Please mute your microphones.
You may keep your video on if you wish.
We will begin shortly.

Thank you.

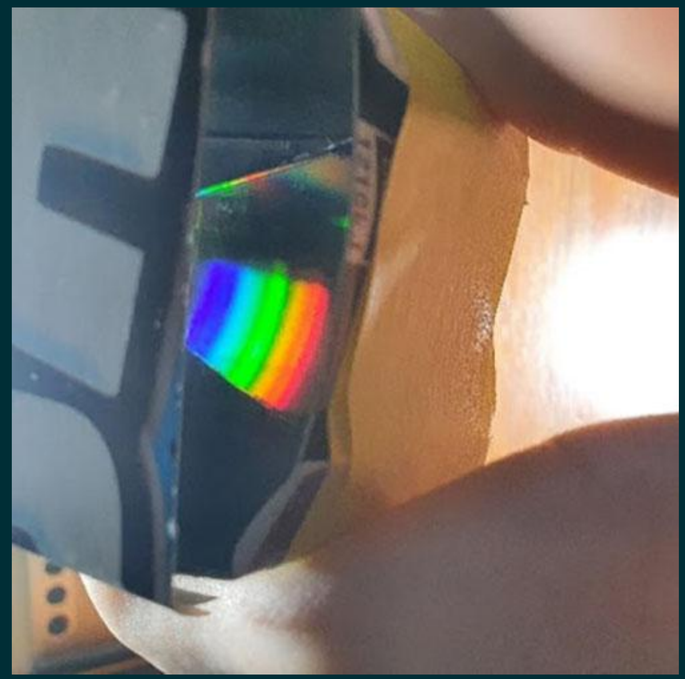
FYS

Spectrometer

Physics / Optics

Materials

- Spectrometer Template from UWM Chemistry (printed out, was attached in our email/text)
- Cardboard
- Scissors
- Glue or Sticky tape
- CD or DVD
- Optional: Box cutter/X-Acto knife



Steps 1 and 2

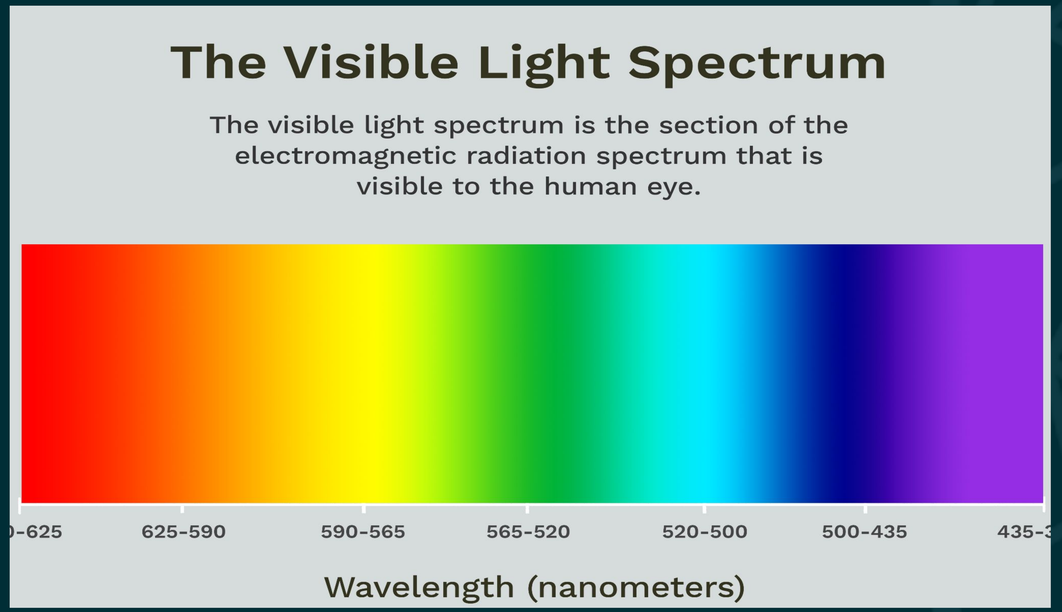
1. Make sure the template sheet is printed out. Cut a rectangle around one of the templates on the sheet.
2. Stick the template onto the cardboard, and cut the cardboard so that it’s a similar size to the paper you cut.

Let's Think:

Have you ever seen a glass prism held up to light?
What did you see happen?

