has a clear, positive correlation with health. In metropolitan societies, poor eating and its aftereffects, such as obesity are prevalent health issues. BMI is a useful tool for measuring unhealthy lifestyles. Certain metropolitan lifestyles cause issues with nutrition. An imbalanced diet and excessive fast food intake worsen conditions like cardiovascular disease.
- **Exercise:** Exercise is a part of a healthy lifestyle and is used to treat general health issues. Regular exercise and a balanced diet improve general health and well-being. Several research emphasise the link between happiness and leading an active lifestyle.
- **Substance abuse:** Addiction is viewed as a bad way of life. In addition to numerous health issues, smoking and substance use can cause brain damage, cancer, asthma, and cardiovascular disease.
- **Medication abuse:** Adverse medication-related behaviours include self-medication, sharing medications, using medications without a prescription, prescribing excessive amounts of drugs, prescribing large quantities of each drug, prescribing unnecessary drugs, writing prescriptions incorrectly, ignoring contradictory medication, ignoring the negative effects of drugs, and failing to explain the effects of drugs.

Effects of Lifestyle Diseases

Heart disease, diabetes, cancer, stroke, arthritis, migraines/headaches, sleep disorders, musculoskeletal disorders, nerve compression disorders, carpal tunnel syndrome, tendinitis, degenerative neck, back disorders, pulmonary disease, osteoporosis, arteriosclerosis, gallbladder disease, kidney and liver disease, Alzheimer's and dementia are a few examples of the effects of lifestyle diseases.

Some of the effects of lifestyle diseases are diabetes, cancer, chronic respiratory diseases, and cardiovascular diseases are the four main lifestyle diseases.

Cardiovascular Diseases

- Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels. They include:

- Coronary Heart Disease:
- Coronary heart disease is a condition that affects the blood arteries that provide blood to the heart muscle.
- Cerebrovascular Disease:
- Cerebrovascular disease is a condition that affects the blood arteries that feed the brain Peripheral Arterial Disease:
- Peripheral arterial disease is a condition that affects the blood arteries that provide blood to the arms and legs.

Causes of Cardiovascular diseases (CVDs)

- *Unhealthy diet:* Diets high in saturated fats, trans fats, cholesterol, and sodium can increase the risk of CVDs.
- *Physical inactivity:* Lack of regular physical activity can lead to obesity and other risk factors for CVDs.
- *Tobacco use:* Smoking and exposure to second-hand smoke can damage blood vessels and increase the risk of CVDs.
- *Excessive alcohol consumption:* Heavy drinking can raise blood pressure, contribute to obesity, and increase the risk of heart disease.
- *High blood pressure:* Hypertension puts extra strain on the heart and blood vessels, leading to CVDs.
- *High cholesterol levels:* Elevated levels of Low Density- Lipoprotein (LDL) cholesterol ("bad" cholesterol) can lead to plaque buildup in the arteries, increasing the risk of heart disease and stroke.

Symptoms

- Chest pain or discomfort (angina)
- Shortness of breath
- Pain, numbness, or weakness in the arms or legs
- Irregular heartbeat
- Fatigue
- Swelling in the legs, ankles, or feet
- Sudden weakness or numbness of the face, arm, or leg (especially on one side of the body) indicating stroke

Prevention

- Eat a heart-healthy diet rich in fruits, vegetables, whole grains, and lean proteins.
- Exercise regularly (at least 150 minutes of moderate aerobic activity per week).
- Avoid smoking and limit alcohol consumption.
- Manage stress through relaxation techniques, adequate sleep, and mental health support.
- Regularly monitor blood pressure, cholesterol, and blood sugar levels.

Chronic Respiratory Diseases

Airflow from the lungs is blocked as a result of chronic respiratory disorders. Breathing difficulties, cough, mucus production, and wheezing are all symptoms. Long-term exposure to irritating gases

or particulate matter, most often cigarette smoke, is the most common cause. People with chronic respiratory disorders are more likely to have heart disease, lung cancer, and other illnesses. The following are two more prevalent chronic respiratory diseases:

Causes of chronic respiratory diseases

- **Poor Nutrition:** The immune system is weakened by insufficient consumption of important nutrients.
- The body's ability to fight respiratory infections might be hampered, and lung function might be compromised by inadequate nutrition. A diet deficient in vitamins and antioxidants may make people more vulnerable to respiratory diseases, including asthma and chronic obstructive pulmonary disease (COPD).
- **Lack of Exercise:** Living a sedentary lifestyle is linked to respiratory problems. Frequent exercise increases lung capacity and strengthens the respiratory muscles, which improves lung function. In addition to lowering the incidence of obesity-related respiratory conditions, including sleep apnoea and asthma, physical activity also aids in maintaining a healthy weight.
- **Exposure to Second-hand Smoke:** Inhaling second-hand smoke exposes individuals to harmful toxins and irritants. Second-hand smoke can exacerbate existing respiratory conditions and increase the risk of developing new ones. Children exposed to second-hand smoke are particularly vulnerable, with higher rates of asthma, bronchitis, and respiratory infections.
- **Smoking:** Chronic obstructive pulmonary disease (COPD) and lung cancer are two main respiratory disorders that are primarily caused by smoking tobacco.

Symptoms:

- Chronic cough
- Shortness of breath, especially during physical activities
- Wheezing
- Chest tightness
- Frequent respiratory infections
- Fatigue

Prevention:

- Avoid smoking and exposure to secondhand smoke.
- Minimise exposure to air pollutants and occupational hazards.
- Maintain a healthy lifestyle with a balanced diet and regular exercise to strengthen respiratory muscles.
- Use protective equipment in workplaces with dust, chemicals,

Symptoms of some lifestyle diseases.

- **Cardiovascular Diseases (CVD)**

  Symptoms: Chest pain or discomfort (angina), shortness of breath, irregular heartbeat, fatigue, dizziness, leg swelling, and sudden cardiac arrest.

- **Type 2 Diabetes**

  ***Symptoms*:** Increased thirst, frequent urination, unexplained weight loss, fatigue, blurred vision, slow healing of wounds, tingling or numbness in the extremities.

- **Obesity**

  Symptoms: Excessive body weight, difficulty in physical movement, fatigue, shortness of breath, joint pain, and an increased risk of developing other health issues such as diabetes and heart disease.

- **Hypertension (High Blood Pressure)**

  Symptoms: Often, hypertension has no noticeable symptoms, but some people may experience headaches, dizziness, blurred vision, or nosebleeds in severe cases.

- **Respiratory Diseases (e.g., Chronic Obstructive Pulmonary Disease - COPD)**

  Symptoms: Chronic cough, wheezing, shortness of breath, frequent respiratory infections, and chest tightness.

- **Lung cancer**

  Symptoms: Lung cancer symptoms may vary but common ones include persistent coughing, coughing up blood, chest pains, shortness of breath, unexplained weight loss, fatigue, etc.

Prevention of Lifestyle Diseases

Quit Smoking: Stopping smoking (or never starting) lowers the risk of serious health problems, such as heart disease, cancer, type 2 diabetes, and lung disease, as well as premature death—even for longtime smokers.

Eat Healthy: Eating healthy helps prevent, delay, and manage heart disease, type 2 diabetes, and other chronic diseases. A balanced, healthy dietary pattern includes various fruits, vegetables, whole grains, lean protein, and low-fat dairy products and limits added sugars, saturated fats, and sodium.

