WS2
WOMEN SUPPORTING WOMEN IN THE SCIENCES

Training for Educators

Light & Color

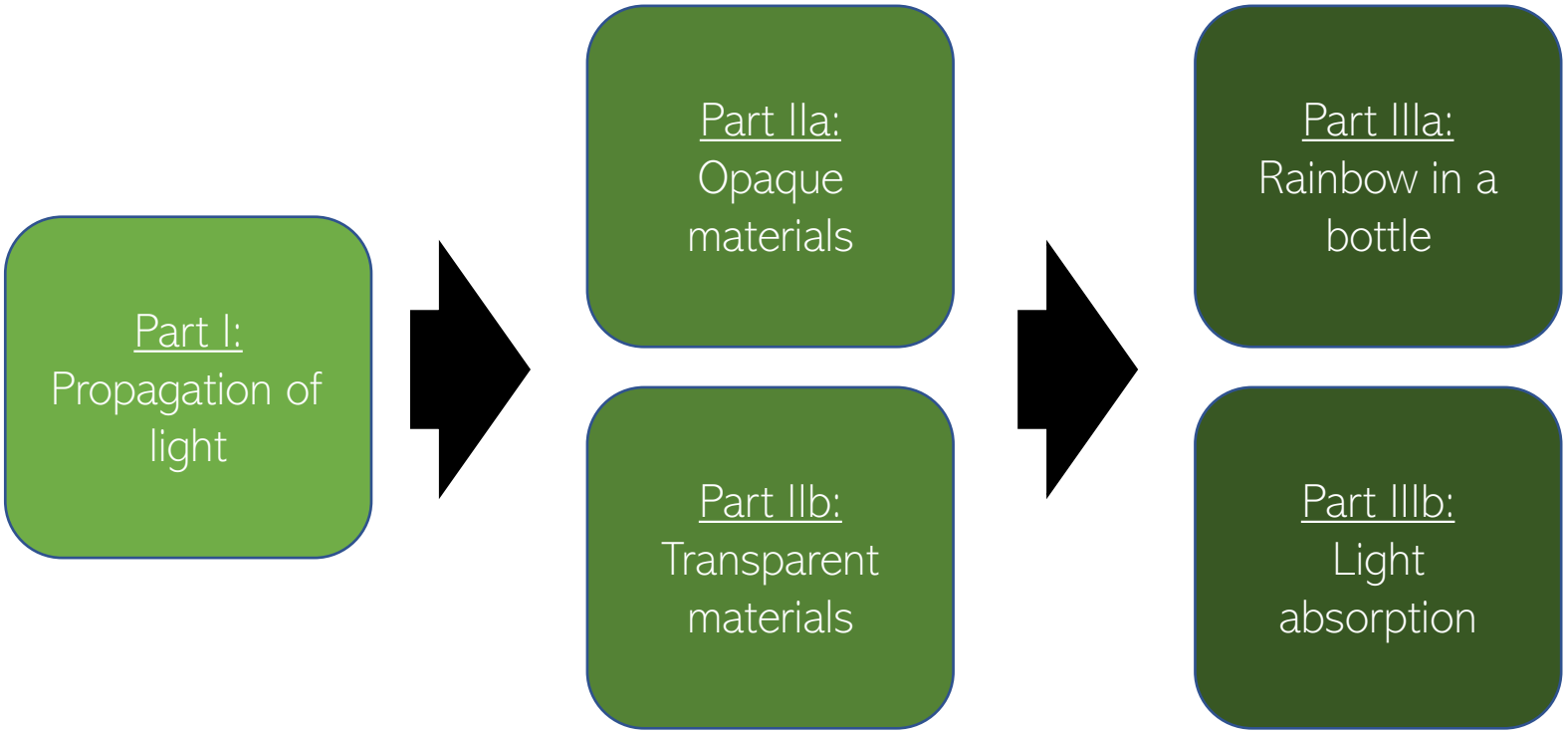
Laboratory for Primary Level Students

Ages 6-12

Mission of the lab

- This laboratory will teach light and color concepts through experiments related to how light travels and how light is absorbed, reflected, and transmitted.
- <u>The main takeaways are:</u>
  - Light travels in a wave in a straight line.
  - Light can be blocked by opaque materials and transmitted through transparent materials.
  - Many colors we see are those not absorbed by the material but instead those reflected from white light.

