Photonics in Everyday Life

Date

Author

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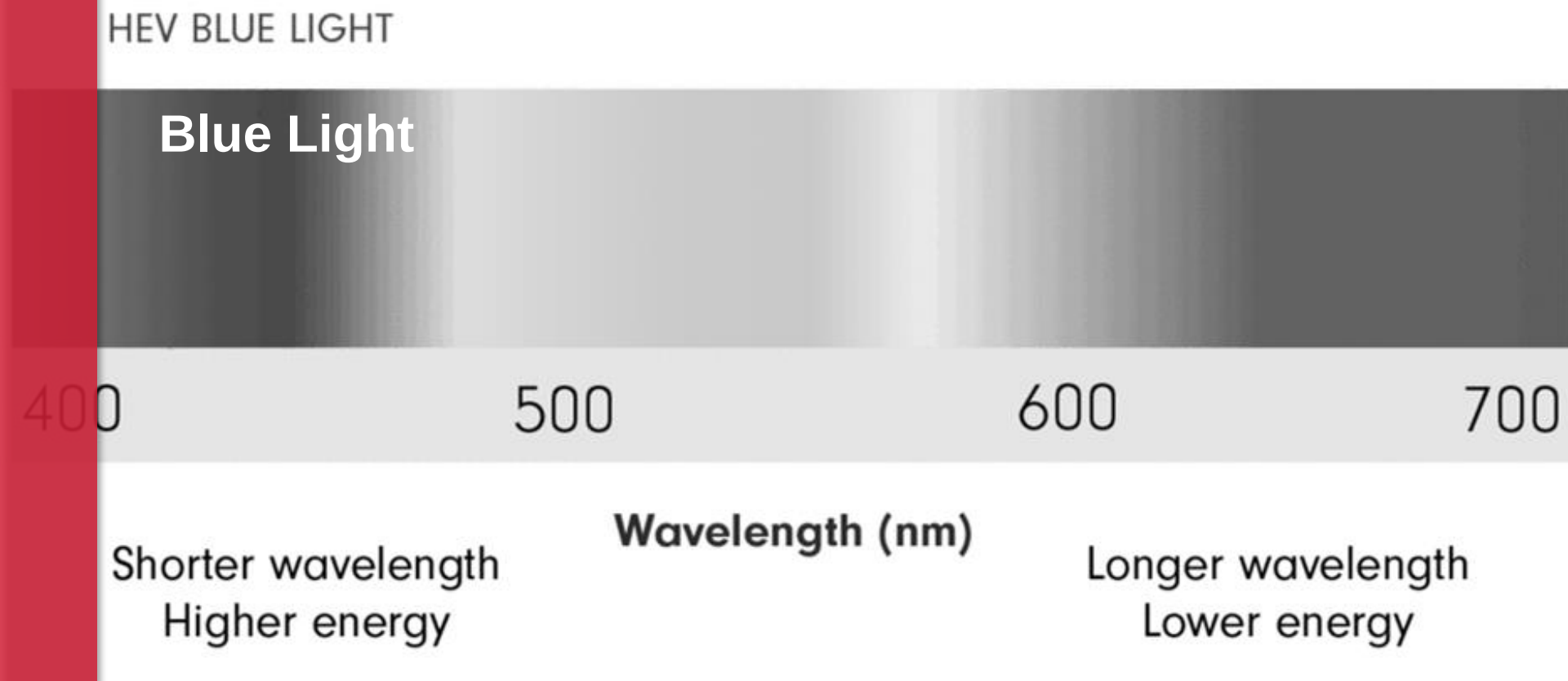
THORLABS

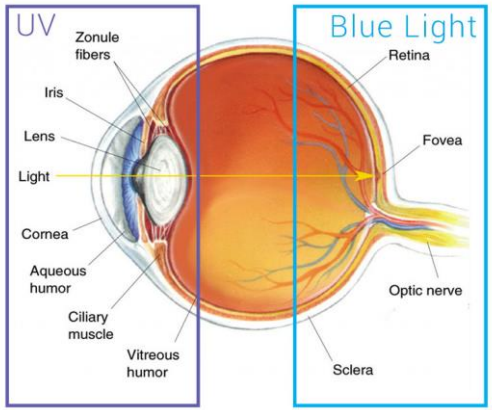
VISIBLE LIGHT SPECTRUM



The Basics

- What is it?
  - Blue light is a color in the visible light spectrum with wavelengths between 415 and 496 nm.