Get Regular Physical Activity: Regular physical activity can help you prevent, delay, or manage chronic diseases. Aim for moderate-intensity physical activity (such as brisk walking or gardening) for at least 150 minutes a week, with muscle-strengthening activities 2 days a week.

Avoid Drinking Too Much Alcohol: Over time, excessive drinking can lead to high blood pressure, various cancers, heart disease, stroke, and liver disease. By not drinking too much, you can reduce these health risks.

Take Care of Your Teeth: Regular dental visits at least annually, regardless of natural teeth presence or dentures, are essential for early detection and treatment of oral health issues, ensuring overall dental well-being

Get Enough Sleep: Insufficient sleep has been linked to the development and poor management of diabetes, heart disease, obesity, and depression. Adults should get at least 7 hours of sleep daily.

Know Your Family History: If you have a family history of chronic diseases, like cancer, heart disease, diabetes, or osteoporosis, you may be more likely to develop that disease yourself. Share your family health history with your doctor who can help you take steps to prevent these conditions or catch them early.

Make Healthy Choices in School and at Work: By making healthy behaviours part of your daily life, you can prevent conditions such as high blood pressure or obesity, which raise your risk of developing the most common and serious chronic diseases. Learn more about healthy actions you or your loved ones can take.

Learning Tasks

1. Identify at least four lifestyle diseases.
2. Explain at least four causes of lifestyle diseases.
3. Describe at least four preventive measures of lifestyle diseases.

Pedagogical exemplars

Collaborative Learning Approach:

- Divide the learners into mixed-ability groups and invite a resource person such as a healthcare giver, medical practitioner, or public health nurse to talk about lifestyle diseases. Provide the resource person with guidelines on the key points to cover, including common lifestyle diseases, their causes, effects, prevention strategies, and the impact of stigma.
- After the talk, encourage learners to discuss and share their understanding of the key points with their group members. This discussion allows for peer learning and comprehension reinforcement.
- Assign each group to prepare a group presentation summarising what they learned from the talk. Emphasise that each member should contribute according to their abilities and provide support and guidance as needed.

Research-Based Learning

- Task learners with assessing lifestyle diseases within their environment. Provide guiding questions to help them identify diseases that are often stigmatised due to societal perceptions or misconceptions.
- Encourage learners to conduct research-based inquiries into the identified diseases, focusing on factors such as prevalence, causes, symptoms, treatment options, and societal attitudes towards those affected.
- Facilitate cross-sharing sessions where learners present their findings to their peers. Encourage constructive feedback and discussions on the impact of stigma on individuals and communities affected by these diseases.

Talk-for-Learning Approaches:

- Use talk-for-learning to guide learners to analyse the differences between various lifestyle diseases based on causes, effects, preventive measures, and strategies for managing stigma.
- Assign mixed-ability groups to demonstrate the differences between various lifestyle diseases based on causes, effects, preventive measures, and strategies for managing stigma.
- Provide resources such as articles, case studies, and real-life examples to support their discussions. Facilitate cross-sharing sessions where learners present their findings to their peers and presentations. Encourage a supportive and inclusive learning environment where learners feel comfortable expressing their ideas and perspectives.

Key Assessment

Level 1: Identify at least four lifestyle diseases.

Level 2: Explain at least three causes of lifestyle diseases.

Level 3: Analyse the effects of smoking and alcohol consumption on the prevalence of lifestyle diseases.

Level 4: Reflect on your own lifestyle choices and habits, considering factors such as diet, physical activity, stress management, and sleep hygiene, and develop a personalised action plan for reducing your risk of developing lifestyle diseases based on evidence-based recommendations and behavioural change techniques.

WEEK 20

Learning Indicator: *Analyse the attributes of drugs.*

Theme or Focal Area: Recreational Drugs and the Negative Effects these have on the Body and Society in General

Overview of drugs

Drugs are chemicals and substances that affect both your mind and your body. The prolonged use of drugs may lead to physical and/or psychological dependence. Drugs are substances that can alter the normal functioning of the body when introduced into it. The term drug is also used for substances which are habit-forming and are often abused, for example, narcotics such as cocaine, morphine, heroin, marijuana, etc. The term "drugs" can apply to therapeutic drugs and recreational drugs. Some recreational drugs are legal, and others are illegal. An overdose of any drug may lead to death. They can be classified into various categories based on their effects and uses.

Classes of drugs:

- Narcotics
- Depressants
- Stimulants
- Hallucinogens
- Anabolic steroids

Narcotics ("opioids")

Overview

The term "narcotic" comes from the Greek word for "stupor" and originally referred to a variety of substances that dulled the senses and relieved pain. Though some people still refer to all drugs as "narcotics," today "narcotic" refers to opium, opium derivatives, and their semi-synthetic substitutes. A more current term for these drugs, with less uncertainty regarding its meaning, is "opioid." Examples include the illicit drug heroin and pharmaceutical drugs such as OxyContin, Vicodin, codeine, morphine, methadone, and fentanyl.

Physiological Effects

Besides their medical use, narcotics/opioids produce a general sense of well-being by reducing tension, anxiety, and aggression. These effects are helpful in a therapeutic setting but contribute to drug abuse. Narcotic/opioid use comes with a variety of unwanted effects, including drowsiness, inability to concentrate, apathy, slowed physical activity, constriction of the pupils, flushing of the face and neck, constipation, nausea, vomiting, slowed breathing, constricted (pinpoint) pupils, cold, clammy skin, confusion, convulsions, extreme drowsiness, and slowed breathing.

Narcotics are highly addictive substances. They act on the brain's reward system, causing a surge of dopamine, which reinforces drug use and makes quitting difficult. Prolonged use can lead to physical dependence, where the body adapts to the presence of the drug and requires it to function normally. Withdrawal symptoms may occur when drug use is discontinued. With continued use, the body may develop tolerance, requiring higher doses to achieve the same effects. This can increase the risk of overdose. Narcotics can depress the central nervous system, leading to respiratory depression, coma, and death in cases of overdose.

Societal risks from recreational drugs

- Substance abuse, including narcotics, imposes significant costs on society, including healthcare expenses, lost productivity, and criminal justice expenditures.
- Addiction to narcotics can strain relationships with family members, leading to domestic violence, neglect of children, and breakdown of family structures.
- Individuals struggling with narcotic addiction often face stigma and discrimination, which can hinder their access to treatment and support services.
- Opioid overdoses, in particular, have become a major public health crisis in many countries, contributing to a significant number of deaths each year.

Heroin

Heroin is a highly addictive drug, and a rapidly acting.. Heroin is an opiate, a class of drugs that are either naturally derived from the flowers of the poppy plant or synthetic substitutes. Heroin is produced from morphine, a naturally occurring substance that comes from the seedpod of poppy plants. It carries a strong risk of addiction and physical dependence. Heroin is abused by injecting, snorting or smoking it, and all three can cause the same level of addiction, as well as serious health problems. Heroin targets and stimulates the brain's natural reward system.

Physiological effect

- Heroin binds to opioid receptors in the brain, leading to feelings of euphoria and pain relief.
- It depresses the central nervous system, causing slowed breathing and heart rate.
- Long-term use can lead to tolerance, dependence, and withdrawal symptoms.

