

Photon Phun

Grades:	Grades 2-5
Team Size:	2-3 competitors
Duration:	20 minutes for grades 2-3; 45 minutes for grades 4-5
Supervisors:	Tim Arthur, Tara Kowalewski, Dave Pawlowski

Summary 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, passing through all 3 mirrors, to illuminate each target. 2nd and 3rd graders will participate in 1-2 hands-on experiments and answer a few questions about their observations. 4th and 5th grade competitors will participate in 3-4 hands-on experiments and answer a few questions about their observations, complete a written exam about light, and also complete one reflection diagram. Teams will receive points for each target illuminated target 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.)

Changes from Previous Year

Reflection Relay: Target for 4th and 5th graders will now be 50 % smaller.

Written exams: 4th and 5th grade exams will no longer be limited to multiple choice.

Concepts Covered – 2nd & 3rd Grade:

- Reflection of light.
- Colors of the rainbow and how a rainbow is produced.
- The RGB and CMYK color models.
- 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.
- Understand primary and complementary colors of light and how they differ from pigments (i.e., additive versus subtractive color mixing).
- Understand why a prism splits white light into different colors

- **Concepts Covered – 4th & 5th Grade:**
- Colors of the rainbow and how a rainbow is produced.
- The RGB and CMYK color models.
- 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.
- 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 prism splits white light into different colors

Rules/Competition Format

Reflection Relay Room:

- 1) Teams will enter the reflection relay room one team at a time. The reflection relay room will be dimmed but not completely dark.
- 2) Teams will be given a maximum of **3 minutes** in the reflection room.
 - a. Each team will receive brief instructions from the event supervisor and then have **up to 1 minute** to survey the room and strategize. After a maximum of one minute, or sooner if the team announces they are ready to start, the team will begin their reflection relay.
 - b. The relay will begin when the supervisor says “GO”, at which point the timer will start.
 - c. Each team will have up to **2 minutes** to illuminate as many of the 6 targets as they can.

- d. Using less strategy time (2a) will not increase the time for the reflection relay (2c).
 - e. The reflection relay will end after 2 minutes. A countdown clock will be located in the room. A timekeeper will note the time when the event supervisor says “NEXT” after a target has been hit.
 - f. At the end of 2 minutes, the timer will sound an alert and the event supervisor will say “STOP”.
- 3) There will be one light source in the room provided by the event supervisor.
 - a. The light source will remain in the same fixed position in the room for the entire grade’s reflection relay. It will be placed at approximately chest height.
 - b. The light source may be placed by the event supervisor 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 touch or 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, will not receive any additional time for their reflection relay, and will not receive points for any targets hit while the line is crossed.
 - 4) There will be 6 targets in the room.
 - a. Targets are numbered 1 through 6
 - b. Target for 2nd and 3rd graders are approximately 8.5” x 11”.
 - c. Targets for 4th and 5th grader will be ~50 % smaller than 2nd and 3rd grade targets.
 - d. The *recommended* ordering will be 1, 2, 3, 4, 5, 6. Difficulty will increase with target number.
 - e. Teams are NOT required to illuminate the targets in numerical order.
 - f. Targets may be positioned anywhere in the room (on the walls, the ceiling, on the floor, under a table, in a cupboard, etc).
 - 5) Teams must reflect light from the source, sequentially through all 3 mirrors, to each target. When the target has been illuminated, the event supervisor will count “1, 2, 3, NEXT” at which point the target and hit time will be recorded by the timekeeper and the team may move on to the next target.
 - 6) Every member of the team must hold at least one mirror.
 - a. If a team has only 2 members, one member must hold two mirrors.
 - b. Teams may not bring in their own mirrors and may not bend, distort, or alter the mirrors in any way.
 - c. Mirrors used will be approximately 10 x 10 cm square. The mirrors will be acrylic, not glass.
 - d. Mirrors must be held at least 1 foot apart.
 - e. The light must be reflected sequentially through all three mirrors.
 - 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.

Hands-On Experiment Room:

2nd & 3rd Grade Experiments:

- 1) 2nd and 3rd grade teams will participate in 1 or 2 hands-on experiments. These experiments will utilize their knowledge of the colors of light. They will be asked to perform an experiment and record their observations.

4th & 5th Grade Experiments and Quiz:

- 1) 4th and 5th grade teams will take a written test, worth 60 points. The test will include a short written quiz, a reflection diagram, and 3 to 4 hands-on experiment stations with multiple questions per station.
- 2) The multiple-choice quiz may ask questions about any of the 4th and 5th grade topics listed above.
- 3) 4th and 5th graders will participate in 3-4 hands-on experiment stations that may include topics from any listed above. Participants will be asked to complete the experiments and record their observations. Each experiment may have a time limit. If the experiment is not completed within the time limit the team will be asked to move on. Teams are still permitted to answer the questions after the time limit has expired, but may not return to the experiment station.
- 4) An example 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 the beam of light will hit along its 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 5th grade diagram could require from 4 – 6 reflections to solve.
- 5) The reflection diagram will have a Light Source (labeled “S” or “Source”), a target (labeled “Target”), mirrors, and potentially non-reflective obstacles (labeled “O” or “Obstacle”). There will be one 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

2nd and 3rd graders will be scored as follows:

- a. 60 points for the Reflection Relay (10 points per target hit).
- b. 20 points for the hands-on experiment responses.
- c. The best score out of 80 possible points wins.

4th and 5th graders will be scored as follows:

- a. 60 points for the Reflection Relay (10 points per target hit).
- b. 60 points for the written portion (quiz, reflection diagram, and hands-on experiment responses).
- c. The best score out of 120 possible points wins.

Tie Break Criteria

- a. A tie score will be broken first using the highest number of targets hit.
- b. If a second tie breaker is required, the fastest finishing time for the last target hit in the reflection room will be used.

Materials Distributed by WESO

Follow the link below for a list of the Photon Phun event equipment provided by WESO. Each school has been provided these materials.

<https://docs.google.com/viewer?a=v&pid=sites&srcid=YWFwcy5rMTIubWkudXN8d2Vzby13aXphcmRzfGd4OjYzMTM1YzEzMzY4OGQ2OGI>

Additional Materials useful for practices

The script used in the reflection room can be found on the WESO website

Materials to be brought to competition

Students should bring nothing to the competition. All equipment will be provided.

Additional Resources/References

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.

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.

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. Mirrors must be at least 1 foot apart.

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 Relay Room with a clear plan and

with assigned team member roles. Practice and a plan are especially critical to teams with only two members.

Example Questions

Multiple Choice Quiz: (4th & 5th only)

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: (4th & 5th only)

