Infrared Light

Overview: Infra-red light is in the part of the electromagnetic spectrum that isn't usually visible to human eyes, but using this nifty trick, you will easily be able to see the IR signal from your TV remote, remote-controller for an RC car, and more!

What to Learn: When you press the button on your remote control to your TV, you're using infrared light (IR) to control your TV. Infrared light is invisible to our eyes. However, snakes can detect IR and see the redder hues that we can't. Every warm body gives off light in the IR, so snakes use this to find mice in the cool night.

Materials :

You will need these items:

- remote control for TV or stereo
- camera (video or still camera)

This is just a suggested list of objects. Feel free to find your own!

- metal frying pan or cookie sheet
- plastic sheet
- plastic baggie
- trash bag (white or black, or both)
- wooden cutting board

Experiment

1. Grab a remote control and verify that it is indeed working. Turn the device on and off using the remote.
2. Grab a sheet of plastic, like a cutting board, and place it between your remote and the device. Does it turn on when you aim the beam at it? Does the plastic block the beam?
3. Open up a trash bag and place one side of the bag between your remote and the device. Did that block the beam, or did the remote turn on the device?
4. What else can you try? How about a clear bag?
5. A clear bag filled with water?
6. A sheet of paper?
7. What about a metal pan? Find something that's not coated with Teflon. Does infrared go through metal?
8. What if you point it at a white wall behind you, pretending the white wall is a mirror and aiming it so it will reflect it back to the device?
9. Complete the table.
10. Now let's make the invisible infrared light *visible*. Take your camera (either still or video camera will work) and turn it on. Put it on a mode where you can see through the view screen. Aim the infrared camera right at the emitter for the remote (usually near the top) and press a button. Point the remote right at the camera and watch through the camera. Our eyes normally can't see the infrared light, but the camera can!

11. The camera can also see the otherwise dark end of the remote! If your camera has a special night vision mode, where it's especially sensitive to infrared light? If so, try it!

Infrared Data Table

Item/Object Tested	Guess FIRST! *Will the Infrared Light Pass Through?*	What Happened? *(Did it pass through or not?)*

Reading

Different detectors are sensitive to different colors. Your eyeballs are sensitive to specific colors in the 400-700 nm (nanometer) range which is how long one wavelength is. A nanometer is extremely tiny!

The frequency of red light is around 430 trillion Hz (Hertz, which is one wave cycle per second). If you were to count the number of waves passing a certain point in one second, you'd count 430 trillion waves. If you counted 750 trillion waves, the light would be violet. Different colors have different frequencies.

Light energy (also called *electromagnetic radiation)* with the lowest amounts of energy and longest wavelengths (1mm to 1km) are **radio waves**. These are emitted by radio galaxies like quasars, supernova leftovers, and the radio tower at the top of the hill. Radio waves from space with a wavelength greater than 100 meters are reflected back into space by our atmosphere. Radio waves are detected in space by the COBE satellite, the VLA in New Mexico, and the Arecibo Observatory in South America.

The next step down in wave size is **microwaves,** which have more energy than radio waves but are a shorter wavelength. These are the ones inside your microwave that excite the water molecules inside your food so that your food heats up.

Infrared (IR) has slightly more energy and an even smaller wavelength (700 nanometers, or nm to 1mm), and you can feel this light as warmth on your skin when you step into the sun. There's a lot of infrared radiation in space

around the star-forming clouds and objects with a temperature above 1000°C. SOFIA and the Infrared Observatory both detect infrared from various stars in space.

Visible light or optical light waves are the visible rainbow you can see with your eyes after a rainy day. These wavelengths have more energy and shorter wavelengths (300 to 700 nm) than infrared. The Hubble Space Telescope and Earth-bound optical telescopes look at stars, galaxies, and planets.

Ultraviolet (UV) light has more energy and shorter wavelengths (10nm to 390nm) than visible light, and you'll find hot stars emit largely in this region of the spectrum. The ozone layer protects us from most of the UV, but not all. That's why you get a sunburn if you don't wear sun block, and why colors fade in sunlight. SkyLab, Astrotelescope and SOHO all search for UV. SOHO looks directly at the sun's corona to get amazing images in UV.

X-rays have even more energy and short wavelengths (0.01nm to 10 nm) than UV light, and you'll find these are emitted by active black holes, supernova remnants, and very hot stars (we're talking 1 million to 100 million°C). Fortunately for us, these are quickly absorbed in the upper atmosphere and most never make it to the surface of Earth. X-rays generated on earth are emitted by electrons outside the nucleus of an atom. ROSAT looked at cluster galaxies to detect X-ray sources.

Deadly **gamma rays** have the most amount of energy and the shortest frequency (less than 0.01 nm), and you'll find these in areas of superflares from pulsars, supernovas, and radioactive atoms. Gamma rays are like X-rays, in that they both can go through thick materials, and would rather go through your detector than into it to be detected. Gamma rays on Earth are generated inside the nucleus of an atom. The Compton Observatory looked at quasars to detect gamma rays.

Exercises

1. Look over your data table. What *kinds* of objects (plastic, metal, natural, etc.) allow infrared light to pass through them?

2. Why does the camera work in making the infrared light visible?

Answers to Exercises: Infrared Light

1. What kinds of objects allow infrared light to pass through them? (Check data.)

2. Why does the camera work in making the infrared light visible? (The camera is a viewer that lets us see this special frequency of light. Light is technically what we call *electromagnetic radiation.* Radio waves, infrared, microwaves, X-rays, and gamma rays are all *electromagnetic radiation*. If you could see the radio waves, then you could see radio towers as they transmit. They would appear to light up. If you could see all forms of light, then not only could you see the radio towers, but also your cell phone, the doctor's X-ray cameras, and your car radio would all be lit up as they operated. It's all made out of the same stuff, just not all of it is visible to our eyes.)