New Normal Curriculum
Instructional Guide

Physics

Class IX

Royal Education Council

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Foreword

The overriding aspiration of Bhutanese education, including science education, is drawn from the principles and the philosophical foundations of Gross National Happiness (GNH). From a curricular point of view, Bhutanese science education is informed, in part, by the underlying assumptions of 21st century educational paradigm. Historically, Bhutanese science education witnessed several episodes of changes, including the refinement of, and changes to, theories, ideas, and beliefs over time. Therefore, the current context of Bhutanese science education is shaped by several rounds of initiatives undertaken over the past several decades.

Bhutanese science education began its saga with the foreign borrowed science curriculum. By the early 1980s, the Royal Government of Bhutan (RGoB), however, tailored science curriculum based on the national narratives of Bhutan. This was piqued by a new educational vision set forth by New Approach to Primary Education (NAPE). Since then, the standard-based science curriculum served its purpose in fulfilling the both national goals and subject-specific aspirations for several decades.

Conversely, in light of the changing dynamics of the 21st century, states around the world experienced a plethora of unprecedented real-world problems. Correspondingly, education systems around the world, including Bhutan, called for dramatic change in educational vision, especially from standard-based science curriculum to competency-based science curriculum. Therefore, the New Normal Curriculum in Science (NNCS), including life sciences today underpins steadfast beliefs of providing life-long or competency-based learning experiences. As it stands, the NNC in life sciences largely aspires in transforming science education from traditional didactic approaches to contemporary approaches of learning by doing.

At the core, NNC in life sciences speaks more from the tone of integrative approach to science, technology, engineering, and mathematics (STEM) education. Indeed, most of its curricular intentions entail situating both content and instructional practices in authentic contexts, connected to real-world situations, or address contemporary issues. Therefore, under the auspices of NNC in life sciences, most of the classroom instructional practices in science are expected to be both performance tasks and performance-based assessment, partly or wholly, propelled by the spirit of scientific inquiry and engineering design process.

Overall, I am confident that this instructional guide will help our science teachers and learners in realising curricular intentions of NNC in life sciences. It is expected that it inspires both teachers and learners in learning science by actively engaging in the practices of science or STEM at large. Consequently, the concepts, skills, and values acquired would help our learners achieve the full development of science or STEM proficiency.

Tashi Delek

(Kinga Dakpa)
Director General

Acknowledgments

The Royal Education Council (REC), Paro extends earnest gratitude to all the educationists, educators, and relevant professionals who extended invaluable insights in the production of this instructional guide.

Our sincere thanks also goes to schools, Dzongkhag education office, and relevant agencies from MoE for their unfeigned cooperation and support rendered in the production process of this instructional guide. REC sincerely acknowledges that the participation of teachers and professionals would not have been possible without your continued support and cooperation.

The REC also genuinely acknowledges the retrieval and use of contents and resources, either in part or whole, from relevant websites and other forms of sources. Moreover, the REC reassures that these resources will exclusively be used for the educational or learning purposes.

Weighting and Time Allocation

Theme	Topics	Time in Minutes	Weighting
Newtonian Mechanics	Force and Acceleration	465	13
	Newton's Law of Motion	348	10
Fluid Mechanics and Thermal Physics	Pressure in Fluids	332	10
	Buoyant Force	465	13
	Temperature and Heat	498	12
Electricity and Magnetism	Electric Charge	316	8
	Electromagnetism	348	10
Waves and Optics	Ray Optics	332	8
	Waves	248	8
Space Physics	The Moon	248	8
Total		**3600**	**100**

**The total time required to complete the topics is 3600 minutes or 90 periods of 40 minutes in a period.*

Table of Contents

1. Newtonian Mechanics

Competencies:

- Analyse and communicate the inferences of motion graphs by using mathematics and Computer Assisted Instruction (CAI) tools and apps to understand the nature of motion through graphical representation.
- Experiment and use the concept of laws of motion to explain the applications of these laws on real-life situations.
- Carry out scientific investigation to substantiate the mathematical relationship among the net force, mass, and acceleration to predict the motion of an object.
- Use natural phenomena and modern technology to construct a clear concept of effects of forces in opposite directions and relate them to everyday life.

1.1. Force and Acceleration

1.1.1 Graphical Representation of Distance-Time Graph. *(Scope: representation and interpretation of speed, velocity and acceleration from distance-time graph and velocity-time graph).*

Objective(s): i. Illustrate distance-time graph and velocity-time graph manually and using CAI tools.

Learning Experiences

Contact: The teacher may carry out the instructional practices in the following sequence of 5E model (engage, explore, explain, elaborate, and evaluate). The teacher may introduce the concept of speed and velocity, distance-time graph, velocity-time graph, and provide hypothetical data to deliver the lesson as follows:

- The learner engages in the reflection of what they know and recognises what they don't yet understand regarding the concept.
- The learner explores the distance-time graph by carrying out practical demonstrations or using hypothetical data provided by the teacher.
- The learner plots graphs using graph paper and CAI tools to explain distance-time graphs.
- The learner elaborates on the concept of distance-time graph to construct and explain velocity-time graphs using available data.
- The learner shares their work for feedback and validation by peers and the teacher to draw generalisation on the concepts.

Non-contact: The teacher may provide the links https://youtu.be/Xo3KBoEMDEo, https://youtu.be/apewLkLAR-U, https://youtu.be/vxFYfumAAlY, and https://youtu.be/-FF7OghWGiE and share worksheet and activities on distance-time graphs and velocity-time graphs through Collaborative Learning Technologies (CLT).

- The learner watches the video from the links https://youtu.be/Xo3KBoEMDEo, https://youtu.be/apewLkLAR-U, https://youtu.be/vxFYfumAAlY, and https://youtu.be/-FF7OghWGiE and makes notes of the key points.
- The learner plots graphs using graph paper and CAI tools to study distance-time graphs and velocity-time graphs based on the information gathered from the videos or from the data provided by the teacher in the worksheet.
- The learner completes the worksheet and explains the concept of velocity and acceleration.

- The learner uploads the work through CLT.

Assessment:
Contact: The teacher may assess the learner's ability to comprehend the concept of speed, velocity, and acceleration from the graphs using a checklist. The teacher may assess the learner's skills to record data, plot graphs (manually and using CAI tools), interpret the concept of velocity and acceleration from the graph, and relate the concept to daily experiences using a rubric. The teacher may provide necessary intervention to the learner based on the need.

Non-contact: The teacher may assess the learner's ability to comprehend the concept of speed, velocity, and acceleration from the graphs using a set of questions developed and shared through CLT. The teacher may assess the learner's skills to record data, plot graphs (manually and using CAI tools), interpret the concept of velocity and acceleration from the graph, and relate the concept to daily experiences using a rubric. The teacher may provide necessary intervention to the learner based on need.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/Xo3KBoEMDEo
- https://youtu.be/apewLkLAR-U
- https://youtu.be/vxFYfumAAlY
- https://youtu.be/-FF7OghWGiE

1.1.2 Balanced and Unbalanced Force. *(Scope: resultant force due to balanced and unbalanced force to determine the state of a body).*

Objective(s): ii. Describe the effects of balanced and unbalanced force to determine the state of a body.

Learning Experiences:
Contact: The teacher may deliver the lesson in the following order of activity. The teacher may provide the worksheet to note down the effects of balanced and unbalanced force based on the data collected from the simulation link https://bit.ly/3tnNGvp .

- The learner varies the forces to see the effect of balanced and unbalanced force from the simulation link https://bit.ly/3tnNGvp .
- The learner records the forces in use, initial state of a body, the net force, and final state of a body in the worksheet.
- The learner infers the effects of balanced and unbalanced force based on the information gathered and relates the concept to the real life situations.

Non-contact: The teacher may prepare a video lesson using simulation or provide the simulation link https://bit.ly/3tnNGvp along with the worksheet on balanced and unbalanced force and upload through CLT.

- The learner varies the forces to see the effect of balanced and unbalanced force from the simulation link https://bit.ly/3tnNGvp .
- The learner records the forces in use, initial state of a body, the net force, and final state of a body in the worksheet.
- The learner infers the effects of balanced and unbalanced force based on the information gathered and relates the concept to the real life situations.
- The learner submits the completed worksheet through CLT.