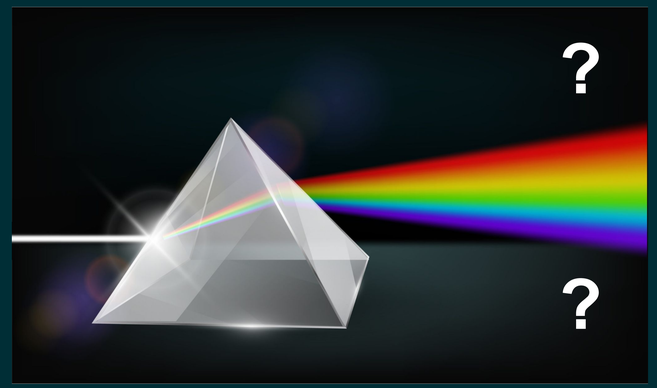
Light

- In reality, the light that we see everywhere is just white light. The reason why we see multiple different colors from this white light is because of our eyes.
- This white light is then changed into these different colors of the Visible Light Spectrum. This spectrum is filled with all the colors that we can see.
- *What other object in nature has these colors?*

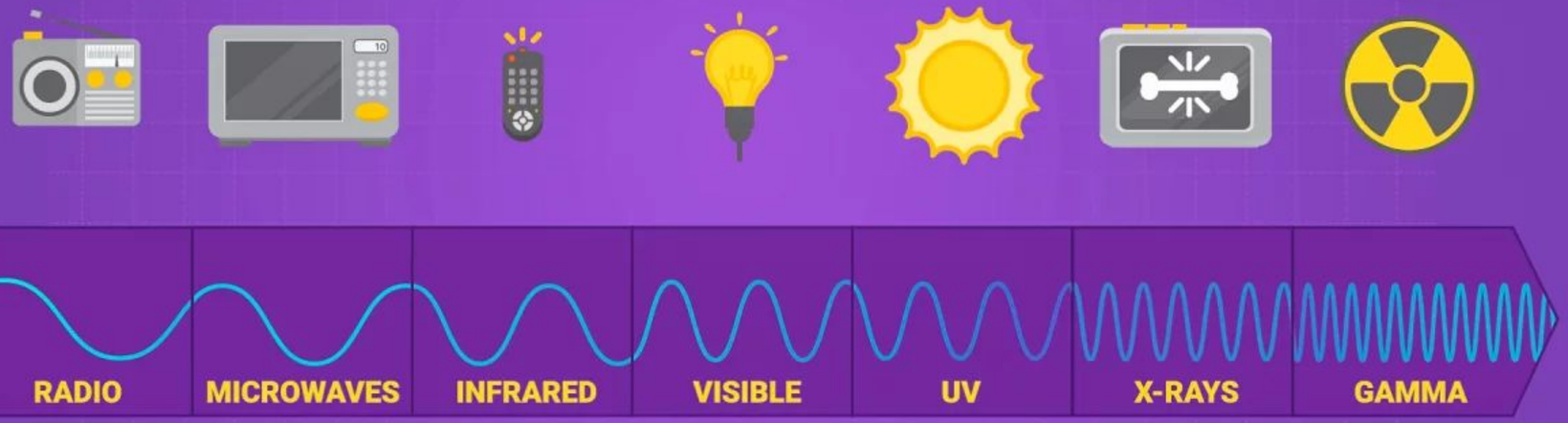


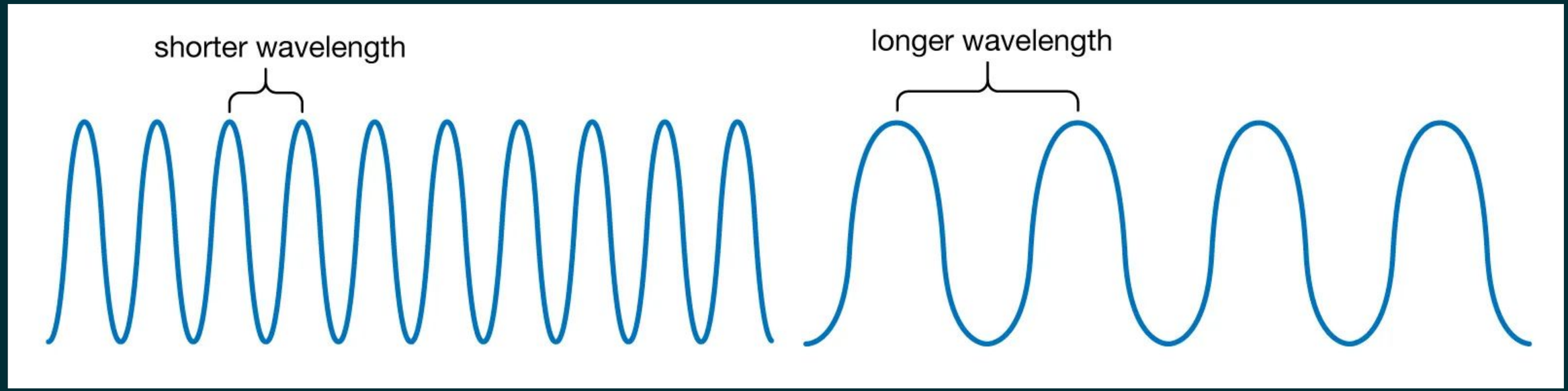
The Electromagnetic Spectrum

- The different colors of the visible light spectrum aren't the only types of light, though.
- If we had a special kind of camera, we could detect another type of light. We would see this type of light next to the **red** light. *What do you think this type of light is called?*
- *What type of light would we see next to the **violet** light?*