Hazards on the body

Because it enters the brain so rapidly, heroin is particularly addictive, both psychologically and physically. Heroin users report feeling a surge of euphoria or "rush," followed by a twilight state of sleep and wakefulness. Drowsiness, respiratory depression, constricted pupils, nausea, a warm flushing of the skin, dry mouth, slow and shallow breathing, blue lips, fingernails, clammy skin, convulsions, coma, and possible death and heavy extremities. Overdose is a significant risk, with symptoms including respiratory depression, coma, and death. Sharing needles increases the risk of contracting infectious diseases such as HIV and hepatitis.

Hazards on Society

- Heroin addiction often results in unemployment, financial instability, and strained relationships.
- Users may engage in criminal behaviour to support their addiction, leading to legal problems.

Stimulants

Stimulants speed up the body's systems. This class of drugs includes prescription drugs such as amphetamines, methylphenidate, diet aids, and illicitly produced drugs such as methamphetamine, cocaine, and methcathinone. Example of Stimulants: methamphetamine, cocaine):

Physiological effect

Stimulants increase the release of dopamine and norepinephrine in the brain, leading to heightened alertness and energy. They elevate heart rate, blood pressure, and body temperature.

Prolonged use can result in tolerance, psychosis, and cardiovascular issues.

Hazards on body

Overdose of stimulants can cause seizures, heart attacks, and strokes.

Long-term use can lead to severe dental problems ("meth mouth"), cognitive impairment, and mental health disorders.

Hazards to Society

Stimulant abuse can lead to erratic behaviour, social isolation, and relationship problems.

Users may experience difficulties at work or school due to impaired cognitive function and focus.

Effect on the Stimulants

When used as drugs of abuse and not under a doctor's supervision, stimulants are taken to produce a sense of exhilaration, enhance self-esteem, improve mental and physical performance, increase activity, reduce appetite, extend wakefulness for prolonged periods, and "get high". Dizziness, tremors, headache, flushed skin, chest pain with palpitations, excessive sweating, vomiting, high fever, convulsions, and cardiovascular collapse may precede death and abdominal cramps.

Example of stimulants

Cocaine is an intense, euphoria-producing stimulant drug with a strong addictive potential that can be risky even the first time you use it. It is a hydrochloride salt derived from processed extracts of the coca plant leaves. Cocaine overstimulates the brain's natural reward system, causing it to be a highly addictive drug.

Physiological effect

Cocaine blocks the reuptake of dopamine, serotonin, and norepinephrine, producing intense feelings of pleasure and increased energy. It constricts blood vessels, leading to elevated blood pressure and an increased risk of heart attack and stroke. Chronic use can result in tolerance, dependence, and severe cardiovascular issues.

Hazards on the body

The intensity of cocaine's euphoric effects depends on how quickly the drug reaches the brain, which depends on the dose and method of abuse. Following smoking or intravenous injection, cocaine reaches the brain in seconds, with a rapid build-up in levels. This results in a rapid-onset, intense euphoric effect known as a "rush." Other effects include increased alertness and excitation, restlessness, irritability, and anxiety. The physiological effects of cocaine include increased blood pressure and heart rate, dilated pupils, insomnia, and loss of appetite. The widespread abuse of highly pure street cocaine has led to many severe adverse health consequences, such as Cardiac arrhythmias, ischemic heart conditions, sudden cardiac arrest, convulsions, strokes, and death.

Hazard to Society:

- Cocaine use often leads to financial instability, legal troubles, and strained relationships.
- Users may experience mood swings, aggression, and paranoia, contributing to social conflicts.

Depressants

Depressants will put you to sleep, relieve anxiety and muscle spasms, and prevent seizures. Common street names for depressants Examples: Alcohol (beer, wine, vodka, tequila, gin, etc.), Sleeping Pills, Marijuana

Physiological effects

Depressants enhance the activity of the neurotransmitter gamma-aminobutyric acid (GABA), resulting in sedation and relaxation. They slow down heart rate, breathing, and brain activity.

Prolonged use can lead to tolerance, physical dependence, and potentially life-threatening withdrawal symptoms

Hazard to the body

Depressants used therapeutically do what they are prescribed to induce sleep, relieve anxiety and muscle spasms, and prevent seizures They also cause amnesia, leaving no memory of events that occur while under the influence, reduce reaction time, impairment of judgment, and confusion Long-term use of depressants produces psychological dependence and tolerance. Some depressants can relax the muscles. Unwanted physical effects include slurred speech, loss of motor coordination, weakness, headache, light-headedness, blurred vision, dizziness, nausea, vomiting, low blood pressure, and slowed breathing. For example, alcohol is a central nervous system depressant. Alcohol goes directly from your digestive system into your bloodstream, and within minutes, it spreads to the entire body. The brain gets the highest concentration because it gets more blood than any other body part.

Hazards to Society

- Depressant abuse can impair judgement and coordination, leading to accidents and injuries.
- Users may experience difficulties maintaining relationships and meeting responsibilities at work or home.

Alcohol

Physiological effects

- Alcohol is a central nervous system depressant that slows down brain activity and impairs cognitive and motor function.
- It increases the release of dopamine, producing feelings of pleasure and relaxation.
- Chronic alcohol abuse can lead to liver disease, cardiovascular issues, and neurological damage.

Hazards to Society

- Alcohol abuse contributes to a wide range of social problems, including drunk driving accidents, violence, and family dysfunction.
- Excessive drinking may lead to job loss, financial difficulties, and legal consequences.

Hazards on the body

- High blood pressure, heart disease, stroke, liver disease, and digestive problems.
- Cancer of the breast, mouth, throat, oesophagus, voice box, liver, colon, and rectum.
- Weakening of the immune system.
- Learning and memory problems, including dementia and poor school performance
- Mental health problems including depression and anxiety.
- Social problems, including family problems, job-related problems, and unemployment.

Hallucinogens

Hallucinogens are found in plants and fungi or are synthetically produced and are among the oldest known groups of drugs used for their ability to alter human perception and mood.

Effect of Hallucinogens

Perceptual distortions at different doses, settings, and moods are examples of sensory effects. Time and space-related mental aberrations are among the impacts of psychic energy. Time may seem to stop, resulting in dilated pupils, high blood pressure, and an accelerated heart rate. 3,4-methylenedioxy-methamphetamine, or MDMA, is an example of a hallucinogen. It functions as a stimulant and a psychedelic, causing energizing effects, time and perception distortions, and an increased appreciation of tactile experiences. Teenagers and young adults use it to boost euphoria, feelings of intimacy,

empathy, and sexuality while lowering inhibitions. While users refer to 3,4-methylenedioxy-methamphetamine (MDMA) as "ecstasy," researchers have found that many ecstasy tablets actually include a number of additional, potentially dangerous substances or drug combinations in addition to MDMA. These include: Methamphetamine, ketamine, cocaine, the over-the-counter cough suppressant dextromethorphan (DXM), the diet drug ephedrine, and caffeine

Physiological Effects

Hallucinogens are a diverse group of drugs that alter perception, thoughts, and feelings. Examples include lysergic acid diethylamide (LSD), psilocybin (magic mushrooms), and 3,4-methylenedioxy-methamphetamine (MDMA)/ecstasy. Physiological effects can vary depending on the specific drug, but common effects include hallucinations, altered sensory perception, increased heart rate, and changes in body temperature.

Hazard on Body

While hallucinogens are not typically associated with physical dependence or overdose deaths, they can still pose risks to both the individual and society. Psychological dependence, flashbacks, and exacerbation of underlying mental health issues are potential hazards.