- Where does it come from?
  - 25-30% of light emitted from the sun is blue-violet material (which can be damaging).
  - Digital screens, fluorescent lights and LED lamps also emit it.



FAQs

- Is blue light bad for you?
  - Your eyes are not great at blocking blue light naturally. Because of this, it can pass through your cornea and lens and ultimately reach your retina.
  - Too much blue light exposure can harm the light-sensitive cells in your retina, which could eventually result in vision problems including eye strain, blurry vision, cataracts, dry eyes, fatigue, headaches, poor quality of sleep due to disruption of natural body clock, and retinal damage that could lead to irreversible vision loss.

- Should I get blue light glasses?
  - The lenses in blue light glasses are said to be designed to block or filter blue light from digital screens. Some glasses have a special coating while others have a pink or amber tint to filter out wavelengths of blue and green. However, the jury is still out on how effective these glasses really are.
  - Additionally, while blue light, in large doses, can cause harm to the retina, digital screens are not a unique or strong example of blue light exposure. Indirect sunlight produces 25x the amount of blue light that a typical screen does, and direct sunlight produces 250x as much.

FAQs Cont.

- What else can I do to protect my eyes from blue light?
  - Practice the 20-20-20 rule – every 20 minutes you look at something 20 ft away for 20 seconds. This makes your eyes relax and reminds them to blink again at your normal rate.
  - Use artificial tears if you experience dry eyes.
  - Sit at an arm's length (~25 in) away from your screen.

Rain-Sensing Windshield Wipers

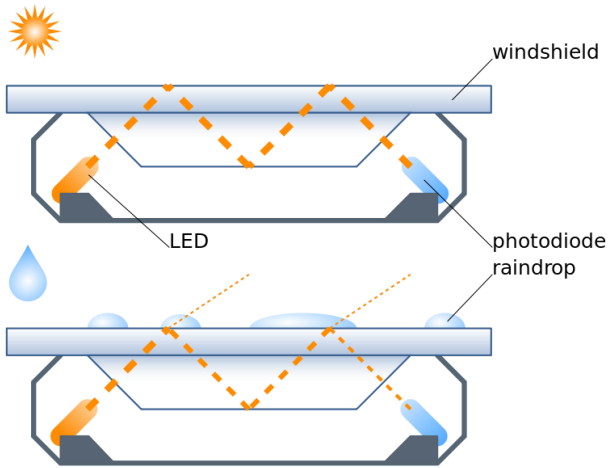
The Basics

- What is it?
  - These windshield wipers tell the car when it is raining so it automatically turns on the wipers without having the driver lift a finger. The wipers can also automatically adjust to the amount of rain.
  - Some newer cars have this sensor, but not all.

- How does it work?
  - The sensors have a light source such as an LED and a light detector such as a photodiode.
  - The LED sends infrared light to the windshield, which is reflected on its inner side. It then returns to the photodiode on the other side of the sensor.
  - When raindrops hit the windshield, they scatter light, causing the photodiode to receive less light from the LED, which triggers the windshield wipers. The les light the photodiode receives, the faster the windshield wipers will move due to more rain scattering more light.

FAQs

- Why don't all cars have this already?
  - While this automated process is convenient, it has some drawbacks as well. Depending on where the sensor is, it can malfunction due to the elements.
  - For example, when the sun is setting it may be at a low enough angle to shine directly into the sensor, interfering with how it collects its infrared light and accidentally triggering the wipers in dry conditions.