Summary of experiments



There are 5 experiments in total.

Supplies list

- Light sources (sunlight, fluorescent bulbs, candles, etc.)
- Straws or hollow tubes of any kind or color
- Thread or string
- Cardboard
- Clear plastic (binder sheet or other piece of plastic)
- Pencil
- Scissors
- Water
- Spray bottle
- Fabric of various colors (T-shirts or other fabric): white, black, blue, red, yellow
- Ruler (optional)
- Flashlight (optional)

Safety considerations

- Students should never look directly at the Sun. This can permanently damage their eyes. If you are using the Sun as a light source, have the students look at a sunny spot on the ground or at the horizon away from the direction of the Sun.
- If you use candles as your light source, the students need to be careful. Since candles are a fire hazard, the table should be cleared of all objects when performing the experiment.

Setting up your space

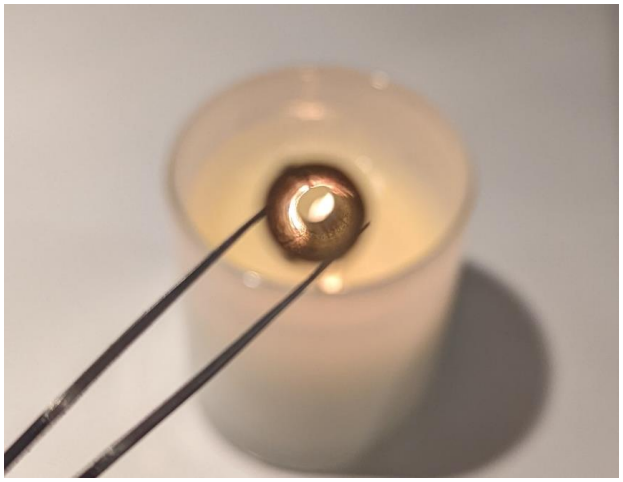
- Gather your supplies and separate by experiment(s) on your table.
- These are our recommendations:
  - Every student should have a pencil. Manuals can be printed for all students or shared by small groups.
  - Part I – straws
    - You will need one straw per student.
  - Parts IIa and IIb – cardboard, clear plastic, thread, candles (or other light source), scissors
    - You will need 3 pieces of equally-sized cardboard **and** clear plastic, one candle, and a length of thread or string (~20 cm) per group (~3-4 students). A few scissors (~1 pair per 3-4 groups) can be shared in the classroom.
  - Part IIIa – spray bottle filled with water
    - You will need at least one spray bottle for the entire group.
  - Part IIIb – fabric of various colors
    - You will need at least one piece of white and black fabric for each group (~3-4 students). Other colors are encouraged if available.

Part I: Propagation of light

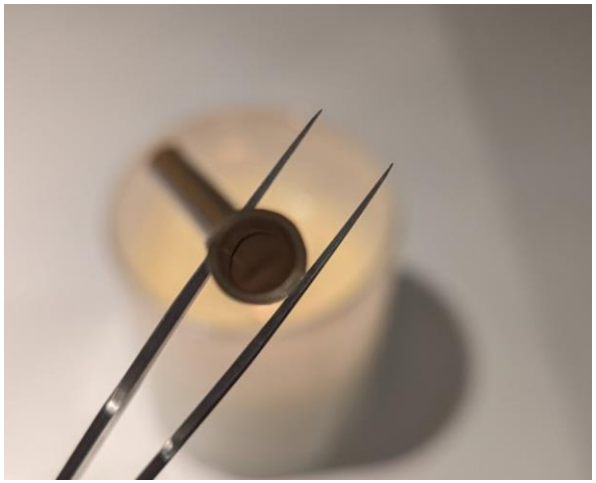
- Set-up:
  - Each student have a straw and light source (indirect sunlight, lamp, or candle)
- Procedure:
  - Students should use the straw to look at the light source. Then students will bend the straw once and twice to look at the same light source.
- Results
  - Students should notice that light passes through the hole in the straw when it is not bent. When the straw is bent, light does not travel through the straw as easily.
- The takeaway is that light wave travels in a straight line and can be blocked by objects (like the bend in the straw)