Hazards to the Society

The societal impact of hallucinogens can be complex. While some people use them recreationally in controlled environments, others may experience negative outcomes such as accidents, injuries, or psychological trauma. In some cases, the use of hallucinogens can lead to risky behaviours or impaired judgment, which can have negative consequences for both the individual and society.

Effect of 3,4-methylenedioxy-methamphetamine (MDMA)

MDMA mainly affects brain cells that use the chemical serotonin to communicate with each other. Serotonin helps to regulate mood, aggression, sexual activity, sleep, and pain sensitivity. Clinical studies suggest that MDMA may increase the risk of long-term, perhaps permanent, problems with memory and learning. MDMA causes changes in perception, including euphoria and increased sensitivity to touch, energy, sensual and sexual arousal, need to be touched, and need for stimulation.

Marijuana

Marijuana is a mind-altering (psychoactive) drug produced by the *Cannabis sativa* plant. Marijuana contains over 480 constituents. THC (delta-9-tetrahydrocannabinol) is believed to be the main ingredient that produces the psychoactive effect.

Physiological Effects

Marijuana, also known as cannabis, contains psychoactive compounds such as tetrahydrocannabinol (THC) that affect the brain and body. Short-term effects can include altered senses, altered sense of time, changes in mood, impaired body movement, and impaired memory. Long-term use can lead to respiratory issues, cognitive impairment, and addiction.

Hazards to the Body

When marijuana is smoked, the THC passes from the lungs and into the bloodstream, which carries the chemical to the organs throughout the body, including the brain. In the brain, the THC connects to specific sites called cannabinoid receptors on nerve cells and influences the activity of those cells. Sedation, bloodshot eyes, increased heart rate, coughing from lung irritation, increased appetite, and decreased blood pressure. While marijuana is generally considered less harmful than many other drugs, it can still pose risks to both individual health and society. These risks include impaired cognitive function, respiratory problems, addiction, and potential.

Hazards to Society

The societal impact of marijuana use is a topic of ongoing debate. Some argue that legalisation can lead to increased tax revenue, reduced strain on the criminal justice system, and improved access to medical marijuana for patients in need. Others raise concerns about potential negative effects, such as impaired driving, increased youth access, and the normalisation of drug use.

Steroids

Anabolic steroids are synthetically produced variants of the naturally occurring male hormone testosterone that are abused to promote muscle growth, enhance athletic or other physical performance, and improve physical appearance. Common street names include Arnolds, Juice, Pumpers, Roids, Stackers, and Weight Gainers.

Physiological Effects

Steroids, particularly anabolic steroids, are synthetic variations of the male sex hormone testosterone. They can have various effects on the body, including increased muscle mass, strength, and endurance. However, they can also cause serious health problems, such as liver damage, cardiovascular issues, hormonal imbalances, infertility, and psychiatric effects like aggression and mood swings.

Hazard on Body

Long-term use of steroids can have devastating effects on both the individual's health and society at large. Healthcare costs associated with treating steroid-related health problems can be substantial, and the societal impact of steroid abuse extends to issues such as crime and violence. Outside of sports, steroid abuse can lead to social and interpersonal problems, including strained relationships and legal issues.

Societal Effects

In sports, the use of steroids is often associated with cheating and unfair competition. Athletes may use steroids to enhance their performance, which can undermine the integrity of the sport and create an uneven playing field.

Attributes of Drugs

- **Classification:** Drugs can be categorised into legal and illegal substances. Legal drugs include prescription medications and over-the-counter drugs, while illegal drugs are substances prohibited by law due to their potential for abuse and negative health effects.
- **Purpose:** Drugs may serve therapeutic purposes to treat medical conditions, relieve symptoms, or manage chronic diseases. On the other hand, some drugs are used for recreational or non-medical purposes, leading to potential abuse and addiction.
- **Effects**: Drugs can have different effects on the body, such as stimulant drugs that increase alertness and energy, depressants that slow down bodily functions, hallucinogens that alter perception and sensory experiences, and analgesics that relieve pain.
- **Routes of Administration**: Drugs can be taken orally as pills or liquids, inhaled through the lungs, injected directly into the bloodstream, absorbed through the skin, or administered via other routes, influencing their onset and duration of effects.
- **Addiction and Dependence:** Some drugs have a high potential for addiction and can lead to physical and psychological dependence. Prolonged use of such substances may result in tolerance, requiring higher doses to achieve the same effect.
- **Side Effects and Risks:** Drugs can produce various side effects, ranging from mild to severe, depending on the individual's response and dosage. Misusing or abusing drugs can also lead to adverse health consequences, including organ damage, mental health issues, and overdose.

- **Legal and Social Implications:** The legality of drugs varies between countries and regions, and the possession, distribution, and use of certain drugs can lead to legal consequences. Additionally, drug abuse can have significant social impacts, affecting relationships, work performance, and overall well-being.

Pedagogical Exemplars

- Invite guest speakers, such as healthcare professionals, substance abuse counsellors, or recovered addicts, to share their expertise and personal experiences with drug use and addiction.
- Students engage in discussions, role-playing scenarios, and hands-on activities related to the effects of different drugs on the body and mind, refusal skills, and strategies for making healthy choices.
- Screen documentaries or educational videos that explore various aspects of drug use, addiction, and recovery. Afterwards, facilitate group discussions to reflect on key themes, raise questions, and encourage critical thinking about the issues presented.
- Create role-playing scenarios that simulate common situations involving drugs, such as peer pressure to experiment with substances or encountering someone under the influence. Students can take on different roles and practice communication skills, assertiveness, and decision-making strategies in response to these scenarios.
- Assign research projects where students investigate specific aspects of drug use and its impact on individuals, families, and communities.
- Engage students in community outreach projects focused on drug prevention and education.
- Visiting drug rehabilitation centres and participating in substance abuse prevention programs.

Key Assessment

Level 1: Describe any four classes of drugs and their effects.

Level 2: Describe any three classes of drugs and their effects.

Level 3: Describe any two classes of drugs and their effects.

Section Review

These lessons were structured to provide a holistic learning experience. This section focuses on the use of comprehensive approaches that integrate differentiated instruction to help learners identify and manage common risks and hazards present in their environment, offering learners insight into potential dangers and strategies to mitigate them effectively. Furthermore, it emphasises the importance of understanding lifestyle diseases, their causes, impacts, and preventive measures to promote healthier living. Finally, it provides a comprehensive analysis of drugs, exploring their attributes and effects to foster informed decision-making regarding their use. Through acquiring this knowledge, learners are empowered to prioritise their well-being and make positive choices for themselves and their communities.

Additional Reading

1. Read articles and case studies concerning lifestyle diseases

Resources

1. Teaching/Learning Resources:
2. Public Address system, resource person
3. Pictures/videos of humans suffering from lifestyle diseases.
4. Worksheets and activities on environmental hazards.
5. Health Journals
6. Internet sources, , ,
7. Scientific journals on lifestyle diseases
8. https://www.dea.gov/sites/default/files/2023-04/Heroin%202022%20Drug%20Fact%20Sheet.pdf

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SECTION 9: PRODUCTION IN LOCAL INDUSTRY

Strand: **Relationships With the Environment**

Sub-Strand: Relationship with the environment

Learning Outcome: *Produce local soap in the community.*

Content Standard: Demonstrate understanding of the process of local soap making and design methods of producing soaps for different purposes for income generation.