Assessment:
Contact: The teacher may assess the learner's ability to explain the concept and effect of balanced and unbalanced force, record data, calculate the resultant force, draw inferences, and relate the concept to daily experiences using a rubric. The teacher may provide necessary intervention to the learner based on need.

Non-contact: The teacher may assess the learner's ability to explain the concept and effect of balanced and unbalanced force, record data, calculate the resultant force, draw inferences, and relate the concept to daily experiences using a rubric from the work submitted through CLT. The teacher may provide necessary intervention to the learner based on need.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://bit.ly/3tnNGvp

1.1.3 Momentum of a Body. *(Scope: explanation, mathematical expression, simple numerical problem, and applications).*

Objective(s): iii. Investigate variables that describe the momentum.

Learning Experiences:
Contact: The teacher may carry out the instructional practices on momentum and its variables based on the following order of CER (claim, evidence and reasoning) model. The teacher may set the tone to create a claim by the learner with question(s) or example(s) after conducting a demonstration of momentum using available materials.

- Based on the teacher's demonstration, the learner makes a claim on the variables used to describe momentum.
- The learner performs the experiment using available materials to gather the evidence to validate their claim.
- The learner justifies their claim with the evidence based on mass and velocity, and solves related numerical problems.
- The learner relates and explains its applications in real life situations.

Non-contact: The teacher may upload the link https://youtu.be/0zxTIn67q3Y on the momentum and variables used to describe the momentum through CLT. The teacher may set the tone to create

a claim by the learner with question(s) or example(s) and instruct the learner to gather evidence to support the claim.

- The learner explores the concept of momentum from the link https://youtu.be/0zxTIn67q3Y and derives the required mathematical expression.
- The learner makes a claim on the variables used to describe momentum based on the mathematical expression.
- Based on the teacher's instruction, the learner gathers evidence by performing experiments using available resources to validate the claim. *(Follow safety precautions while performing the experiment).*
- The learner justifies their claim with the evidence based on mass and velocity, and solves related numerical problems.
- The learner relates and explains its applications in real life situations and uploads their work through CLT.

Assessment:

Contact: The teacher may assess the ability of the learner to identify and explain the variables that describe momentum, solve related numerical problems, and relate its real life applications using a checklist. The teacher may assess a learner's ability to follow instruction, gather relevant evidence, and communicate reasons using a rubric. The teacher may provide intervention based on need.

Non-contact: The teacher may assess the ability of the learner to identify and explain the variables that describe momentum, solve related numerical problems, and relate its real life applications using a checklist. The teacher may assess the learner's ability to follow instruction, gather relevant evidence, and communicate reasons using a rubric. The teacher may provide intervention based on need.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/0zxTIn67q3Y

1.1.4 Equations of Linear Motion. *(Scope: linear motion equations and simple numerical problems).*

Objective(s): iv. Apply three equations of linear motion to solve simple numerical problems related to real life experiences.

Learning Experiences:

Contact: The teacher may introduce the variables used in the equations and carry out the instructional practices on equations of linear motion. The teacher may provide questions based on the three equations of motion and facilitate the learner to apply those equations in solving real life situations.

- The learner notes the equations and solves the questions along with the teacher.
- The learner solves the questions provided by the teacher and submits for the assessment.

Non-contact:The teacher may prepare a video lesson on the application of equations of linear motion or may provide the links https://youtu.be/GX5zToM_Vvg and https://youtu.be/WJN_F3PYp58 and upload through CLT.

- The learner watches the videos and explains the variables used in the equations.
- The learner solves the questions provided by the teacher based on the examples given in the videos.
- The learner solves the questions provided by the teacher and submits through CLT.

Assessment:

Contact: The teacher may use a rubric to assess problem solving skills, critical thinking, accuracy of the work, ability to complete the work, and relate the significance of the equations of linear motion in daily activities.

Non-contact: The teacher may use a rubric to assess problem solving skills, critical thinking, accuracy of the work, ability to complete the work, and relate the significance of the equations of linear motion in daily activities submitted through CLT.

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Resources

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/GX5zToM_Vvg
- https://youtu.be/WJN_F3PYp58

1.1.5 Newton's First Law of Motion. *(Scope: inertia of rest and motion, and applications).*

Objective(s): v. Apply the concept of Newton's first law of motion to design a simple model that explains the benefits of wearing a seat belt.

Learning Experiences:

Contact: The teacher may introduce the lesson on inertia, types of inertia, and the law of inertia to familiarise the learner with the terminologies and foundational concepts. The teacher may design an activity and instruct the learner to carry out the investigation to exhibit the applications of inertia of rest and motion in the following order of POGIL (process-oriented guided inquiry learning) approach.

- The learner familiarises the basic concepts and terminologies to explain the law of inertia through a group discussion.
- The learner uses everyday examples related to rest and motion to explore the applications of the law of inertia.
- The learner gathers information to design a simple model that explains the benefit of wearing a seat belt while travelling in a car.
- The learner shares their generalisation based on the model to the class and relates the significance of the law of inertia in daily life.

Non-contact: The teacher may deliver the lesson (recorded video or presentation) on inertia, types of inertia, and the law of inertia to familiarise the learner with the terminologies and foundational

concepts through CLT or upload the links https://youtu.be/1XSyyjcEHo0 and https://youtu.be/5oi5j11FkQg. The teacher may design an activity or instruct the learner to carry out the investigation on the application of law of inertia in the following manner of POGIL (process-oriented guided inquiry learning) approach. The teacher may instruct the learner to improvise a simple model to explain the benefits of wearing a seat belt.

- The learner explains the basic concepts and terminologies to describe the law of inertia from the lesson shared by the teacher or from the links https://youtu.be/1XSyyjcEHo0 and https://youtu.be/5oi5j11FkQg.
- The learner uses everyday examples related to rest and motion to explore the applications of the law of inertia.
- The learner improvises a simple model to explain the benefits of wearing a seat belt while travelling in a car.
- The learner shares their generalisation based on the model, relates the significance of the law of inertia in daily life and submits it through CLT.

Assessment:

Contact: The teacher may assess the learner's ability to identify and explain applications of the law of inertia, follow instructions, improvise the model, incorporate feedback, and relate the significance of the law of inertia in daily life using a rubric. The teacher may intervene whenever necessary.

Non-contact: The teacher may assess the learner's work submitted through CLT on the ability to identify applications of the law of inertia, follow instructions, use the improvised model to explain the application of the law of inertia, incorporate feedback, and relate the significance of the law of inertia in daily life using a rubric. The teacher may intervene whenever necessary.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/1XSyyjcEHo0
- https://youtu.be/5oi5j11FkQg

1.1.6 Kinematic Equations for Constant Acceleration to Analyse the Motion of Objects. *(Scope: relation among force, mass and acceleration, simple numerical problems).*

Objective(s): vi. Conduct an investigation to support the claim that Newton's second law of motion describes the mathematical relationship among the net force, mass, and acceleration.

Learning Experiences:

Contact:The teacher may use a confirmation inquiry model to deliver the lesson on Newton's second law of motion. The teacher may ask the guiding question related to force, mass, and acceleration. The teacher may provide the learner with relevant materials, procedures to carry out the experiment, numerical problems, and guide the learner through learning experiences.

- The learner explores information on the question from relevant resources (book, handouts, internet, etc.).
- The learner carries out the experiment as per the teacher's instruction using relevant materials.
- The learner collects and analyses data to draw a relationship between the net force, mass, and acceleration.
- The learner constructs a mathematical relation and uses it to solve given numerical problems.

Non-contact: The teacher may record a video on the concept of Newton's second law of motion or upload the video link https://youtu.be/vaz8J5jBSQQ or any other relevant resources on CLT. The teacher may instruct the learner to use the simulation link https://bit.ly/3qOM2BB to verify Newton's second law of motion and complete the worksheet provided using CLT.

- The learner explores information on Newton's second law of motion from the video uploaded by the teacher or from the link https://youtu.be/vaz8J5jBSQQ or any relevant resources.
- The learner performs the experiment using the simulation link https://bit.ly/3qOM2BB, and draws relationships among force, mass, and acceleration.
- The learner completes a worksheet and related numerical problems and submit the work through CLT.