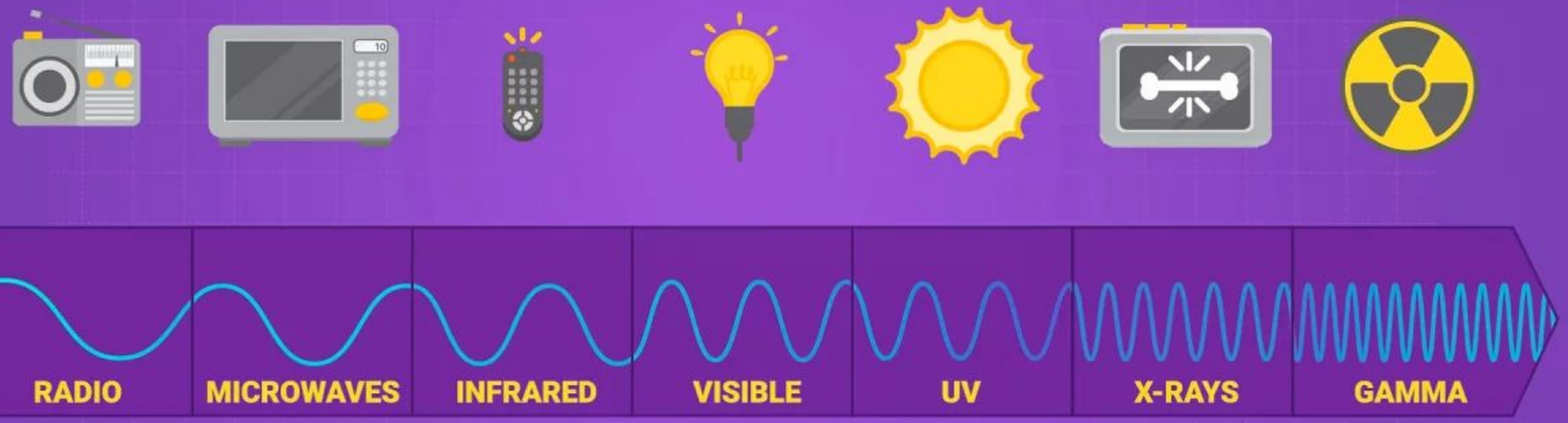


Electromagnetic Spectrum



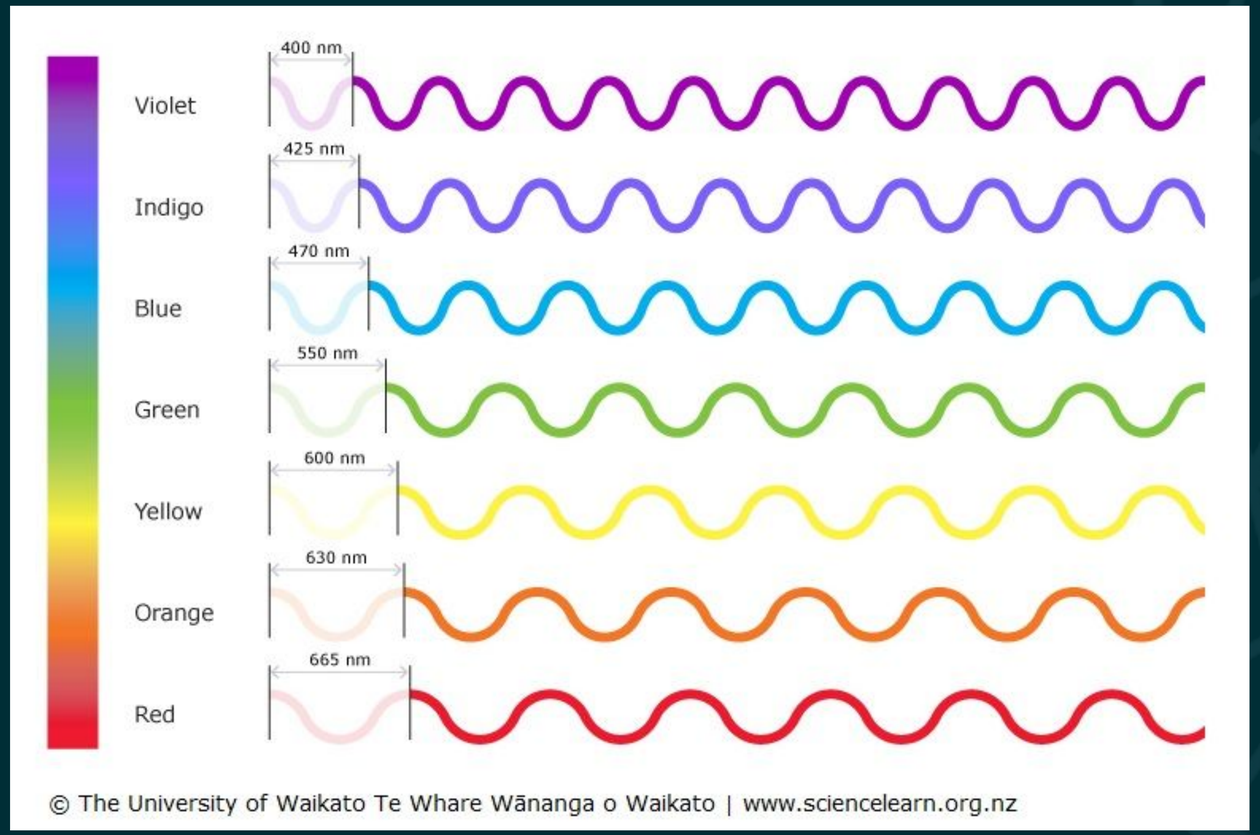

shorter wavelength
longer wavelength

Electromagnetic Spectrum



Wavelengths of Visible Light

- Light travels in the form of waves.
- Different types of light have different frequencies and wavelengths, which our eye perceives as different colors.
- Look at the picture. *Which type of light has the longest wavelength?*



Steps 3 and 4

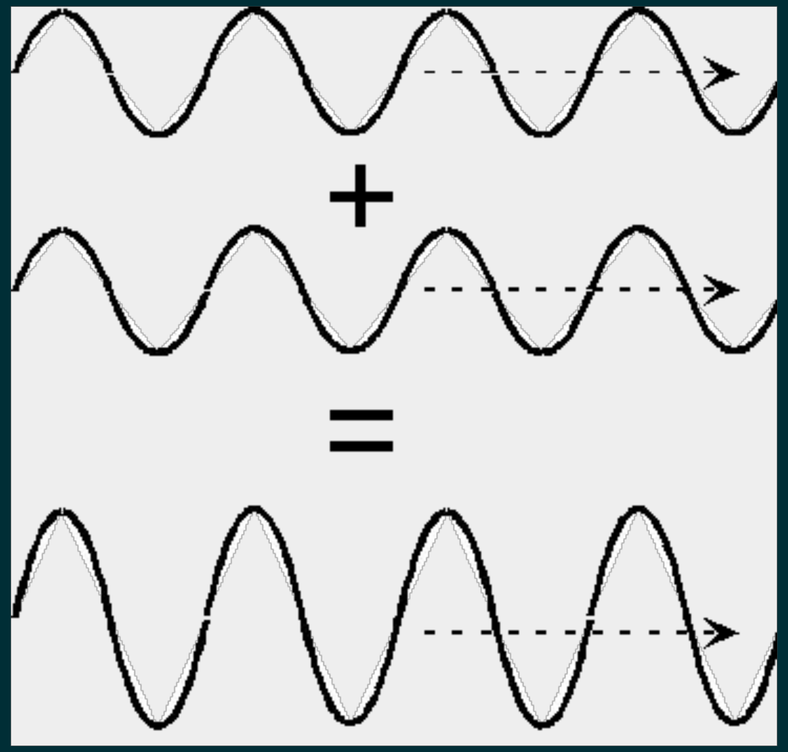
3. Now that the glue has dried, cut along all of the solid lines on the template. Do not cut the dotted lines.
4. Cut the slit with straight edges carefully, so as to let through some light.

Let's Think:

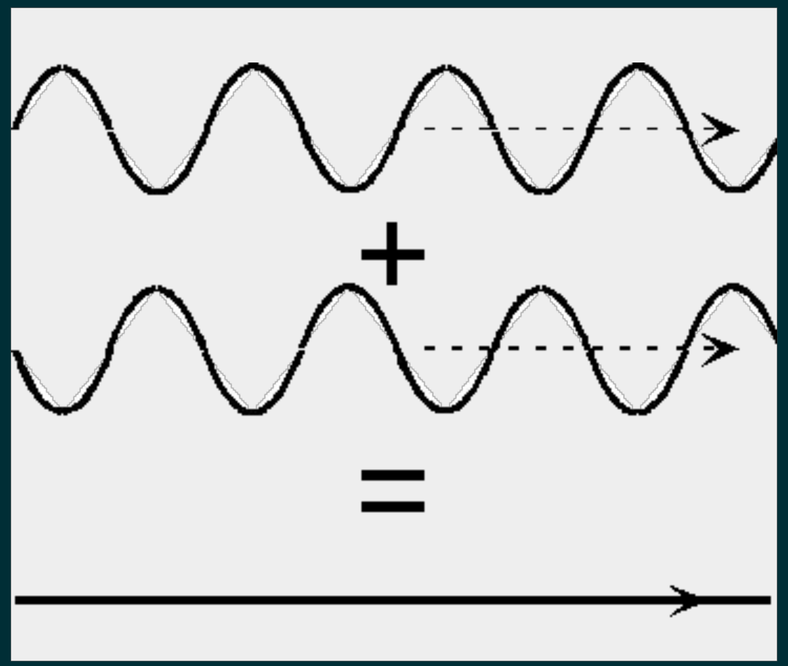
If you want the dog to go faster, when should you push it?