INTRODUCTION AND SECTION SUMMARY

In this activity, learners will learn about the scientific procedures involved in each production stage while experimenting with the production of local soap and kenkey. Learners can name the physics and chemistry concepts that underlie emulsification, fragrance incorporation, and saponification. Similarly, scientific procedures such as fermentation and heat-induced chemical reactions are crucial to the various stages of kenkey manufacture. Scientific methods, including experimentation, analysis, and observation will also be used to maximise soap production. These activities provide interdisciplinary links facilitating integration with language arts, mathematics, social studies, biology, chemistry, and physics. For instance, in mathematics, students can calculate ingredient proportions and measure mixing times accurately. In social studies, they can explore soapmaking's historical and cultural significance in various communities. In language arts, they can write procedural texts or research the scientific literature on soap production. Collaboration with local businesses or environmental science initiatives can foster connections with economics and ecology.

The Weeks covered by the section are:

Week 21: Produce local soap in the community.

Week 22: Experiment to produce different types of soap.

Week 23: Identify the science underlying the stages of production.

Week 24: Explain scientific processes in the stages of production of kenkey.

SUMMARY OF PEDAGOGICAL EXEMPLARS

Teaching soap-making and kenkey production involves field trips, hands-on experiments, enquiry-based learning, integrating scientific concepts and interdisciplinary connections. Teachers should differentiate instruction to meet diverse learner needs, focusing on essential knowledge, skills, and critical thinking. Assessment methods include performance tasks, written reflections, and presentations, evaluating students' ability to produce quality products and communicate their understanding effectively. Gifted students are encouraged to explore advanced scientific concepts through independent research projects and cross-disciplinary investigations, enhancing their learning experience. This approach promotes a holistic understanding of soap-making and kenkey production, emphasising scientific and cultural significance.

ASSESSMENT SUMMARY

This section focuses on level 3, formative and summative assessment. Assessment will include field trips, laboratory work, report writing, and practical work where the local soap-making and kenkey production are demonstrated to enhance learners' process skills. Further, short tests, class exercises, assignments, group discussions, report writing, and project work group presentations where marks

are awarded and recorded are incorporated. Summative assessment should be done at the end of the lesson, section, and end of the semester. See the assessment manual for more details as to how to assess. However, both formative and summative assessments contribute to the cumulative records of the learners.

WEEK 21

Learning Indicator: *Describe the process of local soap production.*

Theme or Focal Area: Production of Local Soap

Overview

Soap is a common cleansing agent well known to everyone. The oldest detergent known to man is soap which the Romans are said to have produced from animal fats, oil, and wood ash. Potash, an alkali derived from wood ash that comprises potassium hydroxide, potassium carbonate, and salt, is leached from the wood ash. Soap is the sodium or potassium salt of fatty acids (palm oil) that is created by boiling oil and fat with caustic soda or caustic potash, respectively. It comes in different varieties such as bars, liquids, and powders (e.g., detergents). Other ingredients can be added to soap to give it different qualities, such as scent or texture. The process of soap-making is called saponification. Saponification

Saponification, an alkaline hydrolysis reaction involving fats, oils and alkali, is the process used to make soap. Triglycerides (from palm oil) are broken down into glycerol and fatty acids using lye.

Saponification Reactions: Fat + Lye → Soap + Glycerol

The production of local soap typically involves several steps, which may vary depending on the specific type of soap being made and the available resources.

Process of soap-making

Ingredient Selection

Local soap production often begins with selecting ingredients. Common ingredients for soap-making include fats or oils (such as palm oil, coconut oil, or shea butter), water, and caustic soda (sodium hydroxide) or potash (potassium hydroxide) as a base.

Ingredients and Formulation

Preparation of Ingredients: The fats or oils are usually melted down when is applied. This ensures they are in a liquid state and ready to be mixed with the other ingredients.

Mixing: Once the oils are melted, they are combined with the caustic soda (NaOH) or potash (KOH) solution. This mixture is stirred or blended thoroughly until it reaches a specific consistency known as “trace.” This is the point where the mixture thickens, and the ingredients are fully incorporated.

Additives: Additional ingredients such as fragrances, colourants, exfoliants (such as oatmeal or herbs), or moisturizers (such as glycerine) may be added at this stage to enhance the soap’s properties or aesthetics. After adding the additives, continue stirring for approximately two minutes until the paste is homogenous.

Moulding: Pour the resulting paste into plastic or wooden moulds (covered with a plastic film) in the desired forms. The moulds are then left to sit undisturbed until the soap solidifies and hardens.

Curing: After moulding, the soap needs to cure for a certain period, typically several weeks. During this time, the soap undergoes a chemical process called saponification, where the fats or oils react with the caustic soda or potash to form soap. Curing also allows excess water to evaporate, resulting in a harder and longer-lasting bar of soap.

Cutting and Packaging: Once cured, the soap is removed from the moulds and cut into individual bars or other desired shapes. It may then be packaged for sale or personal use. Packaging options can range from simple wrapping with paper or cloth to more elaborate labelling and branding.

Safety rules

Production of soaps and detergents require the use of chemical products that are potentially dangerous for the human organism. Several safety rules must therefore be observed.

Safety gear

- A jacket, an apron or a long-sleeved shirt made of a hard material (denim, velvet, etc.) must be worn.
- A pair of plastic or rubber gloves -When preparing caustic soda solutions, it is necessary to wear well-fitting plastic or rubber gloves.
- A protective mask or scarf - To avoid the inhalation of toxic vapours from the dissolving soda, a protective mask or material soaked in water must be worn, covering the entire nose and mouth area.
- A pair of protective goggles must be worn during the soap or detergent production.
- A pair of rubber boots or closed-toe shoes must be worn during the preparation of the caustic soda solution.

Safety instructions

- It is essential to work near a water source.
- If the caustic soda solution encounters the skin, rinse off thoroughly with water to alleviate the effects of the soda.
- If the soda solution is swallowed, drink copious amounts of water.
- Always pour the soda into the water, and not the other way round, to avoid experiencing a violent reaction that could damage your skin or your eyes.
- Drinking, eating, and smoking are prohibited during soap production operations.
- Avoid any distractions during soap production operations.
- Chemical products used for the maturing or drying stages of soap production must be kept out of the reach of children and domestic animals.
- Soap-making equipment must not be used for cooking.

Learning Task

1. Explain the term saponification.
2. Explain how technology can help in the production of local soap.
3. Describe the process of making local soap.

Pedagogical Exemplars

- Organise a visit or field trip to local soap-making facilities where learners can observe the production process firsthand. Let learners take notes/photos from the field trip.
- Put learners in mixed-ability groups to cross-share and reflect on the notes they wrote during the field trip for peer review and presentation.

- Putting learners in mixed-ability groups, let them search the Internet, and think-pair-share on the science in the process (Saponification) of local soap making.
- Showcase real-life examples of local soap producers who have successfully established their businesses.
- Research the different approaches to making soap in Ghana and other places.

Key Assessment

Level 1: Explain any 3 stages in the production of local soap.

Level 2: Explain saponification in your own words.

Level 3: Write a report on the processes involved in soap making from your field trip.

WEEK 22

Learning Indicator: *Explain the processes of producing different types of soap.*

Theme or Focal Area: Experiment to Produce Different Types of Soap

Overview of Soap

The different types could be African black and African white soap, these are both traditional soap varieties that have distinct differences in terms of ingredients, production methods, and properties. They are natural, handmade products that have gained popularity worldwide for their effectiveness in cleansing and nourishing the skin as well as for their cultural significance.