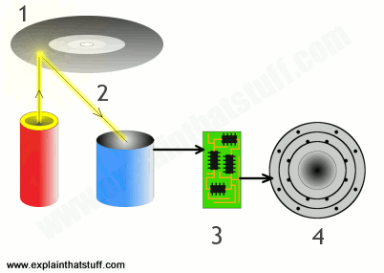
CD Players


PORTABLE STEREO RADIO CD PLAYER
naxa
NPB-251
CD-R/RW PLAYBACK
REPEAT
PROG
STOP
REW
F.F
PLAY/PAUSE
08

The Basics

- What is it?
  - For those of you too young to remember, CDs, or compact discs, store data in the form of tiny indentations on the smooth disc surface. A CD player then uses a laser beam to read the indentations and convert them into digital data.
  - CDs can store a variety of information from music to family photos to video games.

- How is the data stored as indentations?
  - The data stored is in binary code – 1s and 0s. A bump on the CD, known as a pit, represents the number 0 and the lack of a bump, known as land, represents the number 1.
  - This means that a CD with a music album on it actually stores every song on it as a long string of 1s and 0s and a CD player knows to convert into music for you as you're listening to it!



FAQs

- How does the CD player read the CD?
  - When you turn on the CD player, a motor rotates the CD at different speeds to read the outer and inner edges of it. They player will turn the CD at 200 rotations per minute (RPM) to read the outer edge and 500 RPM to read the inner edge.
  - A laser beam scans the underside of a CD from the center of the disc to the outer edge as it spins. When the beam falls on land (1) it reflects the light back, but when it falls on a pit (0) it scatters the light.
  - The CD player has an electronic light detector that recognizes when the laser has hit land, and in turns sends a signal to the system that generates a number 1. When it does not detect light, it sends a signal that generates the number 0.

- Why do scratches make a CD unreadable?
  - The scratches cause the laser beam to scatter, causing the light detector to send the wrong information to the circuit and not be able to read the data correctly.

Optics in Cameras

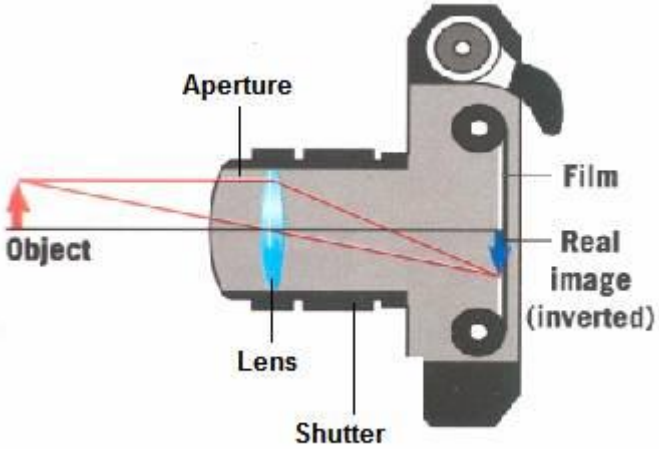
The Basics

- Why are optics involved in cameras?
  - Cameras need to capture light waves the same way our eyes reflect and absorb them.
  - The two main parts of a camera are the lens that collects light and the light detector that receives the projected light from the lens – aka optics.

- How does the lens work?
  - Its job is to take the beams of light that bounce off an object and redirect them to form an image that looks just like the scene in front of the lens.
  - Because light bounces off an object in every direction, it is important that this lens reverses the paths of the light all back to one point in order to get an image that looks exactly like the scene in front of it.
  - In a standard convex lens, one or both sides of the glass curves out. This means rays of light passing through will bend towards the center of the lens upon entry, which effectively reverses the path of light from an object.
  - Thus, cameras typically have a convex lens in them. Many cameras lenses today are actually made of multiple lenses to continue to alter how the camera receives light.