Assessment:

Contact: The teacher may use a rubric to assess the learner's ability to explain the concept of Newton's second law of motion, carry out an experiment, draw inferences, solve numerical problems, and relate applications in daily life. The teacher may provide necessary feedback and intervention based on need.

Non-contact: The teacher may use a rubric to assess the learner's ability to explain the concept of Newton's second law of motion, draw inferences on the law, solve numerical problems, and relate applications in daily life using a worksheet submitted through CLT. The teacher may provide necessary feedback and intervention based on need.

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Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/vaz8J5jBSQQ
- https://bit.ly/3qOM2BB

1.1.7 Newton's Third Law of Motion. *(Scope: qualitative explanation and applications.)*

Objective(s):

vii. Design a model to demonstrate and relate the concept of Newton's third law of motion to real life situations.

Learning Experiences:

Contact: The teacher may use a three phase guided learning cycle (exploration phase, concept invention phase and application phase) to deliver the lesson on the explanations and applications of Newton's third law of motion. The teacher may guide the learner to plan and design a working model to demonstrate Newton's third law of motion (eg. a d.c. motor driven boat).

- The learner explores the information related to Newton's third law of motion from any relevant sources or daily experiences.
- The learner plans and designs a working model to demonstrate Newton's third law of motion.
- The learner demonstrates the working of the model to verify Newton's third law of motion.
- The learner uses two identical spring balances to verify and validate the existence of equal and opposite forces.
- The learner explains Newton's third law of motion based on evidence gathered and relates the concept to real life situations.

Non-contact: The teacher may upload the video link https://youtu.be/y61_VPKH2B4 to explain the concept and application of Newton's third law of motion. The teacher may instruct the learner to explore and prepare an interactive conceptual model to demonstrate the law.

- The learner explores the information related to Newton's third law of motion from the link https://youtu.be/y61_VPKH2B4.
- The learner gathers information to design a conceptual model or working model that demonstrates Newton's third law of motion.
- The learner explains Newton's third law of motion based on evidence gathered and relates the concept to real life situations.
- The learner submits the work through CLT.

Assessment:

Contact: The teacher may use a rubric to assess the scientific skills (observation, questioning, gathering evidence, designing model, drawing inferences) of the learner through observation. The teacher may assess the ability of the learner to explain Newton's third law, applications of the law, and relate the significance of the law in daily life. The teacher may support the learner with necessary feedback and intervention.

Non-contact: The teacher may use a rubric to assess the scientific skills (observation, questioning, gathering evidence, designing model, drawing inferences) of the learner through observation. The teacher may assess the ability of the learner to explain Newton's third law, applications of the law, and relate the significance of the law in daily life from the work submitted through CLT. The teacher may support the learner with necessary feedback and intervention.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/y61_VPKH2B4

2. Fluid Mechanics and Thermal Physics

Competencies:

- Experiment and communicate the results of fluid pressure to relate its applications in mechanical and fluid engineering.
- Elucidate phenomena based on the result of an investigation on Archimedes' principle and relative density to comprehend the working of devices and machines such as hydrometer, lactometer, submarine and ship etc. and design any model based on Archimedes' principle.
- Measure the temperature of the bodies in different scales and convert it from one scale to another scale to understand relationships among various temperature measuring scales.
- Carry out an experiment to investigate the mode of transfer of thermal energy (heat) to apply the concept in designing heat efficient devices.
- Illustrate the latent heat of fusion and vaporization through experimentation and be able to relate to the natural phenomena.
- Analyse and compare the specific heat capacity of substances to make the right choice of materials for specific purposes such as high specific heat capacity material as coolant and low specific heat capacity material as utensils.
- Describe and apply the conceptual understanding of thermal expansion of matter in designing devices like thermometers and infrastructures.

2.1. Pressure in Fluid

2.1.1 Pressure Inside a Liquid. *(Scope: laws of liquid pressure, derivation of mathematical expression, and applications in daily life).*

2.1.2 Atmospheric Pressure and Weather Forecasting.

Objective(s): i. Conduct an experiment to verify the laws of liquid pressure and derive mathematical expression to relate its application in daily life.

ii. Evaluate the variation of atmospheric pressure to forecast weather.

Learning Experiences:

Contact: The teacher may use the instructional practices on the fluid pressure by introducing the concept related to pressure. The teacher may provide the interactive simulation link https://bit.ly/2Q3ugxM to engage the learner and use the 5E model as follows.

- The learner uses the interactive simulation link https://bit.ly/2Q3ugxM and engages in the demonstration.
- The learner explores the methods to investigate pressure inside a liquid, use available materials to carry out the experiment, and conduct the investigation.
- Based on the information gathered from the simulation and experiment, the learner explains the laws of liquid pressure.
- The learner derives the mathematical expression for fluid pressure, solves related numerical problems, and relates its application in daily life (eg. variation of atmospheric pressure to forecast weather).

- The learner reflects and incorporates feedback given by the teacher and peers to evaluate their understanding of the concepts and its application.

Non-contact: The teacher may prepare a presentation on the concept of fluid pressure, laws of liquid pressure, atmospheric pressure, numerical problems, and upload it through CLT.

- The learner prepares notes based on the information provided by the teacher.
- The learner explores the factors affecting fluid pressure from the link https://bit.ly/2Q3ugxM .
- Based on the teacher's presentation and the simulation, the learner explains the laws of liquid pressure.
- The learner solves related numerical problems, relates its application in daily life, and submit through CLT.

Assessment:

Contact: The teacher may assess the conceptual understanding of the fluid pressure, laws of liquid pressure, atmospheric pressure, and applications of pressure due to fluid using a checklist. The teacher may use observation form to assess the ability of a learner to explore, organise ideas, carry out investigation, derive expression, solve numerical problems, and elaborate the significance of fluid pressure in daily life. The teacher may provide necessary intervention based on need.

Non-contact: The teacher may assess the learner's conceptual understanding of the topic, the ability of the learner to draw conclusions from the simulation, and elaborate the significance of the concept in everyday experiences using a checklist from the work submitted through CLT. The teacher may provide necessary intervention based on need.

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Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://bit.ly/2Q3ugxM

2.2.Buoyant Force

2.2.1. Upthrust. *(Scope: derivation and calculation of upthrust).*

2.2.2. Archimedes' Principle. *(Scope: verification of Archimedes' principle, Calculation of relative density and its applications).*

Objective(s):

iii. Verify Archimedes' principle to compute buoyant force, relative density and volume of irregular shaped objects through experimentation or simulation.

Learning Experiences:

Contact: The teacher may deliver the lesson on Archimedes' principle and related concepts using a confirmation inquiry cycle. The teacher may provide the question, procedures to carry out the experiment, and related numerical problems.

- Based on the question provided by the teacher, the learner brainstorms on Archimedes' principle and related concepts.

- The learner gathers materials and carries out the experiment by following the procedures.
- The learner collects and analyses data, and draws a conclusion to verify the laws.
- The learner shares the findings, solves the numerical problems, and recognises the significance of the laws in daily experiences.

Non-contact:The teacher may prepare a video lesson or Powerpoint lesson to deliver the lesson on concepts of upthrust, Archimedes' principle, and relative density or use the links https://youtu.be/khc2wUBsFU4, https://youtu.be/05WkCPORlj4, https://youtu.be/Nf8js4AYOHM, and https://youtu.be/omRMpPYh_vw to let the learner verify the Archimedes' principle and apply its concept to in the calculation of the upthrust and relative densities of the solid and liquids. The teacher may provide the simulation link https://bit.ly/3qNX8Xw to supplement the concept and verify the principle. The teacher may upload the links and related activities on CLT.

- The learner explores information on the relation to calculate upthrust, Archimedes' principle, relative density of solid, and relative density of liquids from the lesson provided by the teacher or through any other relevant sources.
- The learner uses simulation to verify archimedes' principle, calculates the upthrust and relative densities of the irregular shaped objects following the instructions provided by the teacher through CLT.
- The learner solves related numerical problems and submits the works through CLT.

Assessment:

Contact: The teacher may assess the learner's conceptual understanding of the principle, the ability of the learner to follow instructions to carry out the experiment, verify the principle, solve numerical problems, and relate the significance of the principle and related concepts in daily life using a rubric. The teacher may provide necessary intervention based on need.