Constructive/Destructive Interference

- It’s not just pushing the dog that makes it go higher. It’s pushing the dog at the **right time**.
- If we have two light waves, they won’t always add together. This depends on timing, just like the dog on the swing.
- The light waves can either **combine** to make brighter light, or **cancel each other out** to make the light less bright.



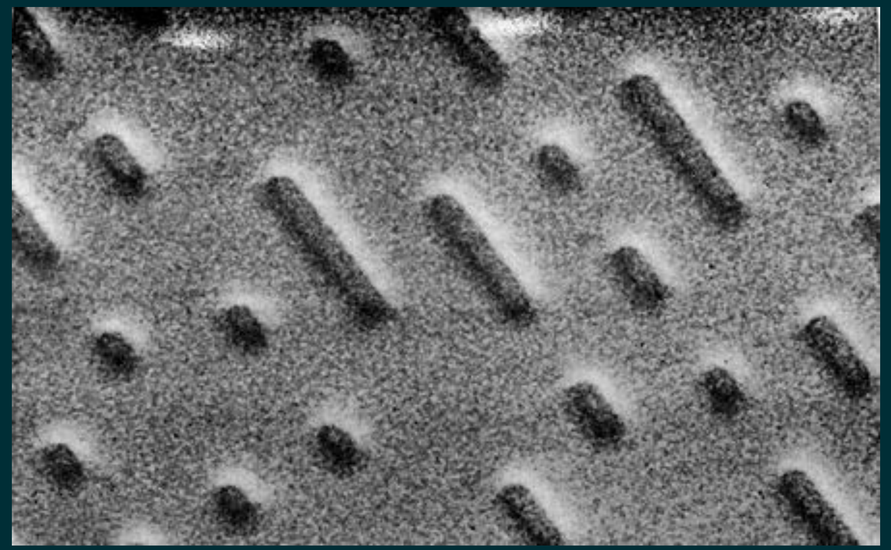
constructive interference:
light waves add together



