UNIT 9: Imaging (Option C)

Content Area: **Science**
Course(s): **IB physics, SL**
Time Period: **Fourth Marking Period**
Length: **4 Weeks**
Status: **Published**

Unit Overview

The formation of images by lenses and mirrors are introduced in this unit. The optical telescope has been in use for over 500 years. It has enabled humankind to observe and hypothesize about the universe. More recently, radio telescopes have been developed to investigate the electromagnetic radiation beyond the visible region. Telescopes (both visual and radio) are now placed away from the Earth's surface to avoid the image degradation caused by the atmosphere, while corrective optics are used to enhance images collected at the Earth's surface. Many satellites have been launched with sensors capable of recording vast amounts of data in the infrared, ultraviolet, X-ray and other electromagnetic spectrum ranges. Advances in communication links using fiber optics have led to a global network of optical fibers that has transformed global communications by voice, video and data.

STAGE 1- DESIRED RESULTS

2020 New Jersey Student Learning Standards- Science

SCI.9-12.HS-PS4	Waves and Their Applications in Technologies for Information Transfer
SCI.9-12.HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
SCI.9-12.HS-PS4-2	Evaluate questions about the advantages of using digital transmission and storage of information.
SCI.9-12.HS-PS4-3	Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
SCI.9-12.HS-PS4-4	Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
SCI.9-12.HS-PS4-5	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

Science and Engineering Practices

- Analyzing and Interpreting Data
- Asking Questions and Defining Problems
- Constructing Explanations and Designing Solutions
- Developing and Using Models
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information
- Planning and Carrying Out Information
- Using Mathematics and Computational Thinking

Cross Cutting Concepts

- Cause and Effect
- Energy and Matter
- Influence of Engineering, Technology, and Science on Society and the Natural World
- Interdependence of Science, Engineering, and Technology
- Patterns
- Scale, Proportion, and Quantity
- Stability and Change
- Structure and Functions
- Systems and System Models

Disciplinary Core Ideas

PS4 A: Wave properties

PS4 B: Electromagnetic Radiation

PS4 C: Information Technologies and Instrumentation

Physical Sciences

- PS1A: Structure and Properties of Matter
- PS1B: Chemical Reactions
- PS1C: Nuclear Processes
- PS2A: Forces and Motion
- PS2B: Types of Interaction

- PS3A: Definitions of Energy
- PS3B: Conservation of Energy and Energy Transfer
- PS3C: Relationship Between Energy and Forces
- PS3D: Energy in Chemical Processes and Everyday Life
- PS4A: Wave Properties
- PS4B: Electromagnetic Radiation
- PS4C: Information Technologies and Instrumentation

Earth and Space Sciences

- ESS1A: The Universe and its Stars
- ESS1B: Earth and the Solar System
- ESS1C: The History of Planet Earth
- ESS2A: Earth Materials and Systems
- ESS2B: Plate Tectonics and Large-Scale Systems
- ESS2C: The Role of Water in Earth's Surface Processes
- ESS2D: Weather and Climate
- ESS2E: Biogeology
- ESS3A: Natural Resources
- ESS3B: Natural Hazards
- ESS3C: Human Impacts on Earth Systems
- ESS3D: Global Climate Change

Engineering. Technology. and Applications of Science

- ETS1A: Defining and Delimiting an Engineering Problem
- ETS1B: Developing Possible Solutioins
- ETS1C: Optimizing the Design Solution

Essential Questions

- What are the regions of the EM spectrum, how are they produced and what can each be used for?
- What is the difference between a real image and a virtual image?
- How do we determine the focal length of a lens algebraically and graphically?
- How do the optical instruments (magnifying glass, microscope, telescope) work?
- What are the uses of single - dish radio telescopes?
- How does radio interferometry telescope work?
- What are the advantages of satellite - borne telescopes?
- What is the difference between step-index and graded-index fibers?
- What is the difference between wave guide and material dispersion?
- What is meant by attenuation?

Enduring Understanding

The progress of a wave can be modeled via the ray or the wavefront. The change in wave speed when moving between media changes the shape of the wave. Optical microscopes and telescopes utilize similar physical properties of lenses and mirrors. Analysis of the universe is performed both optically and by using radio telescopes to investigate different regions of the electromagnetic spectrum. Advances in communication links using fiber optics have led to a global network of optical fibers that has transformed global communications by voice, video and data.

