Light

How this relates to the curriculum:

This demo is most suitable for the Grade 4 Light Unit.

Part 1: Electromagnetic Spectrum

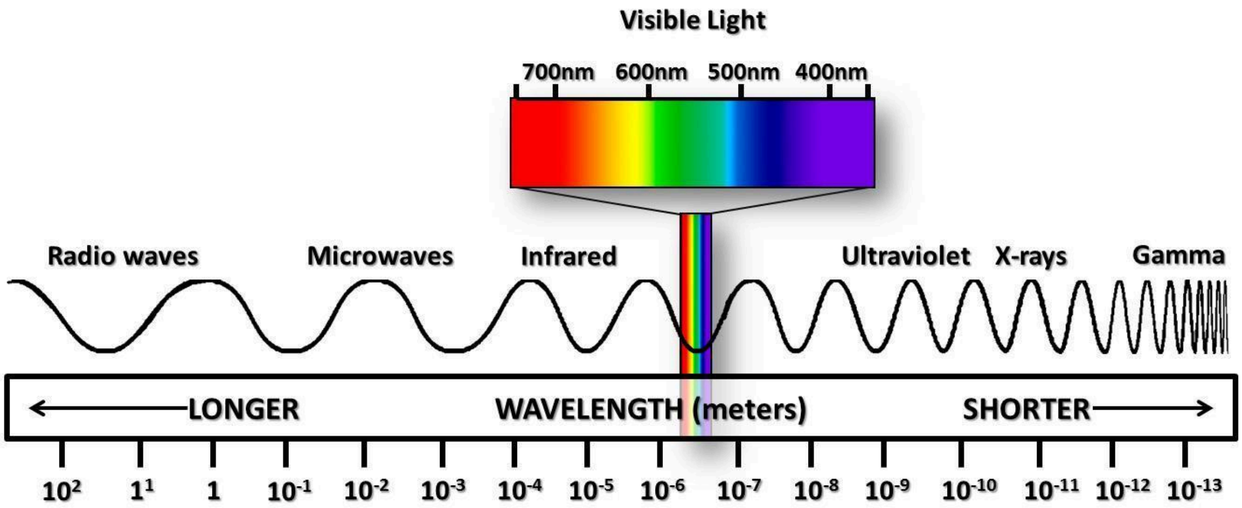
- **PowerPoint slides if the class has a projector or SMART Board. If not, please print out a similar image of infrared and X-Ray Radiation.**

What is light? It's a kind of energy called "electromagnetic (EM) radiation" (but this kind of radiation is not harmful, except for the occasional sunburn). There are many different kinds of EM radiation, including radio waves, microwaves, infrared rays, x-rays, and gamma rays. Our eyes are only adapted to see a very small part of the electromagnetic spectrum, known as visible light. The light that we can see makes up the colours of the rainbow (ROYGBIV – red, orange, yellow, green, blue, indigo, and violet)!

(Show the examples of different types of EM radiation using the provided slides.)

- Infrared radiation is actually heat. We can't see heat, but we sure can feel it!
- X-rays are a form of high-energy radiation that can actually travel through your skin and bounces off your bones, allowing us to take a picture of them! X-rays can be very useful if you have a broken bone.
- Ultraviolet, or UV, light is also a kind of electromagnetic radiation. It travels at a wavelength that is not registered by our eye. It is mainly emitted from the sun, along with visible light, and is the reason why we get sunburned after spending too much time outdoors!
- Other types of EM radiation include microwaves and radio waves!

All forms of EM radiation travel at the same speed (the speed of light – 3×10^8 m/s), but the "size" of the wave is what really determines what type of EMR it is. For example, long waves with low frequencies (e.g. radio waves) are harmless, but really short waves, with high frequencies (e.g. gamma waves) are extremely powerful. How do we measure the size of a wave? We use something called the "wavelength", which is the distance from one peak to the next! You can also measure one "trough" to another (that's the lowest point!)



<u>Activity I: The Ultraviolet Light Spectrum</u>

Materials:

- **Black Light**
- **Your driver's license if you have one!**
- **Yellow Paper and Highlighters**

Here are some fun things to try to show how UV light reveals things that our eyes would not normally see!

Video Events

1. A secret message is written on a piece of paper.
2. The black light is shone on the paper to reveal its written message
3. Ask the students what they see.

