

## SUGGESTED REFERENCES

- "Computing at the speed of light" , W. Wayt Gibbs, Scientific American, November 2004.
- **Topics in Applied Physics**, vol 94: Silicon Photonics Edited by Lorenzo Pavesi and David J. Lockwood. (Springer-Verlag Heidelberg, 2004).
- *Rocky Mountain Research Center* (click on the "cool photonic science" link) [www.rmrc.org](http://www.rmrc.org)
- Silicon Photonics, Research and Development at Intel, <http://www.intel.com/labs/sp/>
- Professor Sajeew John Research Home, <http://www.physics.utoronto.ca/~john/>
- Description of Photonic Crystals, <http://encyclopedia.thefreedictionary.com/photonic%20crystals>

## NATIONAL SCIENCE EDUCATION STANDARDS

**Grades K – 4**  
**Physical Science**  
 Light, Heat, Electricity, & Magnetism

**Grades 5 - 8**  
**Physical Science**  
 Properties and Changes of Properties in Matter  
 Transfer of Energy

**Grades 5 - 8**  
**Science and Technology**  
 Understandings about Science and Technology

**Science in Personal and Social Perspectives**  
 Science and Technology in Society

\*Source: *National Science Education Standards, 1996, National Academy Press*

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# SCIENCE SCREEN REPORT FOR KIDS

VOLUME 17 ISSUE 3

## THE MAGIC OF LIGHT & ELECTRICITY



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## SYNOPSIS

This program explores the future of light driven machines, or photonic devices. They are being developed to replace electronics in devices such as computers. Light is much faster than electrons, and hardware that can control photons will lead to products that are thousands of times faster than current electronics.

Students will learn how science and technology interact to help develop the key components of photonic devices. They will begin to understand the relationship between new ideas developed by scientists and the products that can result when computer engineers and scientists collaborate.

## CURRICULUM UNITS

- CHEMISTRY
- COMPUTER ENGINEERING
- ENGINEERING
- INTEGRATED SCIENCE
- PHYSICS
- SOFTWARE ENGINEERING

## RUNNING TIME

13:42

## BACKGROUND

Computers driven by electricity have been at the center of the technology revolution for more than forty years. But the problem with electrons is that they carry a charge. Because of this, they can be repelled by like forces and two electrons will not run in opposite directions on the same wire because they would interfere with each other. Information carried by light waves will not have the limitations that metal wires encounter. Light photons travel across each other, carrying information to and from places that are great distances apart without a loss of speed.

The properties of light photons have also been used for many years, but we have never been able to control light photons the same way that we control electrons. The photoelectric effect, using light energy to drive a flow of electrons, is used in solar powered calculators, but we have not been able to capture light photons to actually control a device.

Photonic devices need three important parts: a light source that creates a beam of light; a light source that is cheap and easy to turn on and off; and a way to capture the light the same way that metal wires capture electrons. The final piece of the puzzle is a way to change the direction of light so that it could be switched from one place to another without losing its strength.

Capturing light led scientists to conceive ways to move the light around so there would be no loss. If you look at a typical light source, such as a light bulb, the light is diffuse; it spreads out equally in all directions. Capturing any wavelength of that light is possible, but it would represent only a small portion of the total energy produced. Most of the light energy would be lost.

The source of light could not be natural light. Laser light was determined to be the best source of light, but lasers are expensive and large. Engineers made a class of laser that could be switched on and off rapidly. This laser, known as a ViCSEL, is a microscopic device that is can fit easily onto a typical silicon wafer.

The development of photonic microprocessors allows us to take advantage of the properties of light to build faster computers and devices that are simply not possible with electronic microprocessors. This will result in new devices that will allow us to communicate large amounts of data very quickly.

## ADVANCED ORGANIZERS

Prior to viewing this program, students should have some understanding of the following Benchmarks for Science Literacy, Oxford University Press which are excerpted and, in some cases, abbreviated below. Refer to the Benchmarks for more information.

### Benchmark 3: The Nature of Technology Section A - Technology and Science

#### Know by Grades 6-8

- Technology is essential to science for such purposes as access to outer space and other remote locations, sample collection and treatment, measurement, data collection and storage, computation, and communication of information.
- Engineers, architects, and others who engage in design and technology use scientific knowledge to solve practical problems. But they usually have to take human values and limitations into account as well.

### Section C - Energy Sources and Use

- Electrical energy can be produced from a variety of energy sources and can be transformed into almost any other form of energy. Moreover, electricity is used to distribute energy quickly and conveniently to distant locations.

\*Benchmarks can be found at [www.project2061.org/tools/benchol/bolintr.htm](http://www.project2061.org/tools/benchol/bolintr.htm)

## CRITICAL THINKING EXERCISES

- Compare an electronic microprocessor and a photonic microprocessor.
- Describe how a computer might look if its components could be widely separated from each other.
- Describe ways in which scientists and engineers might work together to build a new device.
- Explain why scientists are dependent on engineers to develop new tools to answer scientific questions.
- Compare the properties of photons of light and electrons.

## VOCABULARY

**Electromagnetic Spectrum** . . . The entire range of electromagnetic radiation. At one end of the spectrum are gamma rays, which have the shortest wavelengths and high frequencies. At the other end are radio waves, which have the longest wavelengths and low frequencies. Visible light is near the center of the spectrum.

**Iridescent** . . . . . Producing a display of lustrous, rainbowlike colors.

**Laser** . . . . . A device that produces a nearly parallel, nearly monochromatic, and coherent beam of light by exciting atoms to a higher energy level and causing them to radiate their energy in phase.

**Photons** . . . . . The quantum of electromagnetic energy, regarded as a discrete particle having zero mass, no electric charge, and an indefinitely long lifetime.

**Semiconductor** . . . . . A substance, as silicon or germanium, with electrical conductivity intermediate between that of an insulator and a conductor: a basic component of various kinds of electronic circuit element (semiconductor device) used in communications, control, and detection technology and in computers.

**X-Rays** . . . . . A form of electromagnetic radiation, similar to light but of shorter wavelength and capable of penetrating solids and of ionizing gases.

## CAREER POSSIBILITIES

- CHEMIST
- COMPUTER ENGINEER
- PHYSICIST
- SOFTWARE ENGINEER