

Enduring Understanding # 1: Scientific inquiry affords all learners opportunities to make observations, pose questions, develop hypotheses, design and conduct investigations, and analyze data to draw conclusions.

Holography Benchmarks

Students will understand:	Essential Questions	Students will know the/that	Students will be able to	Notes
1.1 Inquiry is an attitude, a learner centered environment, and a cycle that involves solving problems and critical thinking.	<ul style="list-style-type: none"> -What is a scientific question? -What is a testable hypothesis? -How do I know if my experimental procedure aligns with my hypothesis? -How do I minimize my error in collecting data? -Why is it important to replicate scientific experiments? -What is learning through inquiry? 	<ul style="list-style-type: none"> -Steps to understand scientific inquiry include: observing, using numbers, plotting graphs, measuring, inferring, prediction, formulating models, interpreting data, hypothesizing, and experimenting. -Developing a scientific theory often means repeating or modifying the experiment. 	<ul style="list-style-type: none"> -Pose questions objectively based on observations -Develop hypotheses -Write clear, step-by-step instructions for conducting an investigation. -Demonstrate appropriate practices in research such as repeating the experiment -Gather and analyze necessary and sufficient data -Use data to draw logical conclusions -Use logical argumentation to defend research results -Participate in group discussions/activities on scientific topics. -Use logical problem solving and critical thinking skills in scientific investigations. 	

Enduring Understanding # 2: Exploring systems, order, and organizations in our natural and designed world are integral to understanding the scientific disciplines and their interdependence.

Holography Benchmarks

Students will understand:	Essential Questions	Students will know the/that	Students will be able to	Notes
2.1 Holography is an application of the wave theory of light.	<ul style="list-style-type: none"> -What is a hologram? -How is a hologram different from a regular photograph? 	<ul style="list-style-type: none"> -A hologram is the interaction of two mutually coherent light beams. - Holograms give 3 dimensional images whereas photographs give 2 dimensional images. 	<ul style="list-style-type: none"> -Describe and classify the interference patterns of light beams as destructive or constructive. -Identify parts of a wave and demonstrate constructive and destructive interference of mechanical and electromagnetic waves. 	
2.2 There are two primary holographic classifications.	<ul style="list-style-type: none"> -What is the difference between a reflection and a transmission hologram. 	<ul style="list-style-type: none"> -A transmission hologram is viewable only with a monochromatic light source (i.e. a laser or highly filtered 	<ul style="list-style-type: none"> -Classify a hologram as a reflection or a transmission hologram. 	

		light) and a reflection hologram is often called a white light hologram because it is viewable with white light.		
2.3 Lasers are required for producing holograms.	-How is laser light different from ordinary white light.	-Light from a laser is monochromatic, coherent, collimated and intense. -The wavelength and corresponding frequency determines the energy and color of the light.	- Calculate the wavelength, frequency and energy of the electromagnetic spectrum. -Explain the processes associated with color production.	
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Students will understand:	Essential Questions	Students will know the/that	Students will be able to	Notes
2.4 Holograms are understandable devices operating on the basis of simple optical principles.	-How does a hologram use the principles of divergence and convergence to produce real (pseudoscopic) and virtual (orthoscopic) images?	-Optical elements can converge or diverge light rays.	-Students will be able to produce and identify real and virtual images produced via, converging and diverging mirror and lenses, and holograms.	
2.5 A single beam reflection or transmission hologram is the simplest holographic set-up.	-How does the process for shooting a reflection hologram differ from the process for shooting a transmission hologram?	-Holograms require a reference beam and an object beam to create an interference pattern known as the hologram.	-Set-up, shoot and develop a single beam reflection hologram and a single beam transmission hologram. -Properly display a transmission and a reflection hologram.	
2.6 Holograms reflect, diffract, and refract light to produce images and colors.	-How does a hologram reflect, diffract, and refract light to produce images and colors.	-Reflection is caused by silver halide surfaces in the holograms emulsion. -Diffraction is a characteristic of the parallel fringes in a hologram. -Refraction is due to the changing indices of refraction within a hologram.	-Use mirrors and holograms with the law of reflection to produce a two channel hologram. -Use holograms and diffraction gratings to determine the spacing on holograms and to shoot a color hologram. -Use lenses and holograms to produce ray diagrams and determine the index of refraction for different	

			optical media.	
Enduring Understanding # 3: Both contemporary and historical scientific understandings inform technological, ethical, cultural and life decisions.				
Holography: Benchmarks				
Students will understand:	Essential Questions	Students will know the/that	Students will be able to	Notes
3.1 Social and economic forces strongly influence which technologies will be developed.	-How has the rise in counterfeiting and identify theft encouraged holographic applications? - How has holographic technology impacted our view of data storage?	-Holograms are used in money and on credit cards to prevent counterfeiting. -Holographic data storage has replaced conventional data storage.	- Identify holographic devices in currency and identification documents. -Explain how redundancy in holograms is advantageous for data storage.	
3.2 There have been multiple revolutionary events uniting scientific, social, and political issues.	-How has laser technology and holography affected industry, aviation, transportation, the medical profession, and entertainment. -How have lasers and lightwave communications altered the world in which we live?	- Holographic optical element was developed at Montana State University by professors Phd. Mac Rugheimer and Phd. Larry Kirkpatrick. -Holographic interferometry is used to determine stress patterns and structural defects in industry. -Lasers and holograms are routinely used in medicine. -Laser weaponry is a component of our nation's defense. -Fiber optics have streamlined the manner in which we communicate and transmit information.	-Shoot a holographical element and explain its usage in Heads Up Displays and compound lenses. -Shoot a non destructive test hologram and explain its usage. -Identify and describe the use of lasers and holograms in surgery, dentistry, ophthalmology and pathology. -Describe the advantages and uses of laser weaponry. -Construct a bias circuit and using fiber optics transfer voice data via a laser beam.	