Non-contact: The teacher may assess the learner's conceptual understanding of principle, the ability of the learner to follow instructions, draw conclusions, solve numerical problems, and report the finding using a rubric from the work submitted through CLT. The teacher may provide necessary intervention based on need.

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Resources:

- REC repository
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/khc2wUBsFU4
- https://youtu.be/Nf8js4AYOHM
- https://youtu.be/05WkCPORlj4
- https://youtu.be/omRMpPYh_vw
- https://bit.ly/3qNX8Xw

2.2.3. Floating Bodies.

2.2.4. Applications of Principle of Floatation in Everyday Life.

Objective(s): iv. Design a device to explain the principle of floatation and its application in real life situations.

Learning Experiences:
Contact: The teacher may guide the learner through the process of POGIL on the principle of floatation by initiating group discussion on the foundational concepts of floating bodies, principle of floatation, and hydrometer.

- The learner discusses the foundational concepts of floating bodies, principle of floatation, and hydrometer in group using relevant sources (the internet, books, handouts, downloaded digital content, etc.).
- The learner explores the conditions for floatation based on the information gathered from relevant sources, and draws patterns and relations.
- The learner designs a model of a suit to float in water based on the conditions necessary for floatation.
- The learner shares their generalisation on the principle of floatation to the class and relates the applications of floatation in everyday life.

Non-contact: The teacher may deliver the lesson on the foundational concepts of floating bodies, principle of floatation, and hydrometer by preparing a presentation or handouts, and share it through CLT. The teacher may provide instructions for the learner to explore, design and recognise the applications of the principle of floatation in everyday life.

- The learner explains the basic concepts and terminologies used to describe the principle of floatation and its conditions based on the information shared by the teacher.
- The learner gathers additional information on the application of floatation, and designs a suit (physical or conceptual) to float in water.
- The learner shares their model on applications of floatation in everyday life in any social media.
- The learner incorporates the feedback shared by the viewers and submits it through CLT.

Assessment:
Contact: The teacher may assess the learner's ability to explain the conditions for floating bodies, identify applications of floatation, comprehensiveness of the model, and relate the significance of the principle of floatation in daily life using a rubric. The teacher may intervene whenever necessary and provide required support.

Non-contact: The teacher may assess the learner's work submitted through CLT on the ability to explain the conditions for floating bodies, identify applications of floatation, comprehensiveness of the model, incorporate feedback, and relate the significance of the principle of floatation in daily life using a rubric. The teacher may provide feedback and suggestions whenever necessary.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).

2.3. Heat and Temperature

2.3.1. Measurement of Temperature. *(Scope: temperature scales; Celsius, Fahrenheit and Kelvin scales, conversion of temperature from one scale to another, absolute zero).*

Objective(s): vi. Measure and convert the temperature of bodies from one scale to another scale.

Learning Experiences:
Contact: The teacher may deliver the lesson on the different types of temperature scales, absolute zero, and conversion of temperature from one scale to the other in the following order of activities.

- The learner explores the lower and the upper fix point of the Celsius, Fahrenheit and Kelvin scales.
- The learner deduces the mathematical relation between the two scales (Celsius and Fahrenheit, Celsius and Kelvin).
- The learner measures the temperature of a material (eg. warm water) using Celsius and Fahrenheit thermometer simultaneously.
- The learner uses any one of the measured temperatures and converts to the other scale using the mathematical relation to validate the relation.
- The learner solves related numerical problems to apply the mathematical relation between Celsius and Kelvin scales.

Non-contact: The teacher may upload the video link https://youtu.be/4cM0ollAhKM, numerical problems related to temperature conversion, and instruction through CLT.

- The learner explores the lower and the upper fix point of the Celsius, Fahrenheit, Kelvin scales, and absolute zero.
- The learner deduces the mathematical relation between the two scales (Celsius and Fahrenheit, Celsius and Kelvin).
- The learner solves related numerical problems to apply the mathematical relation and submit through CLT.

Assessment:
Contact: The teacher may assess the learner's ability to identify and explain the applications of the three different temperature scales, convert the temperature from one scale to another scale, and define absolute zero using a rubric. The teacher may intervene based on need.

Non-contact: The teacher may assess the learner's ability to identify and explain the applications of the three different temperature scales, convert the temperature from one scale to another scale, and define absolute zero using a rubric from the work submitted through CLT. The teacher may intervene based on need.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/4cM0ollAhKM

2.3.2. Thermal Energy. *(Scope: explain the term thermal energy, modes of thermal energy transfer, thermal equilibrium, and the zeroth law of thermodynamics).*

2.3.3. Thermal Insulation. *(Scope: applications of thermal insulation).*

Objective(s): vii. Design a device to minimise the transfer of thermal energy to explain the concept of thermal insulation.

Learning Experiences:
Contact: The teacher may use design thinking (empathise, define, ideate, prototype, test) to design a device to minimise the transfer of thermal energy.

- The learner explores the concept of thermal energy, mode of transfer of thermal energy, thermal equilibrium, and zeroth law of thermodynamics from any relevant sources.
- The learner empathises the energy sustainability based on the current pattern of energy use.
- The learner defines the factors affecting the rate of thermal energy consumption and its dissipation.
- The learner in the group generates the idea to develop a model of thermal energy saving device to sustain the thermal energy.
- Based on the ideas generated, the learner develops a prototype in the group.
- The learner tests the prototype and explains how it would minimise the transfer of thermal energy.
- The learner shares the generalisation derived from the prototype and relates the application of thermal insulation in daily life.
- The learner designs awareness programs on the significance of thermal insulation and energy saving devices using any programming languages.

Non-contact: The teacher may prepare a video lesson or PowerPoint lesson to explain the concept of thermal energy, mode of transfer of thermal energy, thermal equilibrium and zeroth law of thermodynamics and share the link https://youtu.be/qcodqXaiczE to supplement the information in the CLT.

- The learner explores the information on the concept from the video or the PowerPoint lesson, and the link https://youtu.be/qcodqXaiczE.
- The learner designs a conceptual prototype (illustration, 2D model, 3D model, etc.,) to explain the concept of thermal insulation.
- The learner shares their prototype in any social media and incorporates feedback.
- The learner recognises the significance of thermal insulation and submits a write-up explaining the working of the prototype through CLT.

Assessment:

Contact: The teacher may use a rubric to assess the concept of thermal energy, comprehensiveness of the model or the prototype, and the values (Environmental, economic and social) of saving thermal energy. The teacher may intervene based on need.

Non-contact: The teacher may develop the questions in Google Form to assess the conceptual understanding of the thermal energy, comprehensiveness of the prototype and the value of saving thermal energy from the work submitted through CLT. The teacher may intervene based on need.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/qcodqXaiczE

2.3.4. Specific Heat Capacity. *(Scope: compare specific heat capacity and its application).*

Objective(s): viii. Conduct an experiment to compare specific heat capacity of different substances to select the substances for specific purposes.

Learning Experiences:

Contact: The teacher may carry out the instructional practices on specific heat capacity and its application by using open inquiry in the following order. The teacher may provide numerical problems based on the concept.

- Based on the teacher's input, the learner explains the foundational concepts on specific heat capacity and its applications, and frame question(s) and hypothesis.
- The learner gathers information from relevant resources to plan and investigate the specific heat capacity of different substances.
- The learner collects and analyses data to draw conclusions on specific heat capacity of different substances.
- The learner communicates the results and generalises the applications of specific heat capacity of different substances for specific purposes.
- The learner solves the numerical problems using appropriate formulae and variables.

Non-contact: The teacher may share the video links https://youtu.be/5we65e7EOcg and https://youtu.be/TqJFIBODrjM on specific heat capacity and its calculation through CLT. The teacher may assign some questions and numericals based on the concepts through CLT.

- The learner gathers information from the video and makes notes of the mathematical relationship to calculate the specific heat capacity and the concepts related to specific heat capacity.
- The learner solves the numerical problems assigned by the teacher, and answers questions related to the application of specific heat capacity of different substances from the information gathered from the videos https://youtu.be/5we65e7EOcg and https://youtu.be/TqJFIBODrjM or from any other relevant sources.
- The learner submits the work through CLT for the assessment.