Students will know…

- Thin lenses
- Converging and diverging lenses
- Converging and diverging mirrors
- Ray diagrams
- Real and virtual images
- Linear and angular magnification
- Spherical and chromatic aberrations
- Optical compound microscopes
- Simple optical astronomical refracting telescopes
- Simple optical astronomical reflecting telescopes
- Single-dish radio telescopes
- Radio interferometry telescopes
- Satellite-borne telescopes
- Structure of optic fibers
- Step-index fibers and graded-index fibers
- Total internal reflection and critical angle
- Waveguide and material dispersion in optic fibers
- Attenuation and the decibel (dB) scale

Possible Misconceptions

- Different wavelengths of light have different energy and therefore different speeds.
- Light always passes straight through transparent objects.
- A photon is a particle with a wave inside.
- Photons of higher frequency are bigger than photons of lower frequency.
- All photons have the same energy.

Students will be able to…

- Construct and interpret ray diagrams of optical compound microscopes at normal adjustment
- Solve problems involving the angular magnification and resolution of optical compound microscopes
- Investigate the optical compound microscope experimentally

- Construct or complete ray diagrams of simple optical astronomical refracting telescopes at normal adjustment
- Solve problems involving the angular magnification of simple optical astronomical telescopes
- Investigate the performance of a simple optical astronomical refracting telescope experimentally
- Describe the comparative performance of Earth-based telescopes and satellite-borne telescopes
- Solve problems involving total internal reflection and critical angle in the context of fiber optics
- Describe how waveguide and material dispersion can lead to attenuation and how this can be accounted for
- Solve problems involving attenuation
- Describe the advantages of fiber optics over twisted pair and coaxial cables

STAGE 2- EVIDENCE OF LEARNING

Formative Assessment

- 3- Minute Pause
- A-B-C Summaries
- Analogy Prompt
- Choral Response
- Debriefing
- Exit Card / Ticket
- Hand Signals
- Idea Spinner
- Index Card Summaries
- Inside-Outside Circle Discussion (Fishbowl)
- Journal Entry
- Misconception Check
- Observation
- One Minute Essay
- One Word Summary
- Portfolio Check
- Questions & Answers
- Quiz
- Self-Assessment
- Student Conference

- Think-Pair-Share
- Web or Concept Map

Authentic Assessments

Lab Work

Quizzes

Benchmark Assessments

Unit Test

STAGE 3- LEARNING PLAN

Instructional Map

- Students will be given the details of the learning outcome of the unit in the beginning of the unit. Every day at the beginning of the class, expected questions/goal will be written on the board.
- Steps to be followed, writing all meaning of important vocabularies on board, using ICT , you tube videos , ppt, use of graph plotting software, simulations using java applets.
- Compare and contrast convex and concave lenses.
- Calculate the size and determine the location of an image formed by a lens.
- Have students verify the thin-lens equation by carrying out the Quantitative Lab *Converging Lens.*
- Explain how optical devices use lenses to focus on and magnify objects.
- Explain how the human eye adjusts to focus on objects at different distances.
- Have students list examples of devices that use lenses. Ask students to predict the types of lenses that are used in these devices and to make sketches that show how they think these lenses are arranged.
- Ask students to determine the magnification of a magnifying glass.
- Have students verify this magnification by finding the focal length of the lens, measuring the height of an object placed a known distance from the lens, and measuring the height of the resulting image.
- Have students construct an astronomical telescope using two convex lenses.
- Explain the advantages of fiber optics over twisted pair and coaxial cables.
- **Lab work:**
- Determination of focal length of a convex lens by two methods ,
- Refractive index of glass;

- Magnification determination using an optical bench;
- Investigating real and virtual images formed by lenses;
- Construct an astronomical telescope.