destructive interference:
light waves cancel each other out

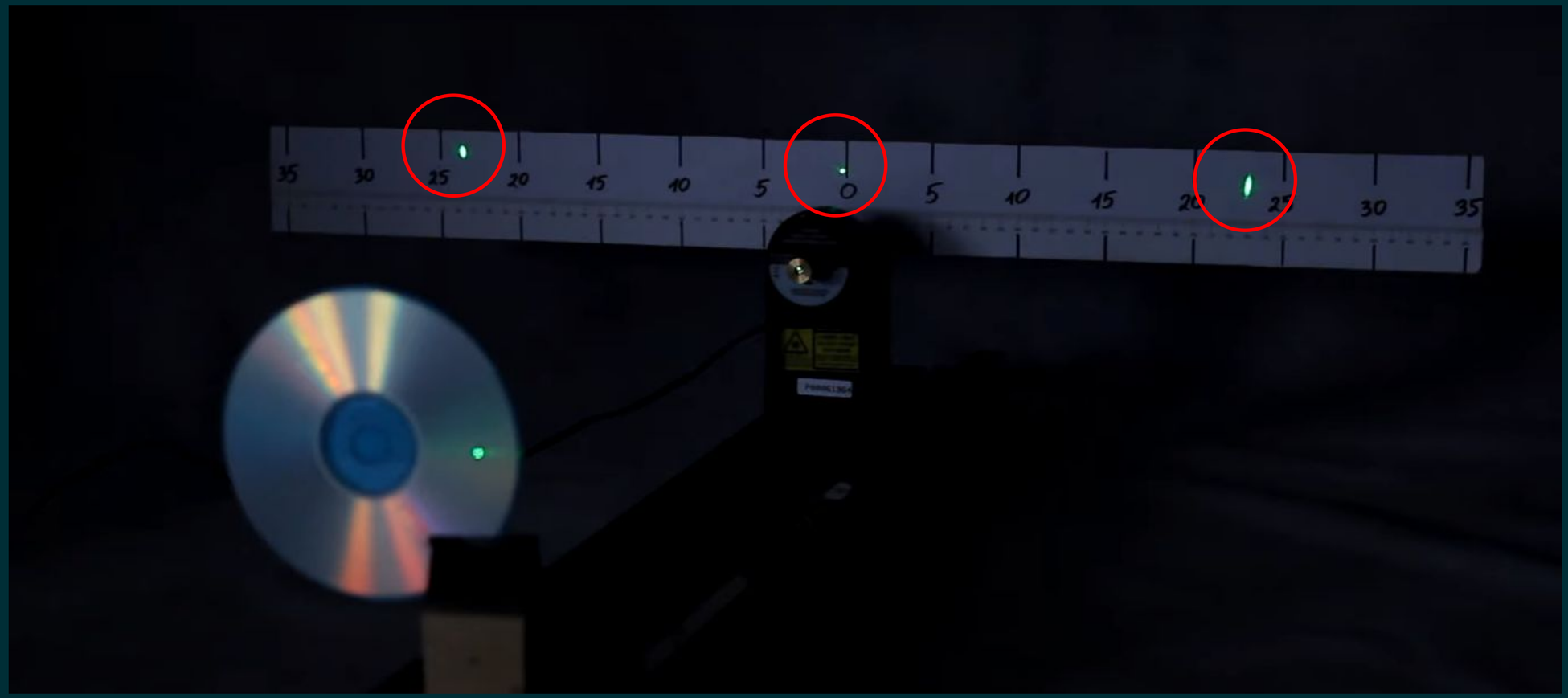
CDs

- If you look closely at a CD or DVD, you might be able to see little **grooves**. But with a microscope zoomed in really far, we can see the grooves much more easily:



Diffraction Grating

- These microscopic grooves cause the light to bounce in all different directions. This is called **diffraction grating**.
- At some angles, the light waves are lined up. *What happens as a result?*
