

## Photon Phun

**Grades:** 2 – 5

**Number of participants:** 2 – 3

**Approximate time:** 20 minutes for grades 2-3; 45 minutes for grades 4-5

**Supervisors:** Tim Arthur, Cheryl Bradshaw, Ted Goodson, Mike Simon

**Brief Description:** This event will test the students' understanding of light and its behavior. All grades will compete in a reflection relay in which the team of students will enter a darkened room with one light source and a total of 6 targets. Using 3 mirrors, the students must try to reflect the light from the source to each target. 2<sup>nd</sup> and 3<sup>rd</sup> graders will also participate in one hands-on experiment and answer a few questions about their observations. 4<sup>th</sup> and 5<sup>th</sup> grade competitors will answer questions about light on a written exam, including 3-4 hands on stations and a reflection diagram. Teams will receive points for each target illuminated and each question answered correctly.

**(Note: A team of 3 is strongly recommended. The reflection relay is significantly more challenging for a team of 2 and adjustments will not be made to the event or the scoring.)**

### Competition, Rules, and Scoring:

#### Reflection Relay

- 1) Teams will enter the reflection room one at a time.
- 2) Teams will be given a maximum of **3 minutes** in the reflection room.
  - a. Each team will have **up to 1 minute** to receive brief directions from the event supervisor, survey the room, and strategize. After a maximum of one minute, or sooner if the team announces they are ready to start, the room lights will be dimmed and the teams will begin their reflection relay.
  - b. The relay begins when the lights go out, the supervisor says “go”, and the timer starts.
  - c. Each team will have up to **2 minutes** to complete as many of the 6-targets as they can.
  - d. Using less strategy time will not increase the time for the reflection relay.
  - e. The reflection room race will end after 2 minutes. A countdown clock will be located in the room. A judge will note the time that each target is hit.
- 3) There will be one light source in the room.
  - a. The light source will remain in the same fixed position in the room for the entire grade's reflection relay.
  - b. The light source may be placed anywhere in the room.
  - c. The light source used will be an adjustable-focus, high intensity LED flashlight.

- d. Students will not be permitted to adjust the light source. The students and their mirrors must keep at least **2 feet** away from the light source. This distance will be marked by tape on the floor. Teams crossing this line will be instructed to move, but will not receive any additional time for their reflection relay.
- 4) There will be 6 targets in the room.
- Targets are numbered 1 through 6 and are approximately 8.5" x 11".
  - The recommended ordering will be 1, 2, 3, 4, 5, 6. Difficulty will increase with target number.
  - Teams are not required to illuminate the targets in numerical order.
  - Targets may be positioned anywhere in the room (on the walls, the ceiling, on the floor, or under a table, in a cupboard, etc).
- 5) Teams must reflect light from the source, sequentially through all 3 mirrors to the target. When the target has been illuminated by reflected light for 3 seconds, the judge will announce "NEXT" and the team can advance to the next target.
- 6) Every member of the team must hold at least one mirror.
- If a team has only 2 members, one member must hold two mirrors, held at least one foot apart.
  - Teams may not bring in their own mirrors and may not bend, distort, or alter the mirrors in any way.
  - Mirrors used will be approximately 10 x 10 cm square. The mirrors will be acrylic, not glass.
- 7) Teams will get 10 points for each target hit. The more difficult targets will **not** be worth more points.
- 8) A lux meter will be used by event supervisors on the day of competition to monitor the intensity of the light source as well as the light/dark conditions of the room. Readings will be recorded throughout the event to ensure consistent conditions for all participants.

### Written Test

- 2<sup>nd</sup> and 3<sup>rd</sup> grade teams will have one set of questions, worth 20 points. The questions will be about the colors of light only (see below for more topic details). This portion of the event may possibly include one hands-on station where students will be asked to perform an experiment and record their observations.
- 4<sup>th</sup> and 5<sup>th</sup> grade teams will take a written test, worth 60 points. The test will include a short multiple choice quiz, a reflection diagram, and 3 to 4 hands-on stations with multiple questions per station.
- 4<sup>th</sup> and 5<sup>th</sup> grade questions may be drawn from the following topics:
  - Colors of the rainbow and how a rainbow is produced.
  - Concept of items being transparent, translucent or opaque.
  - Reflection of light – angle of incidence and angle of reflection
  - Colors of light – how white light is made, how colored light is made, why objects

appear to be certain colors, how objects may look to be different colors in different lights. **(this is the only topic for 2<sup>nd</sup> and 3<sup>rd</sup> grade teams).**