Assessment:

Contact: The teacher may use a checklist to assess the ability of the learner to explain the concept of specific heat capacity, applications of specific heat capacity of different substances, and solve related numerical problems. The teacher may assess the ability of the learner to be inquisitive, follow instruction, collaborate, present findings, and recognize the significance of specific heat capacity of different substances using a rubric. The teacher may provide necessary intervention based on need.

Non-contact: The teacher may design a worksheet on the concept of specific heat capacity, application of specific heat capacity of different substances, solve numerical problems, and relate the significance of specific heat capacity of different substances in daily life. The teacher may provide necessary intervention based on need.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/5we65e7EOcg
- https://youtu.be/TqJFIBODrjM

2.3.5. Latent Heat. *(Scope: latent heat of fusion, explain latent heat of vaporization and its effects).*

Objective(s):

ix. Illustrate the latent heat of fusion and vaporization through experimentation to relate its application to the natural phenomena.

Learning Experiences:

Contact: The teacher may use the 5E model to deliver the lesson on the concept of latent heat of fusion of ice and latent heat of vaporization of water as follows:

- The learner engages in gathering information related to latent heat of fusion and latent heat of vaporization, and its effects.
- The learner explores the relevant materials required for the experiment and prepares an experimental set up under the guidance of the teacher.
- The learner experiments to observe the process of latent heat of fusion of ice and latent heat of vaporization of water.
- The learner explains the concept of latent heat of fusion of ice and vaporisation of water based on the observation using graphical representation.
- The learner elaborates on the effects of latent heat of fusion of ice and vaporisation of water, and relates it to natural phenomena.
- The learner reflects and incorporates feedback given by the teacher and peers to evaluate their understanding of the concepts.

Non-contact:The teacher may prepare a video lesson or presentation or use the video from the link https://youtu.be/xavFw8TlfAk to provide the concept of latent heat of fusion of ice and latent heat of vaporization of water and share it through CLT. The teacher may develop a worksheet and upload it on the CLT.

- The learner gathers information related to latent heat of fusion of ice, latent heat of vaporization of water, and its applications from the learning material shared by the teacher.
- The learner explores for additional information on the concepts from the relevant sources.
- The learner completes the worksheets and submits for assessment through CLT.

Assessment:

Contact: The teacher may use a rubric to assess the engagement of the learners in group discussion, ability to explore the information, use scientific skills in conducting the experiment, gather data, draw inferences, and relate the concept of latent heat to the natural consequences. The teacher may provide necessary intervention based on need.

Non-contact: The teacher may assess the understanding of the concepts by assessing the worksheet, and application of latent heat of fusion of ice and latent heat of vaporization of water from the work submitted through CLT. The teacher may provide necessary intervention based on need.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/xavFw8TlfAk

2.3.6. Thermal Expansion of Matter. *(Scope: types of thermal expansion and its applications, anomalous expansion of water and its effects).*

Objective(s): .x. Describe thermal expansion and relate its application in the engineering field.

Learning Experiences:

Contact: The teacher may carry out the instructional practices on thermal expansion of matter, its types and applications using the flipped classroom model. The teacher may develop learning materials such as PowerPoint presentations, a video or handouts and share it to the learner before class. The teacher may initiate and facilitate discussion on the concepts, and share the DARTs (directed activity related to texts) during the class.

- The learner explores information on the concept from the prepared materials (PowerPoint presentation, a video, or handouts) shared by the teacher (before the class).
- The learner engages in the group discussion and deliberates on types of thermal expansion and their applications to further enhance their learning on the concept (during the class).
- The learner completes the DARTs on thermal expansion of matters and its applications.

- The learner explores for more information on the applications of thermal expansion of matter and relates to the engineering practices and natural phenomena (eg. anomalous expansion of water and its effects).

Non-contact: The teacher may share the prepared learning materials on thermal expansion of matter, its types and applications using a PowerPoint presentation, a video or handouts. The teacher may develop DARTs and upload it through CLT.

- The learner goes through the materials and explores the concept of thermal expansion of matter, its types and applications.
- The learner completes DARTs, explores more information on the applications of thermal expansion of matter from the relevant sources, and relates them to the engineering practices and natural phenomena.
- The learner submits the work through CLT.

Assessment:

Contact: The teacher may use a rating scale to assess the learner's understanding of the concept, and relate the significance of thermal expansion in engineering practices and natural phenomena from the DARTs. The teacher may assess the learner's ability to provide scientific reasoning on the application of thermal expansion using a rubric. The teacher may provide necessary intervention based on need.

Non-contact: The teacher may use a rating scale to assess the learner's understanding of the concept, and relate the significance of thermal expansion in engineering practices and natural phenomena from the DARTs submitted through CLT. The teacher may assess the learner's ability to provide scientific reasonings on the applications of thermal expansion using a rubric. The teacher may provide necessary intervention based on need.

Refer to the New Normal Curriculum Framework in Science (NNCFS- 2021) for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).

3. Electricity and Magnetism

Competencies:

- Interpret electric current using interactive simulation to generate concepts of electrical variables that affect each other.
- Analyse the graph of alternating current and direct current to recognise the power supplied by different sources.
- Apply scientific concepts to design, test, and refine a device that converts energy from one form to another to explain their applications in hydropower, electronics and any other electrical devices.
- Design and construct d.c. motor using the Faraday's laws to explain the concept of electromagnetic induction.

3.1 Electric Charge.

3.1.1. Electric Current. *(Scope: electric current in terms of the flow of charge carried by free electrons in metals or ions during electrolysis, calculate steady current using the formula $I=dq/dt$).*

Objective(s): i. Interpret electric current in terms of flow of charge using interactive simulation to elucidate the understanding of flow of current.

Learning Experiences:

Contact: The teacher may carry out the instructional practices on the electric current using interactive simulation from the link https://bit.ly/30LhfLa and facilitate the learner in solving numerical problems related to the flow of current.

- The learner interprets the electric current using mathematical representation and the flow of charge from the simulation link https://bit.ly/30LhfLa .
- The learner describes the process of charging, the forces between different types of charge, and the flow of charge carried by free electrons in metals or ions during electrolysis using the simulation from the link https://javalab.org/en/electrolysis_of_water_en/
- The learner solves related numerical problems by using the appropriate formula.

Non-contact: The teacher may explain the electric current, process of charging, forces between different charged bodies, and the flow of charge through a presentation, notes or handouts and upload it through CLT. The teacher may provide interactive simulation on the flow of charge and related numerical problems to assist the learning.

- The learner interprets the electric current using mathematical representation and the flow of charge from the materials provided by the teacher and the simulation link https://bit.ly/30LhfLa .
- The learner solves related numerical problems and submits it through CLT.

Assessment:

Contact: The teacher may assess the learner's conceptual understanding of electric current and flow of charge, problem solving skills, curiosity to explore, and the ability to relate the concept to daily applications using a marking scheme and a rubric. The teacher may provide necessary intervention based on need.

Non-contact: The teacher may assess the learner's conceptual understanding on electric current and flow of charge, problem solving skills, and ability to relate the concept to daily application using a marking scheme from the work submitted through CLT. The teacher may provide necessary intervention and support.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://bit.ly/30LhfLa

- https://javalab.org/en/electrolysis_of_water_en/ .

3.2. Electromagnetic Effects

3.2.1. Alternating Current and Direct Current. *(Scope: a.c. and d.c. with graphical representations).*

Objective(s): ii. Analyse the graph of alternating current and direct current using a simulation or an oscilloscope.

Learning Experiences:
Contact: The teacher may use POE (predict, observe, and explain) to teach the concept of alternating current (a.c) and direct current (d.c) with the graphical representations using oscilloscope or simulation from the link https://bit.ly/30HMhn8 . The teacher may provide the video link https://youtu.be/vN9aR2wKv0U to verify the concept of a.c and d.c.The teacher provides a worksheet to be completed by the learner.

- The learner predicts the direction of flow of charge and the types of graph for the a.c. and d.c. before the experiment or the demonstration with the simulation.
- The learner observes the graph of a.c. and d.c displayed on the oscilloscope or the simulation link https://bit.ly/30HMhn8 .
- The learner explains the nature of the graph for a.c. and d.c. to differentiate between two types of current based on visual representation.
- The learner analyses the applications of a.c. and d.c. for different purposes.