- At other angles, the waves aren't lined up. *What happens as a result?*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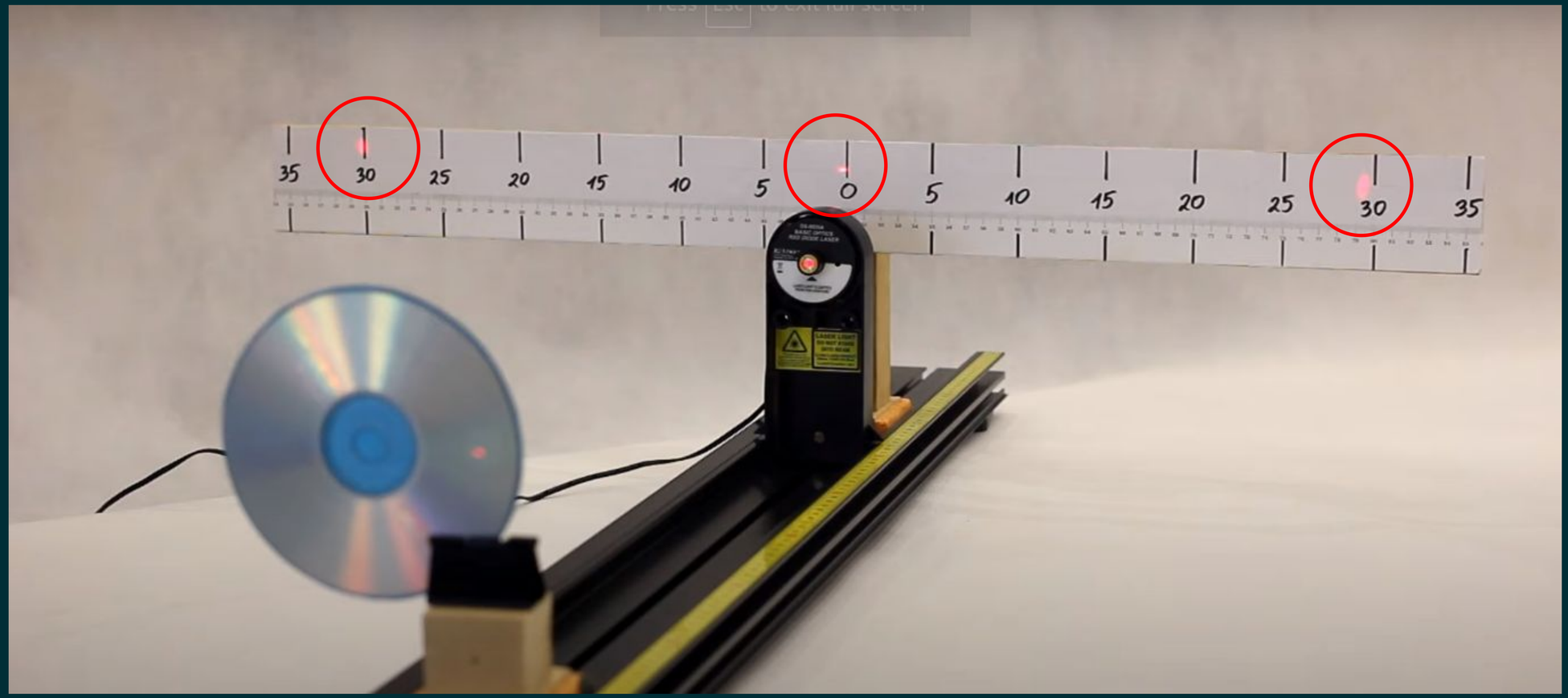
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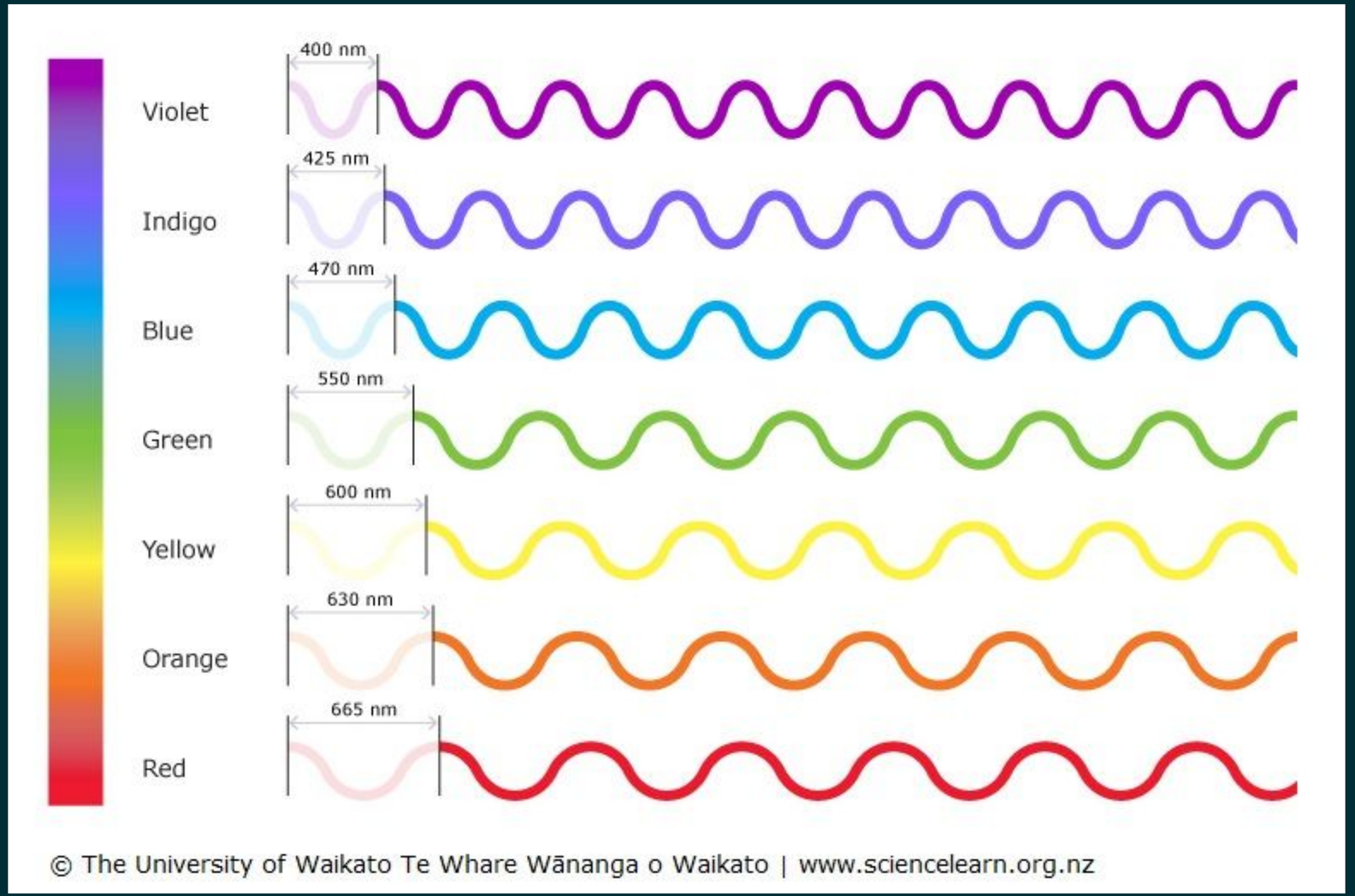
400 nm
Violet
425 nm
Indigo
470 nm
Blue
550 nm
Green
600 nm
Yellow
630 nm
Orange
665 nm
Red
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Spectrometry: the measurement of the interactions between light and matter