- Wave nature of light. Be able to identify a wavelength or frequency period on a wave drawing.
  - Know values and relative orders of wavelengths of colored lights, IR and UV light.
  - Know relationship between wavelength and frequency.
  - Understand primary and complementary colors of light and how they differ from pigments (i.e., additive versus subtractive color mixing).
  - Understand how a lens works.
  - Understand why a glass prism splits white light into different colors
- 4) An example of a reflection diagram is attached. A light beam is shown to be emerging from a source along a particular direction. The competitor will be asked to predict which mirrors a beam of light will hit along a reflection path from the light source to a target. There will be mirrors on the reflection sheet that will not be hit by the light beam. The answer to the reflection sheet is the identifying letter of the mirrors that the light beam hits, in order, on its way from the source to the target. The answer must be completely correct – no partial credit will be given. The number of reflections on each diagram will be the child’s grade level plus or minus 1. That is, a 4th grade sheet could contain from 3– 5 reflections, while a fifth grade diagram could require from 4 – 6 reflections to solve.
  - 5) The reflection sheets will have a Light Source (labeled “S”), a target (labeled “Target”), mirrors and potentially non-reflective obstacles (labeled “O”). There will be a unique solution to each reflection sheet. Students will not be told how many reflections are necessary to solve the sheet.
  - 6) Pencils, along with straight edges and protractors like those provided to participating schools in the coaches’ kit, will be provided in the test room for the kids to use. Teams are not allowed to bring any implements to the competition.
  - 7) Calculators will not be allowed.

### Scoring and Tie Breakers

- 1) 2<sup>nd</sup> and 3<sup>rd</sup> graders will be scored as follows:
  - a. 60 points for the Reflection Relay (10 points per target hit).
  - b. 20 points for the Written Test.
  - c. The best score out of 80 possible points wins.
  - d. A tie score will be broken using the highest number of targets hit. If a second tie breaker is required, the fastest finishing time for the last target hit in the reflection room will be used.
- 2) 4<sup>th</sup> and 5<sup>th</sup> graders will be scored as follows:
  - a. 60 points for the Reflection Relay (10 points per target hit).

- b. 60 points for the Written Test (quiz, reflection diagram, and hands-on stations).
- c. The best score out of 120 possible points wins.
- d. A tie score will be broken using the highest number of targets hit. If a second tie breaker is required, the fastest finishing time for the last target hit in the reflection room will be used.

**Reflection Relay Strategies:**

- Practice as a team.
  - Know your role (designate one person to always be closest to the light, one to be closest to the target, and one floater perhaps).
  - Know how to communicate effectively in the dark and under a 2 minute time limit.
  - It is critical to work together to succeed in the relay.
- Hold the mirror by the edges only to allow the greatest possible surface area for reflections.
- Hold the mirror in front of your chest and brace it against your body. This will help to keep it still and it will also block any non-reflected stray light.
- Look only at where you are aiming your beam of light and trust other team mates to do the same.
- WESO and the Event Supervisors make every effort to not have problems during the event, but just in case...Practice for unexpected conditions: brighter than usual room, dimmer than usual flashlight, someone walked through the beam. It is important to not get flustered and waste time when something unexpected happens.
- If the team has only 2 students, then the person holding 2 mirrors should practice holding one mirror still (braced against your body) and moving only one mirror.

**It is critical to success in this event to practice the Reflection Relay in advance. Students should practice hitting targets in varying locations and they should enter the Reflection Room with a clear plan and with assigned team member roles. Practice and a plan are especially critical to teams with only two members.**