Modification/Differentiation of Instruction

Differentiation Strategies for Special Education Students

- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in "chunks"
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Varied homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

Differentiation Strategies for Gifted and Talented Students

- Increase the level of complexity
- Decrease scaffolding
- Variety of finished products
- Allow for greater independence
- Learning stations, interest groups

- Varied texts and supplementary materials
- Use of technology
- Flexibility in assignments
- Varied questioning strategies
- Encourage research
- Strategy and flexible groups based on formative assessment or student choice
- Acceleration within a unit of study
- Exposure to more advanced or complex concepts, abstractions, and materials
- Encourage students to move through content areas at their own pace
- After mastery of a unit, provide students with more advanced learning activities, not more of the same activity
- Present information using a thematic, broad-based, and integrative content, rather than just single-subject areas

Differentiated Strategies for ELL Students

- Remove unnecessary materials, words, etc., that can distract from the content
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Gradually increase the level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials, including visuals
- Use technology, if available and appropriate
- Differentiate homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Allow students to work at their own pace
- Presenting ideas through auditory, visual, kinesthetic, & tactile means
- Role play
- Provide graphic organizers, highlighted materials
- Strategy and flexible groups based on formative assessment

Differentiation Strategies for At Risk Students

- Remove unnecessary materials, words, etc., that can distract from the content
- Provide appropriate scaffolding
- Limit the number of steps required for completion

- Gradually increase the level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Differentiate homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Presenting ideas through auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment

504 Plans

Students can qualify for 504 plans if they have physical or mental impairments that affect or limit any of their abilities to:

- walk, breathe, eat, or sleep
- communicate, see, hear, or speak
- read, concentrate, think, or learn
- stand, bend, lift, or work

Examples of accommodations in 504 plans include:

- preferential seating
- extended time on tests and assignments
- reduced homework or classwork
- verbal, visual, or technology aids
- modified textbooks or audio-video materials
- behavior management support
- adjusted class schedules or grading
- verbal testing
- excused lateness, absence, or missed classwork
- pre-approved nurse's office visits and accompaniment to visits
- occupational or physical therapy

Peer Tutoring

Repeated Drill and Practice

Cooperative Grouping

Teacher notes

Use of additional reference materials

Modification Strategies

- Cooperative Grouping
- Extended Time
- Frequent Breaks
- Highlighted Text
- Interactive Notebook
- Modified Test
- Oral Directions
- Peer Tutoring
- Preferential Seating
- Re-direct
- Repeated Drill and Practice
- Shortened Assisgnment
- Teacher Notes
- Tutorials
- Use of Additional Reference Materials
- Use of Audio Resources

Differentiation Strategies

High Preparation

- Alternative Assessments
- Choice Boards
- Games and Tournaments
- Group Investigations

- Guided Reading
- Independent Research / Project
- Interest Groups
- Learning Contracts
- Leveled Rubrics
- Literature Circles
- Multiple Intelligence Options
- Multiple Texts
- Personal Agendas
- Project Based Learning (PBL)
- Stations / Centers
- Think-Tac-Toe
- Tiered Activities / Assignments
- Varying Graphic Organizers

Low Preparation

- Choice of Book / Activity
- Cubing Activities
- Exploration by Interest (using interest inventories)
- Flexible Grouping
- Goal Setting With Student
- Homework Options
- Jigsaw
- Mini Workshops to Re-teach or Extend Skills
- Open-ended Activities
- Think-Pair-Share by Readiness, Interest, or Learning Style
- Use of Collaboration
- Use of Reading Buddies
- Varied Journal Prompts
- Varied Product Choice
- Varied Supplemental Materials
- Work Alone / Together

Horizontal Intergration- Interdisciplinary Connections

See Appendix

Vertical Integration- Discipline Mapping

Physics IB SL course is offered during the Junior and Senior years of High School. At this point in their studies, students will have been exposed to the Performance Expectations of the NGSS in Middle school. This course will allow the student to further expand and develop a deeper understanding of the physics concepts taught in earlier years.

Tenth Grade Chemistry

Nineth Grade Biology

Eighth Grade - Chemical Interactions

Seventh Grade - Electromagnetic Force and Gravity and Kinetic Energy

Sixth Grade - Waves

Additional Materials

Internet resources:

Khan Academy

Physicsclassroom.com

Youtube videos

Phet.colorado.edu

http://hyperphysics.phy-astr.gsu.edu/hbase/units.html

https://phet.colorado.edu/en/simulation/bending-light

https://phet.colorado.edu/en/simulation/geometric-optics