FAQs

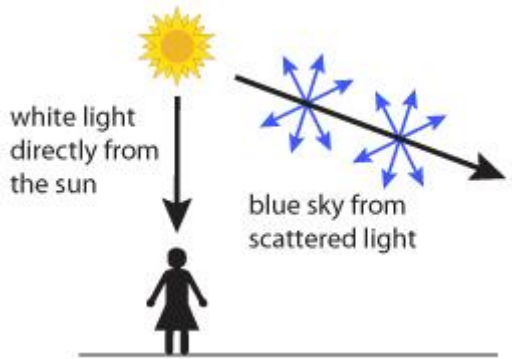
- What about the rest?
  - The camera lens collects the light and projects it onto a light detector surface.
  - Then, through various ways of processing, you get your final image that is shaped to your taste.
  - Many other aspects of the camera impact the final imaging such as focal length, aperture, focusing and stabilization.



Why is the Sky Blue?

The Basics

- Rayleigh Scattering is what impacts the sky's color.
  - As light moves through the atmosphere, most of the longer wavelengths (red-yellow in the visible light spectrum) pass straight through. Many of the shorter wavelengths of light (blue and violet) are absorbed by the gas molecules in the atmosphere.
  - The absorbed light is then radiated in different directions and scattered all about the sky – making it appear blue.



Self-Checkouts

The Basics

- 3 main parts:
  - Illumination system: located inside of the barcode scanner. “Scans” the black and white lines of a barcode by illumination the barcode with a red light. (Either in the handheld scanner or the surface scanner on the checkout machine).
  - Sensor: also located inside of the barcode scanner. The sensor detects the reflected light from the illumination system and sends a signal to the decoder.
  - Decoder: interprets the signal and converts it to text that is sent to the computer software system.
    - Software system hosts a variety of information including manufacturer, cost and quantity of all products sold. It can use this information to generate the right price and other information on the screen.

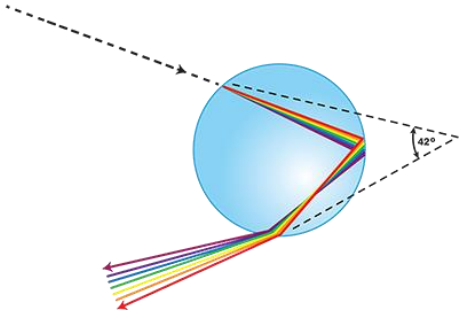
- Barcodes:
  - Play a major role in the function of the scanners at self-checkouts. They are more than black and white lines on individual products.
  - The scanning systems help businesses keep track of tons of information like inventory, an item’s popularity, the times of day an item is more likely to be bought, etc.

Rainbows

The Basics

- What is it?
  - A rainbow is an optical illusion that only occurs when a viewer's perspective aligns just right with sunlight interacting with specific atmospheric conditions.
  - A rainbow is not a physical object and doesn't exist in one static place.

- What are the specific conditions to form a rainbow?
  - Water droplet in the air (so right after it rains).
  - Sun is behind the viewer.
  - Few clouds.



FAQs

- How does the rainbow form?
  - Sunlight shines on a droplet of water. As the light passes into the droplet, it bends (refracts) a little since light travels slower in water than in air. The light then bounces back (reflects) off the back of the droplet and exits the way it enters. Upon exit, the light speeds up and refracts again at multiple angles, creating the colors we see.
  - Colors with longer wavelengths (red) bend less than colors with shorter wavelengths (violet). This means that as the light reflects back to the viewer, the water droplets will appear separated into all of the visible colors of the light spectrum.

- Fun facts:
  - A rainbow is actually a full circle, but we can only see part of it from the ground. If you were in an airplane (at just the right angle in just the right conditions) you could see the full circle.
  - The colors of a rainbow are always in the order of their wavelength (longest to shortest).