African Black Soap: African black soap is known for its dark colour, which comes from the ash content. It has a rough, textured appearance and a natural earthy scent. It is prized for its gentle cleansing properties and is believed to have various skincare benefits, such as moisturising, exfoliating, and treating acne, eczema, and other skin conditions.

African White Soap: African white soap, also known as "Alata Samina" or "Ose Dudu," typically contains similar base ingredients such as black soap, such as palm oil, coconut oil, and shea butter. However, it lacks the ash content that gives African black soap its dark colour. African white soap has a creamier appearance and a milder scent compared to black soap. It is also valued for its gentle cleansing properties and is often used for sensitive skin types. Like black soap, it may have moisturising and skin-nourishing benefits, but without the exfoliating properties associated with ash.

Experiment: Making African Black Soap

Materials: Plantain peels or cocoa pods, Shea butter, Palm oil, Coconut oil, Water, Pot or cooking vessel, Mixing bowl, Spoon or spatula, Safety equipment (gloves, goggles, apron), Soap moulds or containers (stainless steel, heat-resistant plastic).

Optional: herbs or oils for fragrance and medicinal properties

Procedures:

Preparation of Ash:

a. Collect plantain peels or cocoa pods. Remove any dirt or debris.

b. Sun-dry the peels or pods until they are completely dried out.

c. Once dried, burn the plantain peels or cocoa pods until they turn to ash. Ensure they are completely burnt.

d. Allow the ash to cool down.

Making the Soap Base:

a. In a mixing bowl, combine the shea butter, palm oil, and coconut oil in the desired proportions. Use a ratio that suits your preference, but a common ratio is approximately 50 per cent shea butter, 25 per cent palm oil, and 25per cent coconut oil.

b. Heat the mixture gently until it melts and combines thoroughly.

c. Remove from heat and let it cool slightly.

NB: Oil or flammable things should be handle carefully

Mixing Ash and Soap Base:

a. Gradually add the cooled ash to the melted oil mixture while stirring continuously. Ensure thorough mixing to incorporate the ash evenly.

b. If desired, add any optional herbs or oils for fragrance or medicinal properties at this stage.

Moulding the Soap:

a. Once the ash is fully mixed into the oil mixture and the consistency is uniform, pour the soap mixture into soap moulds or containers.

b. Allow the soap to cool and solidify. This may take several hours to overnight, depending on the ambient temperature.

Curing the Soap:

a. After the soap has solidified, remove it from the moulds or containers.

b. Place the soap bars in a cool, dry place to cure for several weeks. During this time, the soap will harden further, and any excess water will evaporate, resulting in a longer-lasting bar of soap.

Testing and Storage:

a. Once cured, test the soap to ensure it is suitable. Check its cleansing properties, lather and fragrance.

b. Store the soap bars in a cool, dry place away from direct sunlight until ready for use.

NB: The production method for African white soap is similar to that of black soap, involving mixing oils and shea butter with water and lye (potassium hydroxide). However, the absence of ash results in a lighter-coloured soap.

Soap making is essentially a neutralisation reaction - if there is not enough fatty acid to react with the sodium hydroxide, the resultant soap will contain unreacted NaOH and the soap will be very caustic.

Learning Tasks

1. Name four materials needed in saponification.
2. Explain the role of at least four materials needed in saponification.
3. Describe the process of making local soap using hands-on activity.

Pedagogical Exemplars

Demonstration: Organise a workshop where participants can learn step-by-step the soap-making process.

Collaborative learning

- Put learners into mixed-ability and mixed-sex groups (where applicable); let the learners experiment with preparing a local soap. They should vary the materials (reactants) to see the outcomes. Teacher should provide support through out the process.
- Learners should create educational videos demonstrating the soap-making process from start to finish.

Key Assessment

Level 1: Name four materials needed in saponification.

Level 2: List and explain the role of four materials needed in saponification.

level 3: Explain why some local soaps are different from each other.

Level 4: Describe the process of making local soap.

WEEK 23

Learning Indicator: *Investigate the Production of Indigenous Food to Identify the Science Underlying the Stages of Production.*

Theme or Focal Area: Identify the Science Underlying the Stages of Production.

Overview

Understanding the scientific principles underlying the stages of production is essential for optimising processes, ensuring quality, and fostering innovation. From traditional practices such as soap-making and kenkey production to modern industrial processes, science plays a fundamental role in every production stage. By identifying the underlying science, we can unravel the reasons behind these processes, unlocking opportunities for improvement and innovation. In this exploration, we delve into the science behind each production stage, from raw material acquisition to final product assembly. This lesson focuses on gari production. In gari production, one of the process that stand out is fermentation to remove the hydrogen cyanide from cassava. The science behind cyanide production in cassava (the basis of many of these foods) is of general interest as is the fermentation of maize meal and locust bean to produce these other food.

Why is obtaining ingredients important in local food production?

There are different types of local foods, such as gari, akyeke, and yakeyake. kenkey [Ga or Fante], aboloo, tubaani, dawadawa, etc.).

Activities involved in preparing gari

Gari is a popular food made from cassava, a starchy root vegetable. Its preparation involves several steps. Gari can be enjoyed in various ways, such as soaking it in water to soften it before consumption or using it as an ingredient in dishes such as gari foto or gari soakings.

Sorting the cassava tuber: Certain cassava tuber roots may be damaged or decaying after harvesting. These are sorted to choose the healthy roots for processing; only healthy roots (free of rot or other damage) should be used in the processing phase.

Fig 15: *Image of sorted cassava tubers*

Cassava for gari production

Cleaning and peeling cassava roots: Cassava roots are covered in soil and dirt when they are freshly harvested, and they must be washed and peeled. The roots are peeled to remove the outer brown skin and the inner thick cream layer and then washed to eliminate stains and debris during the gari preparation process. It is critical to regularly inspect the water supply to ensure that it is not filthy or polluted.

Grating of the cassava: Cassava grating is a phase in the process of eliminating cyanide and making the root fit for human consumption. Automatic graters are required in the cassava mash manufacturing process to meet market and industry demands.

Cyanide Detoxification in Cassava

Cassava (Manihot esculenta) contains cyanogenic glycosides, which can release hydrogen cyanide (HCN) when the plant tissue is damaged. To make cassava safe for consumption, the glycosides must be broken down to remove the hydrogen cyanide.

Process in Cyanide Detoxification

1. Peeling: Remove the cassava peel, which contains higher concentrations of cyanogenic glycosides.
2. Cutting and Grating: Cut or grate the cassava to increase the surface area for more efficient detoxification.
3. Water Soaking: Soak the cassava pieces in water for several hours to days. This process allows water-soluble cyanogenic glycosides to leach out.
4. Fermentation: Allow natural fermentation during soaking, which helps break down cyanogenic glycosides through microbial activity.
5. Sun Drying: Spread the soaked cassava pieces in the sun to dry. Drying further reduces the cyanogenic glycoside content through enzymatic activity and evaporation of HCN.
6. Cooking/Boiling: Boil the cassava pieces to hydrolyze any remaining cyanogenic glycosides and volatilize hydrogen cyanide.

The de-watering and fermentation stages

This is where the cyanide in the cassava mash is removed. The amount of water in the mash is reduced by the use of a hydraulic press. After that, the bags are left to drain and ferment for a few days before being used again. Fermentation involves the action of microorganisms like yeast, bacteria, and fungi that convert sugars into alcohol, acids, and other compounds. It also involves enzymes also play a crucial role in fermentation, catalysing reactions that break down sugars, proteins, and fats.

