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CRIN S04

Curriculum Topic Study (CTS)

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Target Student Population: 8th Grade Physical Science, Visible Light, Color, and Vision

This CTS focuses on visible light, color, and vision, and I will direct the sources and readings toward 8th grade physical science. I will give each section with any subsections, and discuss the sources in some detail.

Section I. Identify Adult Content Knowledge. Within this section are two resources: *Science for All Americans*, and *Science Matters: Achieving Scientific Literacy*. In *Science for All Americans*, a discussion about light is contained within the topic of motion. The section starts by describing objects in (two-dimensional non-repeating) motion and the idea of relative reference points, and moves to changes in motion due to effects of various forces. It then turns to a discussion of waves by describing patterns of motion differently from the description of motion due to forces, and gives various examples of behaviors of waves and some useful terminology when describing waves. The section further discusses the role of wavelength in determining how the wave interacts with matter, and several concrete examples of different interactions between waves and objects. In *Science Matters*, the author discusses how Maxwell created the mathematical description of waves and gives the characteristics of speed, wavelength, and frequency as the essential method of describing waves. It then moves to the electromagnetic spectrum by examining the wavelength of tiny vibrations versus large vibrations, and compares the ends of the spectrum to the wavelength of light. Finally, it discusses visible light as a small portion of the electromagnetic spectrum, and the description of color within the visible spectrum.

Section II. Consider Instructional Implications. The two resources within this section are: *Benchmarks for Science Literacy*, and *National Science Education Standards*. In *Benchmarks*, one emphasis is on the acceptance of qualitative understanding versus quantitative understanding. For many students, equations may hide ideas rather than illuminate them, and these equations may confuse the student and limit their learning. So, by employing more qualitative descriptions

of light, color, and vision, students will have a better background understanding when they are exposed to the mathematics undergirding our explanation of light. In the *National Science Education Standards*, the main point is to provide concrete experiences for the students, again to correct prior misconceptions and building a solid set of background experiences. The *Standards* also advocates discussing the motion of an object and graphing its position and velocity versus time, and this could be another way of representing motion qualitatively and preparing the students to understand the graphs quantitatively.

Section III. Identify Concepts and Specific Ideas. Again, the two resources within this section are: *Benchmarks for Science Literacy*, and *National Science Education Standards*. In *Benchmarks*, there are several points students should know by the end of 8th grade. These include understanding the composition of light and how it mixes, a rudimentary understanding of how vision and hearing work, and what vibrations are and where they come from. It also suggests teaching the properties of waves by using water tables, ropes, and springs, and discussing the electromagnetic spectrum in a qualitative manner. In the *Standards*, the focus is more on the transfer of energy by systems. Light is one way in which systems transfer their energy, and students should learn how the sun transfers its energy through light and the composition of the light from the sun. It also agrees with the *Benchmarks* in asserting students should understand how light interacts with matter through reflection, refraction, and absorption, but again in a qualitative manner.

Section IV. Examine Research on Student Learning. The two resources in the section are: *Benchmarks for Science Literacy*, and *Making Sense of Secondary Science: Research Into Children's Ideas*. In *Benchmarks*, there is a variety of misconceptions by the students. One is that students tend to identify light with its source or its effects rather than thinking of light as something that

moves from place to place, and as a result these students have difficulty explaining the direction and formulation of shadows. Another misconception is that students do not believe their eyes receive light when they see, and this takes the forms of light as "filling" the entire space or that the eye "sees" without any interaction between the object and the eye. In *Making Sense of Secondary Science*, the authors highlight some very pronounced misconceptions concerning vision. Most of the students were not able to correctly identify how light traveled from a source to an object then to the eye, instead choosing various schema involving light rays from the eye towards an object or not including the source in the scheme. Students also doubted the need for light in vision, thinking that light facilitates rather than enables vision. This ties directly to their further research that students do not believe light travels very far distances, but instead is closely bound to the source.

Section V. Examine Coherency and Articulation. The resource in this section is the *Atlas of Science Literacy*, and this ties in very nicely with the information presented thus far. The main points in grades 6-8 are: vibrations set up wavelike disturbances, and some examples of these are light, sound, and earthquakes; wave behavior can be described with its wavelength; something may be seen when light waves that have interacted with the object enter the eye; light is made of a mixture of many different colors; and, human eyes respond to only a narrow range of wavelengths in the electromagnetic spectrum.

Section VI. Clarify State Standards and District Curriculum. The purpose of this section is to link the previous sections to the state standards and school district curriculum, and the state standards are given by the Physical Science SOL guidelines. The previous sections relate directly to SOL PS.9, which is "the student will investigate and understand the nature and technological applications of light." Key concepts in this SOL are: the wave behavior of light

(reflection, refraction, diffraction, and interference); images formed by lenses and mirrors; and the electromagnetic spectrum. The previous sections also directly relate to the WJCC standard 11, and as seen in the figure this is exactly the same standard as the SOL PS.9.

WJC STANDARDS & OBJECTIVES
PHYSICAL SCIENCE ~ STANDARD 11

Virginia Standard PS 9

WJC Objective **Force, Motion, and Energy**

The student will investigate and understand the nature and technological applications of light. Key concepts include

a) the wave behavior of light (reflection, refraction, diffraction, and interference);
b) images formed by lenses and mirrors; and
c) the electromagnetic spectrum.

The district also gives an overview of necessary topics and their view of the essential knowledge, skills, and processes the students should have, and presents this to the teachers.

Overview	Essential Knowledge, Skills, and Processes
The critical scientific concepts developed in this standard include the following: • Light travels in straight lines until it strikes an object where it can be reflected, absorbed, or transmitted. As light waves travel through different media, they undergo a change in speed that may result in refraction. • Light is a form of radiant energy that moves in transverse waves. • There is an inverse relationship between frequency and wavelength. • Electromagnetic waves are arranged on the electromagnetic spectrum by wavelength. All types of electromagnetic radiation travel at the speed of light, but differ in wavelength. The electromagnetic spectrum includes gamma rays, X-rays, ultraviolet, visible light, infrared, and radio and microwaves. • Radio waves are the lowest energy waves and have the longest wavelength and the lowest frequency. Gamma rays are the highest energy waves and have the shortest wavelength and the highest frequency. Visible light lies in between and makes up only a small portion of the electromagnetic spectrum.	In order to meet this standard, it is expected that students should be able • design an investigation to illustrate the behavior of visible light – reflection and refraction. Describe how reflection and refraction occur. • describe the wave theories of light. • model a transverse wave and draw and label the basic components. Explain wavelength, amplitude, and frequency. • compare the various types of electromagnetic waves in terms of wavelength, frequency, and energy. • describe an everyday application of each of the major forms of electromagnetic energy.