Non-contact: The teacher may record a video using an oscilloscope or the simulation from the link https://bit.ly/30HMhn8 deliver the lesson on the concept of a.c. and d.c. with graphical representation shared through CLT. The teacher may also share a video clip from the link https://youtu.be/vN9aR2wKv0U to supplement the information. The teacher may provide instructional guidance as follows:

- The learner predicts the direction of flow of charge and the types of graph for the alternating and direct current.
- The learner plays with the simulation from the link https://bit.ly/30HMhn8 to confirm the direction of flow of current and types of graph for d.c. and a.c.
- The learner defines the a.c. and d.c. and explains their graphs reasoning the nature of graphs formed, takes the screenshot of his process of using the simulations and sends to the teacher with the summary notes for the assessment through CLT. The teacher may intervene and support based on need.

Assessment:
Contact: The teacher may use a rubric to assess the ability of the learner to operate the oscilloscope or simulation, differentiate between a.c. and d.c., communicate the inferences, and appreciate the applications of a.c. and d.c. The teacher may provide necessary intervention and support based on the need.

Non-contact: The teacher may use a rubric to assess the ability of learners to make a logical prediction on the flow of charge of a.c. and d.c., the types of graphs for a.c. and d.c., relate the direction of flow of charges and types of graph to define and differentiate between alternating current and direct current based on the evidence submitted through CLT. The teacher may provide necessary intervention and support based on the need.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://bit.ly/30HMhn8
- https://youtu.be/vN9aR2wKv0U

3.2.2. Electromagnetic Induction *(Scope: Faraday's laws and Lenz's law)*

Objective(s): iv. Conduct an experiment to verify Faraday's laws and Lenz's law and explore their applications in real life situations.

Learning Experiences:

Contact: The teacher may carry out the instructional practices on electromagnetic induction by introducing the concepts of Faraday's laws and Lenz's law. The may provide the simulation link https://bit.ly/3qTF4LK to supplement the information on the concept. The teacher may use the confirmation inquiry cycle to verify Faraday's laws and Lenz's law, and explore their applications in real life situations. The teacher may provide the question and the procedures to carry out the experiment.

- Based on the question provided by the teacher, the learner brainstorms on Faraday's laws of electromagnetic induction and Lenz's law. The learner may use the simulation from the link https://bit.ly/3qTF4LK .
- The learner gathers materials and carries out the experiment by following the procedures.
- The learner collects and analyses data, and draws a conclusion to verify the laws.
- The learner shares the findings to the class and recognises the significance of the laws in the working of a d.c motor.
- The teacher may provide necessary intervention and support.

Non-contact: The teacher may provide conceptual information on the electromagnetic induction and the procedures to carry out confirmatory inquiry to verify Faraday's laws using a presentation or video lesson shared through CLT. The teacher may share the video links https://youtu.be/3HyORmBip-w and https://youtu.be/pMfNuP1Wozw and the simulation link https://bit.ly/3qTF4LK to provide additional information on the concept explained by the teacher.

- The learner gathers information from the learning materials provided by the teacher and brainstorms on the questions related to electromagnetic induction.
- The learner follows the teacher's instruction and uses the simulation link https://bit.ly/3qTF4LK to gather evidence and verify the laws.
- The learner shares the findings to the class and relates the significance of the laws in the working of a d.c motor, and uploads the work through CLT.
- The teacher may provide necessary intervention and support.

Assessment:

Contact: The teacher may assess the learner's conceptual understanding of electromagnetic induction, the ability of the learner to follow instructions to carry out the experiment, verify laws, and relate the significance of the law in the working of a d.c motor using a rubric. The teacher may provide necessary intervention based on need.

Non-contact: The teacher may assess the learner's conceptual understanding of electromagnetic induction, the ability of the learner to follow instructions, draw conclusions, and report the finding using a rubric from the work submitted through CLT. The teacher may provide necessary intervention based on need.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/3HyORmBip-w
- https://youtu.be/pMfNuP1Wozw
- https://bit.ly/3qTF4LK

3.2.3. Force on a Current Carrying Conductor Placed in a Magnetic Field. *(Scope: the simple concepts on Lorentz force, construction and working of d.c. motor).*

Objective(s):

iv. Design a simple direct current (d.c.) motor by applying the concept of electromagnetic induction.

Learning Experiences:

Contact: The teacher may use DBL (design based learning) to teach the concept of force on a current carrying conductor (Lorentz force) and construct a working model of a d.c motor using the following process. The teacher may provide the video link https://youtu.be/5KiyTpmPHIo and instruct the learners to gather the necessary materials required to set up an experiment to demonstrate the Lorentz force.

- The learner discusses in group to set up an experiment to demonstrate the Lorentz force based on information gathered from the link https://youtu.be/5KiyTpmPHIo.
- The learner designs and executes the experiment to demonstrate Lorentz force using the required materials.
- The learner gathers information and necessary materials to construct a model of d.c motor. The learner may use the video from the link https://youtu.be/WI0pGk0MMhg as a reference.
- The learner tests the model and relates the applications of Faraday's laws of electromagnetic induction in various electrical appliances.

Non-contact: The teacher may prepare a video lesson to deliver the concept of force on a current carrying conductor (Lorentz force) and the working of a d.c. motor. The teacher may provide the

video links https://youtu.be/nRDVm5rn_2A and https://youtu.be/WI0pGk0MMhg through CLT.

- The learner explores information on Lorentz force and the construction of a d.c. motor from the learning materials shared by the teacher or from the video links https://youtu.be/nRDVm5rn_2A and https://youtu.be/WI0pGk0MMhg .
- The learner designs a 2D model of a d.c. motor using relevant digital tools based on the information gathered from the videos and learning materials.
- The learner shares their design in any social media and incorporates feedback.
- The learner submits the design with an explanation through CLT.

Assessment:

Contact: The teacher may use a rubric to assess the conceptual understanding of Lorentz force and d.c. motor, ability to construct and experiment on d.c. motor, relate its application in various electrical appliances, and appreciate the applications of electromagnetic induction in modern technology from the works performed by the learner. The teacher may provide necessary intervention based on need.

Non-contact: The teacher may use a rubric to assess the conceptual understanding of Lorentz force and d.c. motor, ability to construct a conceptual model of d.c. motor, relate its application in various electrical appliances, and appreciate the applications of electromagnetic induction in modern technology from the works submitted by the learner through CLT. The teacher may provide necessary intervention based on need.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/nRDVm5rn_2A
- https://youtu.be/WI0pGk0MMhg
- https://youtu.be/5KiyTpmPHIo.

4. Waves and Optics

Competencies:

- Develop and use models to describe the laws of refraction through various materials to relate its applications in daily use.
- Design any working or conceptual model of optical instrument using the concept of total internal reflection to understand its application in various fields.
- Differentiate between transverse and longitudinal waves by using simulations and physical tools and construct the relationship between frequency and wavelength to determine the nature of sound and effective communication.

- Communicate scientific and technical information about the properties of waves and appreciate the positive impact of applications of waves in communication, medicines, and entertainment.

4.1. Ray Optics.
4.1.1. Refraction of Light. *(Scope: refraction of light through a glass slab, laws of refraction, refractive index).*

Objective(s): i. Conduct an experiment to comprehend the laws of refraction using a ray box.

ii. Apply the concept of refraction to construct a simple refracting telescope to observe distant objects.

Learning Experiences:
Contact: The teacher may deliver the lesson on refraction of light in the following order of guided inquiry. The teacher may ask the questions like how does light travel in a different optical medium? The teacher may provide required materials to conduct the experiment to comprehend the laws of refraction. The teacher may also provide the link https://bit.ly/3qGONos to supplement the experimental verification of the laws of refraction.

- The learner researches on questions asked by the teacher from the relevant sources.
- The learner designs and experiments on refraction of light through a glass slab.
- Based on the observation, the learner draws conclusions on the laws of refraction and explains the concept of refractive index.
- The learner verifies their experimental result from the link https://bit.ly/3qGONos .
- The learner solves the numerical problems using the concept of refractive index.
- The learner uses the concept of refraction to construct a simple refracting telescope (as an extended learning activity) and submits it to the teacher.