Spectrometer: *the device* for detecting and analyzing wavelengths of visible light

Now that we've learned what we need to know, let's finish making our spectrometer.

Materials

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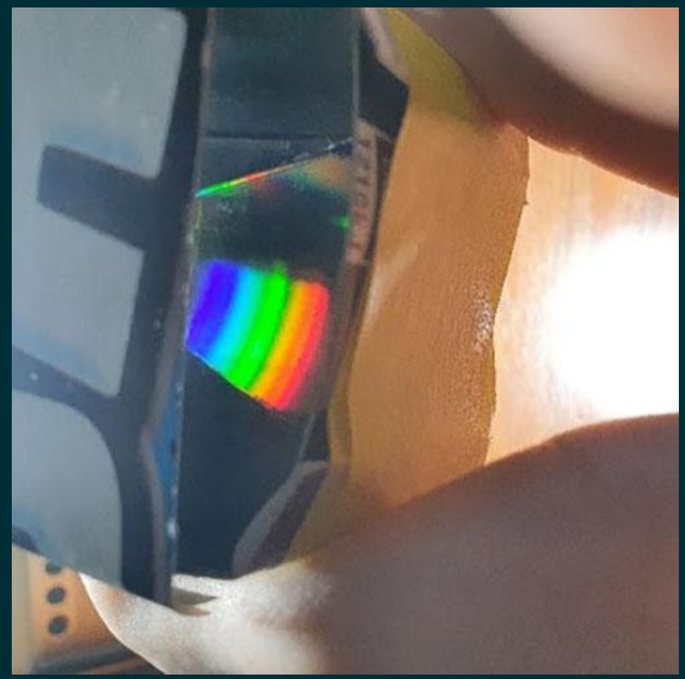