Part I: Propagation of light

Supplies (candle, straw)



No bend in straw



Bend in straw

Part IIa: Opaque materials

- Set-up:
  - Each group should have 3 pieces of equally sized cardboard, a candle, and a length of thread.
- Procedure:
  - Students should cut holes in the 3 pieces of cardboard at the same location. This can be done using thread as a "ruler" and marking the same location on each piece of cardboard and cutting holes at these locations.
  - The students should line up the cardboard pieces (and holes) to see the light from the candle through the holes. Then, the cardboard pieces should be misaligned .
- Results
  - Students should see that light travels through the holes when they are aligned, but not when they are misaligned.
- The takeaway is that light wave travels in a straight line and can be blocked by objects. In this case, the cardboard is opaque and does not allow light to pass through it.

Part IIa: Opaque materials

Aligned cardboard set up (left) and results (right)

Misaligned cardboard set up (left) and results (right)

Part IIb: Transparent materials

- Set-up:
  - Each group should have 3 pieces of equally sized clear plastic (binder sheets), a candle, and a length of thread.
- Procedure:
  - Students should cut holes in the 3 pieces of plastic at the same location. This can be done using thread as a "ruler" and marking the same location on each piece of plastic and cutting holes at these locations.
  - The students should line up the plastic pieces (and holes) to see the light from the candle through the holes. Then, the plastic pieces should be misaligned.
- Results
  - Students should see that light travels through the holes when they are aligned. Light is still visible when they are misaligned.
- The takeaway is that light wave travels in a straight line and can be blocked by objects. In this case, the plastic is transparent and allows some light to transmit through it.

Part IIb: Transparent materials

Aligned plastic pieces set up (left) and results (right)

Misaligned plastic pieces set up (left) and results (right)

Part IIIa: Rainbow in a bottle

- Set-up:
  - The teacher or facilitator should have a spray bottle filled with water.
- Procedure:
  - The teacher or facilitator will spray the bottle into direct sunlight and ask the students to watch. If there are multiple spray bottles, the groups may also do this on their own.
- Results
  - Students should see a rainbow of colors in the sprayed water.
- The takeaway is that white light contains the colors of the rainbow: red, orange, yellow, green, blue, indigo, and violet.

Part IIIb: Light absorption

- Set-up:
  - Each group should have one piece of white and black fabric (plus other colors if available).
- Procedure:
  - Students should consider the temperature of each fabric piece by feel before placing them in the sunlight. Students will then measure the temperature of each fabric piece again by feel after they have been in the sunlight for ~30 minutes.
- Results
  - Students should notice that the black fabric is hotter than the white fabric. Other dark-colored fabrics may be hotter than lighter-colored fabrics.
- The takeaway is that light is absorbed by objects. If an object absorbs all colors and reflects none to our eyes (black fabric), this object will be hotter to the touch in sunlight. If an object reflects the sunlight (white fabric), this object will be cooler.

Design challenge

- Background
  - Students are asked to imagine their future home and pick out materials for it based on light propagation, absorption, and reflection. This challenge can either be done by simply thinking about their home and drawing it or, if supplies are nearby, students could build a model of their future home.
- Questions to ask the students
  - What materials could be used for windows? Walls? Roof? Why?
    - Does the color of these materials matter?
  - Where will you place your windows? Will this make your home hotter or colder?
    - Try to get the students to think about light propagation and transparent versus opaque materials.

Troubleshooting

- For Part II, you can improvise with other materials – just try to get two materials: one that is opaque and one that is transparent.
- With large enough groups in Part II, you won't need to tape or fix the pieces of cardboard/plastic – the groups can work together to align and misalign the pieces.
- If it is cloudy, Part III will not work as well, so it is recommended to wait for a sunny day to complete this experiment.
- If you don't have a spray bottle for Part III, you can also attempt to make a rainbow using a CD or prism.