Non-contact: The teacher may upload the links https://youtu.be/sBb5WUw2_2I, https://youtu.be/4l2thi5_84o and https://bit.ly/3qGONos on Google Classroom. The teacher may also develop and share a worksheet on Google Classroom to record the observations and complete other activities.

- The learner takes note on the concepts of refraction from the links https://youtu.be/sBb5WUw2_2I and https://youtu.be/4l2thi5_84o
- The learner completes the worksheet based on observation from the simulation link https://bit.ly/3qGONos and verifies the laws of refraction.
- The learner solves the numerical problems using the concept of refractive index.
- The learner uses the concept of refraction to construct a simple refracting telescope (conceptual model).
- The learner submits the work through Google Classroom.

Assessment:
Contact: The teacher may use a rubric to assess learner's ability to demonstrate the concept on refraction of light, carry out the experiment by using appropriate materials, make scientific judgement from the observations, solve related numerical problems, and relate the concepts to design optical instruments. The teacher may provide necessary intervention based on need.

Non-contact: The teacher may use a rubric to assess the learner's conceptual understanding of refraction of light, the ability to complete the worksheet and verify the laws, solve related numerical problems, and relate the concepts to design optical instruments from the work submitted through Google Classroom. The teacher may provide necessary intervention based on the need.
Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/sBb5WUw2_2I
- https://youtu.be/4l2thi5_84o
- https://bit.ly/3qGONos

4.1.2.Total Internal Reflection. *(Scope: explanation, natural phenomena and applications).*

Objective(s): iii. Explain the concept of total internal reflection through experimentation to relate its application in natural phenomena.

Learning Experiences:

Contact: The teacher may use the instructional practice to teach total internal reflection in the following order of activity. The teacher may provide necessary materials (laser light, water, semi-circular glass, glass slab, etc.,) to demonstrate the critical angle and total internal reflection. The teacher may provide the simulation link https://bit.ly/3libLRJ.

- The learner explores the information on total internal reflection, critical angle, and conditions for total internal reflection from the relevant sources.
- The learner designs an experiment to demonstrate and explain the concept of total internal reflection, critical angle, and conditions for total internal reflection.
- The learner prepares an interactive PowerPoint presentation to demonstrate the conceptual understanding of total internal reflection, critical angle, and conditions for total internal reflection, and the applications of total internal reflection based on the experimental result.

Non-contact: The teacher may prepare a video lesson on total internal reflection or upload the video links https://youtu.be/ybvjcjndn_4 and https://youtu.be/5VrVqpV7RNA on Google Classroom. The teacher may provide the simulation link https://bit.ly/3libLRJ to verify the concept on total internal reflection.

- The learner observes the demonstration made in the videos or uses the link https://bit.ly/3libLRJ to explain critical angle, total internal reflection, and conditions required for the total internal reflection.
- The learner prepares an interactive PowerPoint presentation to demonstrate the conceptual understanding of total internal reflection, critical angle, and conditions for total internal reflection, and the applications of total internal reflection based on the information gathered.
- The learner submits the work through Google Classroom.

Assessment:

Contact: The teacher may use a rubric to assess the learner's conceptual understanding of critical angle, total internal reflection, conditions required for the total internal reflection, ability of the learner to explore information on the concept, demonstrate total internal reflection, and relate the concepts to natural phenomena from the PowerPoint. The teacher may intervene and provide support wherever necessary.

Non-contact: The teacher may use a rubric to assess the learner's conceptual understanding of critical angle, total internal reflection, conditions required for the total internal reflection, ability of the learner to explore information on the concept, demonstrate total internal reflection, and relate the concepts to natural phenomena from the PowerPoint submitted through Google Classroom. The teacher may intervene and provide support wherever necessary.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/ybvjcjndn_4
- ttps://youtu.be/5VrVqpV7RNA
- https://bit.ly/3libLRJ

4.2.Waves.

4.2.1. Types of Waves. *(Scope: transverse and longitudinal).*

4.2.2. Properties of Waves. *(Scope: terms used in waves, reflection of wave and refraction of wave).*

Objective(s): iv. Describe the properties and terms related to transverse and longitudinal waves using simulations or available materials.

Learning Experiences:

Contact: The teacher may deliver the lesson on waves, the characteristics of transverse and longitudinal waves, and properties of waves in the following order of PROE (predict, reason, observe, explain). The teacher may provide an interactive simulation from the links https://ophysics.com/w6.html and https://cutt.ly/kzL1355 or relevant materials such as slinky or helical springs to demonstrate the nature of transverse and longitudinal waves. The teacher may provide numerical problems related to waves.

- The learner gathers information on the types of waves (transverse and longitudinal waves) with graphical representation, the properties of waves and identifies the terms used to describe waves.
- The learner predicts the mathematical relationship amongst variables (wavelength, frequency, wave velocity, amplitude, and time period) and justifies with reasons.
- The learner uses slinky or helical springs or explores the simulation from the links https://bit.ly/38EzSoA and https://ophysics.com/w6.html to observe the relationships amongst variables (wavelength, frequency, wave velocity, amplitude, and time period).

- The learner explains the types of waves, deduces the relationships amongst variables (wavelength, frequency, wave velocity, amplitude, and time period) based on the observation made from the demonstration or simulation.
- The learner solves the numerical problems related to waves using the mathematical relationships of waves.

Non-contact: The teacher may provide a video links https://youtu.be/AUBAMlMoI1g and https://youtu.be/U0Y3XeopMHA, and the simulation links https://ophysics.com/w6.html and https://bit.ly/38EzSoA on transverse and longitudinal waves, properties of waves, and on variables (wavelength, frequency, wave velocity, amplitude, and time period) through CLT. The teacher may provide the numerical problems related to waves.

- The learner explains the types of waves (transverse and longitudinal waves) with graphical representation after studying the video from the links https://youtu.be/AUBAMlMoI1g and https://youtu.be/U0Y3XeopMHA.
- The learner explores the simulation from the links https://bit.ly/38EzSoA and https://ophysics.com/w6.html to identify terms used to describe waves, and explore further on the relationships amongst variables (wavelength, frequency, wave velocity, amplitude, and time period).
- The learner solves the numerical problems related to waves.
- The learner submits the work through CLT for assessment.

Assessment:

Contact: The teacher may assess the ability to differentiate the types of waves through graphical representation, explain the properties of waves, and applications of waves using a rubric. The teacher may assess the scientific skills of observation, analysis and interpretation of data, and ability to provide scientific justification, and solve numerical problems using a rubric.

Non-contact: The teacher may assess the ability to differentiate the types of waves through graphical representation and explain its properties using a rubric. The teacher may assess the scientific skills of observation, analysis and interpretation of data, and ability to provide scientific justification, and solve numerical problems using a rubric from the work submitted through CLT.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/AUBAMlMoI1g
- https://cutt.ly/kzL1355
- https://youtu.be/U0Y3XeopMHA.
- https://bit.ly/38EzSoA
- https://ophysics.com/w6.html

4.2.3. Uses of Waves. *(Scope: ultrasound, SONAR, RADAR).*

Objective(s): v. Explore the application of waves to argue the pros and cons of waves in daily applications.

Learning Experiences:

Contact: The teacher may use the 5E model to deliver the lesson on applications of ultrasound, SONAR, and RADAR in the following order of activity. The teacher may provide the links

https://youtu.be/I1Bdp2tMFsY , https://youtu.be/TFYuv4bhtLg and https://youtu.be/ql2Y-3hOfGY to supplement the concepts.

- The learner engages in applications of waves from the information provided by the teacher or from the links https://youtu.be/I1Bdp2tMFsY, https://youtu.be/TFYuv4bhtLg and https://youtu.be/ql2Y-3hOfGY.
- The learner explores more information from any other relevant resources(book, handouts, internet, etc.).
- The learner explains the application of waves, pros and cons of the waves in daily applications from the information gathered.
- The learner elaborates on the application of waves in various fields and solves related numerical problems.
- The learner incorporates the feedback provided by the teacher and peer and submits it for assessment.