**Sample Questions**

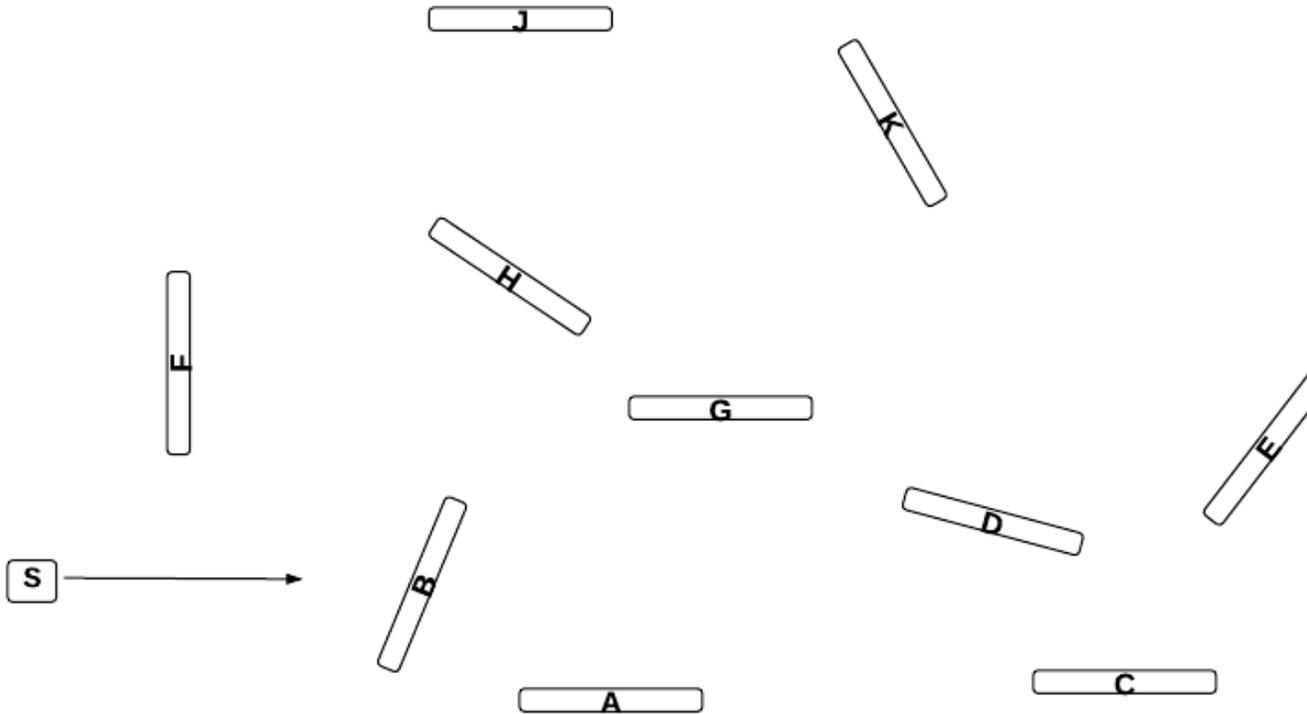
1. Which of these electromagnetic waves have the lowest frequency?
  - A. visible light
  - B. infrared
  - C. ultraviolet
  - D. gamma ray
  
2. Blue jeans appear blue because the jeans have been dyed. This dye
  - A. generates blue light by color synthesis.
  - B. absorbs all colors except blue and reflects blue light.
  - C. absorbs only blue light and so give the jeans a blue color.
  - D. reflects all colors except blue light.
  
3. When you look down into a fishbowl, the fish you see looks
  - A. larger than it really is
  - B. smaller than it really is
  - C. the size it would appear if there were no water
  - D. reversed

Reflection Diagram Example

WESO 2017

Photon Phun Detailed Event Description

Target



**Some References (available at Ann Arbor District Library)**

Rogers, Kirsteen, et. Al., *Light, Sound and Electricity (The Usborne Internet-linked Library of Science)*, 2001, Usborne Publishing Limited. This book has some up to date websites linked to it. While it covers more than light, and covers some light related topics we do not, there are several pages that have good explanations and activities.

Gardner, Robert, *Easy Genius Science Projects with Light*, Enslow Publishers, NJ, 2009. This book has a chapter with interesting experiments about reflection, and another one on color experiments.

**Other useful resources:**

Cole, Joanna, *Magic School Bus Makes a Rainbow: a Book about Color*

Hewitt, Paul G., *Conceptual Physics*.

*Bill Nye the Science Guy* Youth DVD's: Light optics, Light and Color.

The Ann Arbor Hands-On Museum has Light and Optics exhibits- including color, mirrors, lenses, optical illusions, just to name a few.