Fig. 15: *Image of de-watering and fermentation stages*

De-watering process

- **Granulating**: Cassava mash is mechanically reduced in size, resulting in fine granules with a higher surface area, also known as grits.
- **Gari frying**: To get a dry and crispy texture, the grits are roasted or fried in a hot frying tray or pan. Gari is typically white or cream in appearance, but it can be yellow if made with yellow cassava roots or fried in palm oil both of which are abundant in vitamin A and a good source of energy. After being roasted, they are stretched out on a high platform in the open air to cool and dry.
- **Sieving:** The Gari is sieved to remove coarse particles, and a standard-sized sieve is used to generate fine granules from the coarse particles once they have been separated. The big grains are broken down into smaller pieces with the help of a grinder.

The production of gari involves several stages, each influenced by scientific principles

- **Harvesting cassava roots:** Scientific principles of plant biology and physiology come into play during this stage, as enzymes within the cassava roots initiate biochemical reactions that degrade complex carbohydrates into simpler sugars.
- **Grating:** The cassava roots are washed and grated into a pulp. Physics principles of force and motion govern the grating process, as mechanical forces are applied to break down the cassava roots into smaller particles.
- **Fermentation:** The grated cassava pulp undergoes fermentation, where microorganisms such as lactic acid bacteria and yeast metabolise sugars present in the pulp. This fermentation process involves biochemical reactions mediated by enzymes, resulting in the production of organic acids and gases. The science of microbiology and biochemistry underlies this stage of gari production.
- **Dewatering:** The fermented cassava pulp is dewatered to remove excess moisture. Physics principles of gravity and filtration are employed in this stage, as gravitational forces aid in separating the solid gari granules from the liquid phase.
- **Roasting:** Physics principles of heat transfer govern the roasting process, as thermal energy is transferred from the roasting equipment to the gari granules, leading to the evaporation of residual moisture and Maillard reactions that contribute to the characteristic flavour and colour of gari.

Activities involved in preparing tubani

Tubani (*steamed black-eyed peas*)is a popular street food in Ghana made from beans and spices. Our northern family introduced it to Ghanaians. It is a very healthy meal high in protein. It is commonly eaten in the northern regions. It is a type of bean cake cooked by steaming; it is often served with a spicy pepper sauce or other condiments.

Step 1: Soak the Beans

- Begin by soaking 2 cups of black-eyed peas or cowpeas in water overnight. This will help to soften the beans and reduce the cooking time.

Step 2: Prepare the Batter

- Drain the soaked beans and transfer them to a blender or food processor. Add 1 medium-sized onion, 2-3 cloves of garlic, 1-2 fresh chilli peppers (optional), and a pinch of salt.
- Blend the mixture until it forms a smooth batter. You can add a little water if needed to achieve the desired consistency.

Step 3: Fermentation

- Transfer the batter to a large bowl and cover it loosely with a clean cloth or plastic wrap.
- Allow the batter to ferment for about 8-12 hours at room temperature. This fermentation process helps to enhance the flavour and texture of the tubani.

Step 4: Prepare the Steaming Setup

- While the batter is fermenting, set up the steaming apparatus. This can be a large pot with a steamer basket or a specialised steamer.
- Fill the pot with water, ensuring it does not touch the bottom of the steamer basket or the tubani mixture.

Step 5: Forming the Tubani

- After the fermentation period, stir the batter gently to incorporate any settled sediments.
- Take a clean banana leaf or aluminium foil and cut it into squares or rectangles (about 4-6 inches).
- Spoon a portion of the batter onto each leaf or foil, shaping it into a small ball or oblong shape.

Step 6: Steam the Tubani

- Carefully place the formed tubani onto the steamer basket, making sure they are not crowded to allow even cooking.
- Cover the pot with a lid and steam the tubani for approximately 30-45 minutes, or until they are firm and cooked through.

Step 7: Serve and Enjoy

- Once cooked, remove the tubani from the steamer and let them cool slightly.
- Unwrap the banana leaves or foil and serve the tubani warm or at room temperature.
- Tubani is often enjoyed as a snack or a breakfast dish in Ghana, and it pairs well with a spicy pepper sauce as shown in the picture below.

Fig. 16: *Image of Tubani*

Science processes involved in Tubani making

- Soaking fosters microbial growth, particularly lactic acid bacteria and yeast, pivotal for subsequent fermentation. Enzymatic activity breaks down complex carbohydrates and proteins, improving digestibility and flavour.
- **Grinding:** The cooled peanuts are ground into a fine paste using a grinding machine or a traditional mortar and pestle.
- **Fermentation:** Fermentation is a key step in tubani production, where microorganisms metabolise sugars and produce organic acids and gases. This process softens the beans, enhances flavour and improves digestibility.
- **Wrapping and Steaming**: Fresh leaves like banana leaves or plantain leaves are used to wrap the Tubani before the steaming process. The leaves are cleaned and dried before wrapping.
- **Cooling and Serving:** Physics principles of heat transfer and thermodynamics govern the cooling process, as heat dissipates from the hot tubani to the surrounding environment, reducing its temperature to a palatable level.

Learning Tasks

1. Level 1: List the processes involved in tubani processing.
2. Level 2: Explain the bean fermentation and steaming process.
3. Level 3: Explain any two science underlying (fermentation, sun drying, etc.) the named local food production stages.

Pedagogical Exemplars

Talk-for Learning

- Introduce learners to the traditional Ghanaian dish tubani and its cultural significance. Discuss the ingredients used and the traditional method of preparation.

Collaborative learning

- Put learners in mixed-ability groups and assign each group a specific aspect of tubani preparation to investigate, such as bean fermentation, steaming process, or flavour development.
- Place learners into mixed-ability and mixed-sex groups learning styles (where applicable.) Let the learners design an activity to prepare a named local food such as tubani.
- Engage learners in groups to create more activities to prepare a named local food within their communities.
- Encourage learners to do group or individual presentations about ideas generated.
- Allow learners, working in mixed- groups, to use the Internet, books, and journals to brainstorm and write a report on the science underlying (fermentation, sun drying, etc.) the local food production stages.

Key Assessment

Level 1: Identify one indigenous food in your community and its ingredients.

Level 2: Write down the activities involved in preparing your named local food\ dish.

Level 3: What activities will you consider when preparing local food?

WEEK 24

Learning Indicator: *Investigate the production of indigenous food to identify the science processes in the production stages.*

Theme or Focal Area: Science Processes in the Stages of Production of Kenkey

Overview

Kenkey is a popular staple food in Ghana. It consists of fermented and cooked maize dough, wrapped in leaves. Kenkey is a staple swallow food similar to sourdough dumplings from the Ga and Fante-inhabited regions. It is popularly known as kɔmi (pronounced kormi) by the Gas or dokono by the Akans in Ghana.

What is kenkey and how is it made?

Kenkey is one of the principal fermented foods made of ground white corn (maize). The steps involved in the production of kenkey are as follows:

The corn is soaked in water for about three days, making sure to change the water every day without sticking your fingers in the corn

Fig. 16: *Image of grain of maize*

Once the water has been drained from the dry corn, they are taken to a mill to be ground into the powdered form.

Fig. 17: *Image of Powdered form of the gain*

The corn flour is mixed with water and kept for some days to allow for fermentation. In between the fermenting, the dough may look yellowish on the top. Simply rinse it off gently with water.