Steps 5-8

5. Use scissors to cut the CD into wedges that match the wedges on the template. Make sure the reflective film doesn’t peel off.
6. Make sure the iridescent shiny side is exposed, but cover the mirror-like part at the narrow point with tape or glued on paper as shown on the template.
7. Fold on the other dotted lines to make a little box with the CD piece inside on the bottom.
8. Glue or tape edges closed (a to a, b to b, etc.) so that they don't leak light, but do not cover the slit. You can tape g and h less thoroughly so the back can be opened to look at or readjust the CD piece.

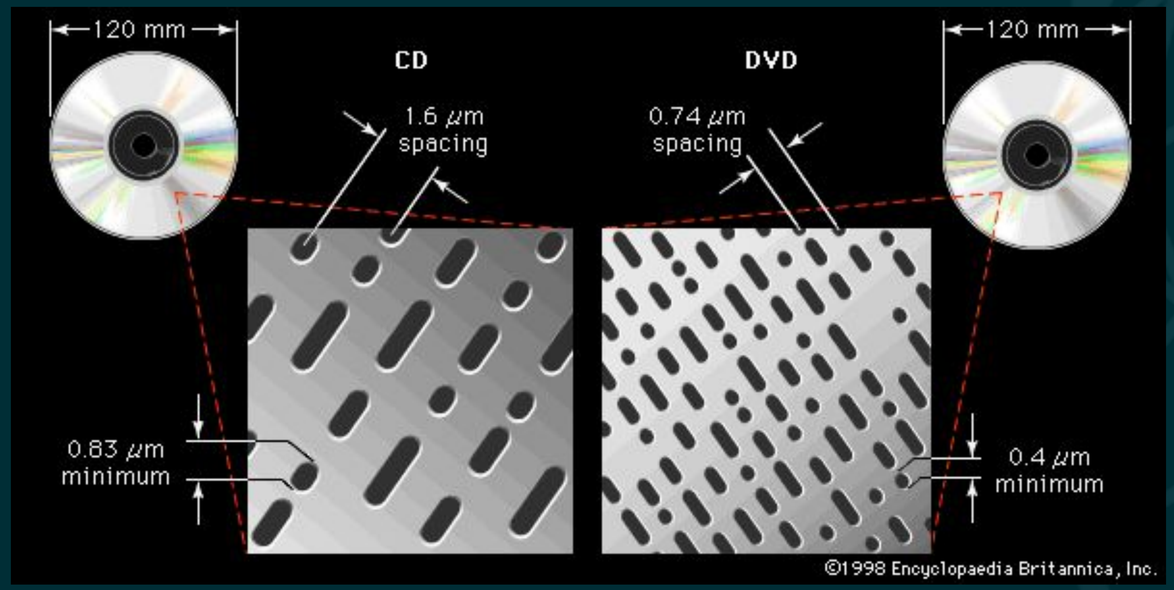
Now point the slit at a light, and look through the hole at the CD. What do you see?

Try looking at different types of lightbulbs such as an incandescent, fluorescent, or RGB light bulb.

Try other light sources BUT DO NOT POINT THIS AT THE SUN!

Why does this work?

A CD has tiny groves that are invisible to the eye. When light is shined on these groves the groves separate the light though reflections into the visible colored spectrum. Using the spectrometer, the light enters through the slit and is separated into its colors which are viewed on the CD.



Now that we've covered the science behind our spectrometer, let's move on to some reflection questions!

Reflection Questions

1. *What would happen if you widened the slit in our spectrometer?*
2. *What real-world applications can spectrometry have, and how might your DIY version be useful?*
3. *What was your favorite part of this experiment?*

Real World Applications!

*Since spectrometry is the study of **light** interaction with matter, it has a wide range of practical applications in various fields:*

- *Chemistry/forensics*
- *Environmental science*
- *Astronomy*
- *Medicine*
- *Art and archaeology*

See you all next week!

Visit our website, **futureforyoungscientists.org**.

If you have any photos from this week, please share these with us by email (futureforyoungscientists@gmail.com) or Facebook, as we would like to be able to share everyone's experience.

FYS will be having a different set of educators for a new session after our lessons end. More information about them can be found on our website under the "Nebula" tab.