What's going on here? The reason black lights are called "black lights" is because they produce very little light that our eyes can see, but a lot of ultraviolet light (UV), which our eyes cannot see.

INTERESTING FACT ABOUT UV LIGHT: Bees and some birds can see UV light. It helps them figure out boys from girls. Also, when they look at a flower, humans, butterflies, and bees all see different things because our eyes detect different wavelengths!

Part 2: Controlling light

How does light travel?
FAST and STRAIGHT

How FAST?
300,000 kilometres per second! Light from the sun takes about 8 minutes to go 149 million kilometres to earth. Does this seem SLOW? Well, if you could DRIVE to the Sun at highway speed [100 kph], it would take you 177 years to get there!

How STRAIGHT?
Perfectly straight until something bends it.

The straight paths of light are called LIGHT RAYS.

There are THREE basic ways to control light

1. **Block it ... with something.** This creates a shadow.
2. **Change its path with a mirror**. This is called a REFLECTION.
3. **Bend it:** Change its direction by making it pass into another transparent material of different density, like glass or water. **This is called REFRACTION, and it's how lenses work.** Another example of this is when you have a straw sitting in a glass of water; it looks like the straw is split in half! There aren't two straws all of sudden, but since water and air bend light differently; we see the appearance of two.

Light is produced, controlled, and detected in so many ways around you! Can you name a few things that either emit or control light?

- Contact lenses, glasses
- Lenses for TV, movie, camera
- Fax machines, telescopes
- Microscopes and magnifiers,
- Fireworks

- Other projectors (computer, TV)

Earlier, we mentioned the third way to control light is to bend it, called refraction! We are now going to break up into five groups (or less) to demonstrate this property of light.

2A) Exploring Refraction

Activity II: Symbol Refraction

Materials

- **Glass Cups**
- **Water (Obtain from drinking fountain or sink)**
- **Paper (supply from classroom)**
- **Writing Utensil (supply from classroom)**

Instructions:

1. A piece of paper showing an arrow pointing to the left.
2. The arrow is lowered behind the glass cup with the arrow behind the cup.
3. Notice anything different? The arrow should now be pointing in the opposite direction!

Why does this happen? As we said earlier, light is cool in that it can change it's direction by passing through another transparent material, in this case glass, air and water. In this experiment, light travelled from air, glass, water, back through the glass, back through the air, before hitting the drawing of your arrow. Anytime that light passes through one medium to the other, it refracts!

2B) Splitting up white light

Did you know that regular light from the sun or from a light bulb really contains all the colors of the rainbow? White light is actually a combination of all colors of light. But you have to split it up to see this.

This is where 'spectroscopes' come in handy. They show the different colors of light that make up white light. Do you think that the colors you see in a fluorescent light are different from incandescent light?

Can you split light without a spectroscope?

YES! You can split up white light into its colors with a **prism**.

Activity III) Using prisms to split light

Materials

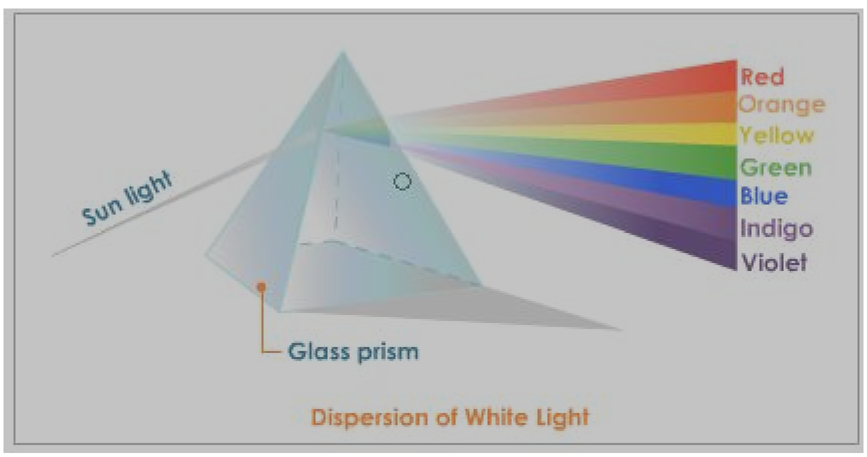
- **Flashlight**
- **Prisms**
- **CD**

Spectrometer

1. A spectrometer is placed in front of a candle.
2. You can see the light splitting into its different rays of visible light.