Fermentation is a metabolic process through which microorganisms such as bacteria, yeast, or fungi convert carbohydrates (sugars and starches) into alcohol, gases, or organic acids under anaerobic conditions (absence of oxygen). It is a form of anaerobic respiration used by certain cells to generate energy in the absence of oxygen

Process of Fermentation

1. **Initiation**: Microorganisms are introduced to the substrate (e.g., yeast added to grape juice for wine).
2. **Lag Phase**: Microorganisms acclimate to their environment; minimal activity.
3. **Exponential Phase**: Rapid microbial growth and metabolism, converting sugars to fermentation products.
4. **Stationary Phase**: Nutrient depletion slows microbial growth; maximum product concentration achieved.
5. **Decline Phase**: Microorganisms die off as nutrients are exhausted and toxic byproducts accumulate.

Importance of fermentation

1. Fermentation extends the shelf life of perishable foods by producing alcohol, acids, and other compounds that inhibit the growth of spoilage organisms and pathogens.
2. Fermentation adds unique flavors and textures to foods and beverages, making them more enjoyable and diverse. For example, the tangy flavor of yogurt or the complexity of wine and beer.
3. Fermentation can increase the bioavailability of nutrients and produce beneficial compounds like vitamins, antioxidants, and probiotics that support health.
4. Fermented foods often contain live beneficial bacteria (probiotics) that can improve gut health and boost the immune system.
5. Fermentation has been a traditional method of food preservation and preparation across cultures for thousands of years, contributing to culinary diversity and cultural heritage.

Fig. 18: *Image of Corn flour mixed with water.*

Divide the dough into two parts once it is fermented. One part will be cooked and the other will be mixed with the cooked one. Water is then added to the raw part and some salt and then cooked.

Fig. 19: *Image of Corn flour mixed with water*

Fig. 20: *Image of 'Aflata'*

Once the dough is cooked, it is added to the raw dough. This cooked dough is called Aflata. Mix the Aflata with a wooden spoon to mix them to form a homogenous dough mixture.

Fig. 21: *Image of 'Aflata' mixed with dough*

Fig. 22: *Image of Mixing 'Aflata' with a wooden spoon*

The next step is to make small balls from the dough and then wrap them in the dried corn husks.

Fig. 23: *image of small balls from the dough*

Make sure to overlap the corn husks slightly until the entire ball is covered. Then twist the tops of the corn husks together and then tuck them into a ball.

Fig. 24: *Image of Moulded Kenkey*

Moulding of Kenkey into balls

Tuck the ends in and mould or squeeze the ball together to close any large holes and cover the twisted end. The wrapped dough packets are placed on a wire rack above water in a large pot and allowed to boil and steam for one to three hours, depending on their size and thickness.

Fig. 25: *Image of Cooking of kenkey (steamed kenkey)*

The final product, kenkey, is served with a sauce and any fish or meat dish.

Fig. 24: *Image of Kenkey served with fish and pepper*

Science processes involved in kenkey making

In local food production, several scientific processes come into play to ensure the safety, quality, and efficiency of the production process.

- **Drying**: The corn is dried to remove water from the corn to help in milling
- **Fermentation:** The rise of the corn dough as a result of the action of bacteria. The key scientific process in preparing kenkey is fermentation. Fermentation is a metabolic process in which microorganisms, such as bacteria and yeast convert carbohydrates into alcohol or organic acids. In the case of kenkey, the fermentation process is crucial as it imparts a unique flavour, texture, and sourness to the final product. The fermentation is facilitated by naturally occurring microorganisms present in the maize kernels, such as lactobacillus bacteria and wild yeast. Additionally, the production of organic acids such as lactic acid and acetic acid acts as natural preservatives, slowing down the growth of spoilage microorganisms and extending the shelf life of the kenkey.
- **Amylase Activity:** Maize contains starch, a complex carbohydrate made up of glucose molecules. During the fermentation process, natural enzymes present in the maize, such as amylase, break down the starch into simpler sugars, primarily glucose. These simpler sugars are then consumed by the microorganisms during fermentation, resulting in the production of lactic acid and carbon dioxide.
- **pH Regulation:** The fermentation process in kenkey involves the production of lactic acid by the beneficial bacteria. The lactic acid lowers the pH of the dough, creating an acidic environment. This low pH inhibits the growth of harmful bacteria and preserves the kenkey. The acidic environment also helps improve the digestibility and nutrient availability of the maize.
- **Gas Production:** As the microorganisms consume the sugars in the maize dough during fermentation, they produce carbon dioxide gas. This gas gets trapped within the dough, causing it to rise and become lighter and more porous. The gas production contributes to the characteristic texture and volume of kenkey.
- **Heating/ Boiling:** Heat is used to change moulded corn dough into the final product for consumption.
- **Heat Denaturation**: After the fermentation process, kenkey is traditionally cooked by steaming or boiling. During the cooking process, heat denatures the proteins present in the maize dough, resulting in structural changes that contribute to the firmness and texture of the final product.

Learning Tasks

1. What are the main ingredients used in making kenkey?
2. Describe the traditional methods of preparing kenkey.
3. How is the corn dough prepared for making kenkey?
4. What is the role of fermentation in the kenkey preparation process?
5. Explain the significance of wrapping the fermented dough using corn husk.

Pedagogical Exemplars

Field trip

- Organise a visit or field trip to local kenkey-making facilities where learners can observe the production process firsthand. Learners will then reflect and make presentations on what they learnt during the field trip.

- Allow learners, working in mixed-ability groups, let them search the Internet, books, journals, think-pair-share, and write a report on the science processes (fermentation, sun drying, etc.) in the stages of production of the local food such as kenkey.

Research-based learning

- Research the different approaches to making kenkey in Ghana and other places.

Key Assessment

Level 1: Write down the science processes involved in kenkey production.

Level 2: What is the importance of washing the corn before grinding it for kenkey?

Level 3: How long does the fermentation process typically take, and what factors can affect it?

Section Review

These lessons were structured to provide a holistic learning experience. It focuses on helping learners to know the scientific procedures involved in each stage of production of local soap and kenkey in the community through experimentation to develop different types. Learners will be able to identify the physics and chemistry concepts that cause emulsification, fragrance incorporation, and saponification. Similar to this, scientific procedures such as fermentation and heat-induced chemical reactions are crucial to the various stages of kenkey manufacture. To maximise soap production, scientific methods, including experimentation, analysis, and observation, will also be used. These activities provide interdisciplinary links that facilitate integration with language arts, mathematics, social studies, biology, chemistry, and physics. For instance, in mathematics, students can calculate ingredient proportions and measure mixing times accurately.

Additional reading

1. Research the different approaches to making kenkey in Ghana and other places.

Resources

1. Curriculum
2. Books
3. Camera.
4. Checklist of science processes involved in processing local food.
5. Voice recording device.
6. Journal from a field trip.

References

1. Internet sources (https://www.youtube.com/watch?v=1MtzyxQiqKo, https://www.youtube.com/watch?v=Kc7duzDEa6Y)
2. Draft curriculum pg. 32-35
3. Amy; Ofori, Hayford; Anyebuno, George Anabila; Amoo-Gyasi, Michael; Amoa-Awua, Wisdom Kofi (2015). “Safety of a street vended traditional maize beverage, ice-kenkey, in Ghana”. Food Control. 55: 200–205.

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