Non-contact: The teacher may prepare a presentation or upload the videos from links https://youtu.be/I1Bdp2tMFsY, https://youtu.be/TFYuv4bhtLg, and https://youtu.be/ql2Y-3hOfGY on applications of ultrasound, SONAR, and RADAR respectively. The teacher may prepare and upload a worksheet on CLT.

- The learner engages in gathering information on application of ultrasound, SONAR, and RADAR in daily life from the video provided by the teacher from the links https://youtu.be/I1Bdp2tMFsY , https://youtu.be/TFYuv4bhtLg, and https://youtu.be/ql2Y-3hOfGY respectively.
- The learner explains the application of waves, pros and cons of the waves in daily applications, and solves the related numerical problems from the worksheet.
- The learner submits the work through CLT.

Assessment:

Contact: The teacher may use a rubric to assess the ability of the learner to explain the applications of the waves, actively engage in the group activities, solve the numerical problems, and relate the concepts learnt to the daily applications. The teacher may provide feedback and intervention based on need.

Non-contact: The teacher may use a worksheet with a marking scheme to assess the ability of the learner to explain the applications of waves in ultrasound, SONAR and RADAR, solve the numerical problems, and relate its application to daily life. The teacher may provide necessary intervention based on need.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Physics Class Nine by Kinley Gyeltshen and Sumitra Subba (Reprint 2019).
- https://youtu.be/I1Bdp2tMFsY
- https://youtu.be/TFYuv4bhtLg
- https://youtu.be/ql2Y-3hOfGY

5. Space Physics

Competencies:

- Gather evidence related to advancement in Moon exploration to describe physical and chemical properties of the Moon and explore future possibilities of human settlement on the Moon.
- Design physical or virtual prototype of any one of the items necessary for human survival on the Moon.

5.1. The Moon

5.1.1. Advancement of Moon Exploration. (*Scope: History of Moon exploration, Current developments, Future possibilities).*

Objective(s): i. Explore characteristics of the Moon and its environment.

Learning Experiences:

Contact: The teacher may introduce the lesson on the moon exploration by sharing history of the Moon exploration, current developments, and future possibilities using the information gathered from the internet, scientific papers, books, etc. The teacher may use the CER (claim, evidence and reasoning) model in the following order. The teacher may set the tone to create a claim by the learner with the question based on characteristics of the Moon.

- The learner gathers information from the explanation by the teacher.
- The learner makes a claim on the characteristics of the Moon and its environment.
- The learner explores information from the internet, scientific articles, and books to gather evidence on their claim.
- The learner justifies their claim with the evidence and shares it to the class.

Non-contact: The teacher may prepare a video lesson or interactive presentation on the Moon exploration by sharing history of the Moon exploration, current developments, and future possibilities using the information gathered from the internet, scientific papers, books, etc. The teacher may instruct the learner to make a claim on the characteristics of the Moon and its environment and find relevant evidence to support the claim. The teacher may share the learning materials through CLT.

- The learner gathers information from the learning materials shared by the teacher on the Moon and its characteristics.
- The learner makes a claim on the characteristics of the Moon and its environment based on the information gathered.
- The learner explores information from the internet, scientific articles, and books to gather evidence on their claim.
- The learner justifies their claim with the evidence and uploads the work through CLT.

Assessment:

Contact: The teacher may assess the learner's ability to explain the characteristics of the Moon, search, retrieve, organise, analyse, interpret scientific information, present and communicate scientific ideas in a logical manner, participate actively, and accept constructive criticism or

feedback from peers and the teacher using a rubric. The teacher may provide necessary intervention based on need.

Non-contact: The teacher may assess the learner's ability to engage in self-directed learning activities, search and retrieve scientific information, present and communicate scientific ideas in a logical manner, and accept constructive criticism or feedback using a rubric from the work submitted through CLT. The teacher may provide intervention when necessary.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Understanding Space: an introduction to astronautics by Sellers et. al (2004).

5.1.2. Physical and Chemical Properties of the Moon and its Environment. (*Scope: position, size, composition).*

Objective(s): ii**.** Describe composition, positions, and sizes of the Moon relative to the Earth.

Learning Experiences:

Contact: The teacher may deliver the lesson on physical and chemical properties of the Moon using CAI tools. The teacher may provide the link https://bit.ly/3coAhfK and guide the learner through required topics to learn the concept on composition, positions, and sizes of the Moon relative to the Earth.

- The learner gathers information on the concept based on the information shared by the teacher.
- The learner explores information related to the concept and completes online activities from the link https://bit.ly/3coAhfK.
- The learner designs a model (illustration, 2D model, 3D model using programming language) to exhibit the compositions, positions, and size of the Moon relative to the Earth and shares it to the class.

Non-contact: The teacher may deliver the lesson on physical and chemical properties of the Moon using CAI tools. The teacher may provide the link https://bit.ly/3coAhfK and instruct the learner to explore the concept of compositions, positions, and size of the Moon relative to the Earth.

- The learner gathers information on the concept based on the information shared by the teacher.
- The learner explores information related to the concept and completes online activities from the link https://bit.ly/3coAhfK.
- The learner designs a model (illustration, 2D model, 3D model using programming language) to exhibit the compositions, positions, and size of the Moon relative to the Earth and submits it through CLT.

Assessment:

Contact: The teacher may assess the ability of the learner to complete online questions shared through the link https://bit.ly/3coAhfK, relevancy of the information, draw conclusions,

comprehensiveness of the model, incorporate feedback, and relate it to some natural phenomena and applications using a checklist. The teacher may provide necessary intervention based on need.

Non-contact: The teacher may assess the ability of the learner to complete online questions given through the link https://bit.ly/3coAhfK, relevancy of the information, draw conclusions, comprehensiveness of the model, incorporate feedback, and relate it to some natural phenomena and applications using a checklist, from the work submitted through CLT. The teacher may provide necessary intervention based on need.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository.
- Understanding Space: an introduction to astronautics by Sellers et. al (2004)
- https://bit.ly/3coAhfK

5.1.3. Impact of the Moon's Environment on Human Health and Survival on the Moon.
Objective(s): iii**.** Explore the requirements for human survival on the Moon.

iv. Design physical or virtual prototype of any one of the items necessary for human survival on the Moon.

Learning Experiences:
Contact: The teacher may gather information from the internet, scientific papers, books, etc. to explore the information on requirements for human survival on the Moon. The teacher may prepare a presentation or handouts to deliver the lesson and follow the open inquiry cycle to engage the learner.

- The learner gathers the information on the requirement of human survival on the Moon from any relevant sources.
- The learner frames question(s) on the requirements for human survival on the Moon using the information gathered.
- The learner explores to answer the question(s) based on the evidence gathered from the internet, scientific articles, and books and shares it to the group or the class.
- Based on the concept learned, the learner designs a physical or virtual prototype of any one of the items necessary for human survival on the Moon and presents it to the class.

Non-contact: The teacher may prepare a video lesson or interactive presentation or handouts on the requirements for human survival on the Moon and shares it through CLT. The teacher may instruct the learner to carry out the open inquiry cycle and engage in the learning experiences.

- The learner gathers the information on the requirement of human survival on the Moon from any relevant sources.
- The learner frames question(s) on the requirements for human survival on the Moon using the information gathered.
- The learner explores to answer the question(s) based on the evidence gathered from the internet, scientific articles, and books.
- Based on the concept learned, the learner designs a physical or virtual prototype of any one of the items necessary for human survival on the Moon and shares it in any social media for comments and feedback.
- The learner submits the work through CLT.

Assessment:

Contact: The teacher may assess the learner's ability to search, retrieve, organise, analyse, interpret scientific information, comprehensiveness of the model, present and communicate scientific ideas in a logical manner, participate actively, and accept constructive criticism or feedback from peers and the teacher using a rubric. The teacher may provide necessary intervention based on need.

Non-contact: The teacher may assess the learner's ability to engage in self-directed learning activities, search and retrieve scientific information, comprehensiveness of the model, present and communicate scientific ideas in a logical manner, and accept feedback using a rubric from the work submitted through CLT. The teacher may provide necessary intervention based on need.

Refer New Normal Science Curriculum Framework (NNSCF, 2021) and Formative Assessment for Classes PP-VI, 2020 for recording and reporting.

Resources:

- REC repository
- Understanding Space: an introduction to astronautics by Sellers et. al (2004)