Prism

1. A prism is held by a window.
2. The light from outside is split by the prism. You can also see the light splitting into its different rays of visible light



CD

You can also use a CD to get the same effect!

1. The CD has many small grooves on it that catch the light in different ways and cause colors to bounce back to our eyes. Tilting the CD around and shows how the color pattern changes.

The rainbows we sometimes see in the sky work in the same way. When sunlight shines on raindrops in just the right way, the sunlight is bent as it moves through the drops. It spreads out and is reflected back to us as a colourful rainbow in the sky.

Gather all Spectroscopes before moving on to the laser demonstration.

What about a laser?
A laser is a special source of light of only one pure color (or **WAVELENGTH**). It is a very concentrated beam of light. It's so concentrated that you can only see a tiny point rather than a big circle like a flashlight shows *(demonstrate the area lit up on the paper or the wall by each light)*. You can't break up laser light into other colors either because it is only one colour. However, you can REFLECT laser light.

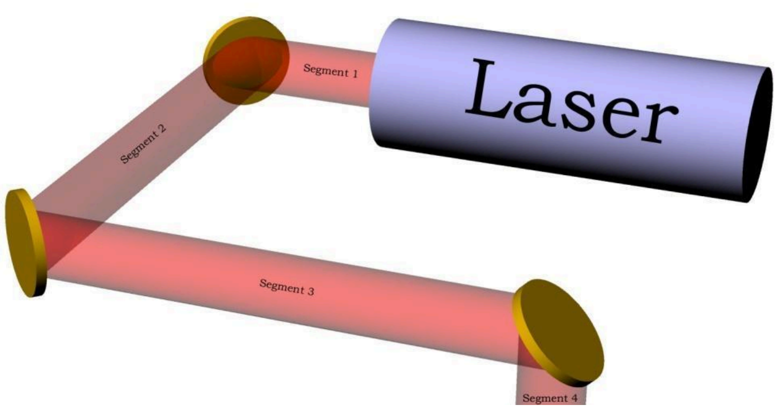
Activity IV: Lasers

Materials

- **Laser**
- **2 Mirrors (found in the demo kits)**
- **Spectrometer**

Video Events

1. The laser is reflected by 2 mirrors



IMPORTANT SAFETY NOTE: PLEASE BE CAREFUL WITH LASERS AS THEY CAN SERIOUSLY DAMAGE THE RETINA IF SHONE DIRECTLY INTO THE EYE.

Part V: Polarizing Light

Materials: Polarizing light sheets.

Video Events

1. Both the polarizing filters are placed overlapping each other in the same orientation. You will be able to see through it.
2. The second polarizing light square is slowly turned 90 degrees. Notice how the you cannot see through the 2 polarizing squares

When light travels it moves in a wave. These sheets have the ability to polarize light, which means that they can put all the light waves in the same plane/direction. The light that is not in the correct orientation is simply blocked by the filter. This is why when two sheets are perpendicular to each other, no light goes through. They each block the light in perpendicular orientations. However when you add a third sheet in between that is angled, it allows some light through from the first filter and some light out through the last filter allowing you to see through them once again.

<u>**Part 3: The Chemistry of Fireworks**</u>

<u>1. Explanation (for Gr 4 and older)</u>

Light is a form of energy. When things are being heated up, their particles are gaining energy from the heat, and emitting energy when they get too hot. This emitted energy comes in the form of light (eg. burning candle.) Think of the boric acid as excited particles. When the flame excites these particles, these particles will release the right amount of energy to produce a green light. The colour of light produced depends on how much energy is being released. Remember the EMR spectrum? Different wavelengths (and therefore different colours) are associated with a certain amount of energy being emitted!

We can use these color emissions and apply them to technologies like neon lights or fireworks OR even the magical campfire powder that changes your fire to blue and green.

(if needed)

<u>2. Detailed explanation</u>

Atoms and ions have two kinds of states: a ground state and an excited state. In the ground state, all electrons in the specific atom are in their lowest energy levels possible. The heat of a flame can excite atoms, as well as ions, – that is, the electrons in the atom absorb energy and occupy a higher energy level. These excited electrons are highly unstable and short- lived, quickly returning to their ground state. When an excited electron returns to its stable ground state, it releases excess energy in form of light. The color of the emitted light is specific for each element: yellow light is specific for sodium, red for lithium and strontium, violet for potassium and rubidium, blue for caesium, green for barium, copper and boron, etc.