

Bell Ringer: Polarizing Filters – ID: 13706

Time required
15 minutes

Topic: Light

- Describe the relationship between light intensity and the orientation of a polarizing filter.

Activity Overview

In this activity, students will investigate the effects of polarizing filters on light intensity. They will use simulated light waves and filters to determine the component of a wave that is able to pass through a filter.

Materials

To complete this activity, each student will require the following:

- TI-Nspire™ technology
- pen or pencil
- blank sheet of paper

TI-Nspire Applications
Graphs & Geometry, Notes

Teacher Preparation

Before carrying out this activity, review with students the concepts of representing vectors and resolving vectors into components. Students will also benefit from reviewing printed diagrams of light rays showing the oscillation of the magnetic and electric fields around the rays. Make sure students are clear on the difference between the direction of propagation of the ray and the direction of oscillation of the waves.

- The screenshots on pages 2–6 demonstrate expected student results. Refer to the screenshots on page 7 for a preview of the student TI-Nspire document (.tns file). The solution .tns file contains sample responses to the questions posed in the student .tns file.
- **To download the student .tns file and solution .tns file, go to education.ti.com/exchange and enter “13706” in the search box.**
- This activity is related to activity 9599: Polarization of Light. If you wish, you may extend this bell-ringer activity with the longer activity. You can download the files for activity 9599 at education.ti.com/exchange.

Classroom Management

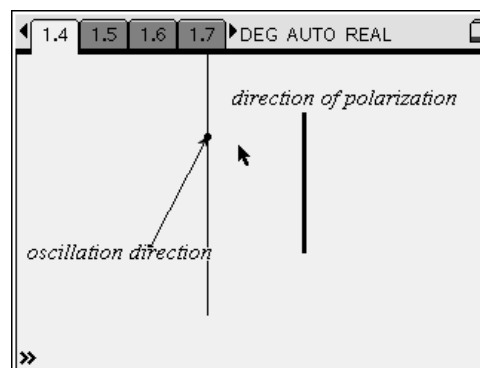
- This activity is designed to be **teacher-led**, with students following along on their handhelds. You may use the following pages to present the material to the class and encourage discussion. Note that the majority of the ideas and concepts are presented only in **this** document, so you should make sure to cover all the material necessary for students to comprehend the concepts.
- If you wish, you may modify this document for use as a student instruction sheet. You may also wish to use an overhead projector and TI-Nspire computer software to demonstrate the use of the TI-Nspire to students.
- If students do not have sufficient time to complete the main questions, they may also be completed as homework.
- In some cases, these instructions are specific to those students using TI-Nspire handheld devices, but the activity can easily be done using TI-Nspire computer software.

The following question will guide student exploration during this activity:

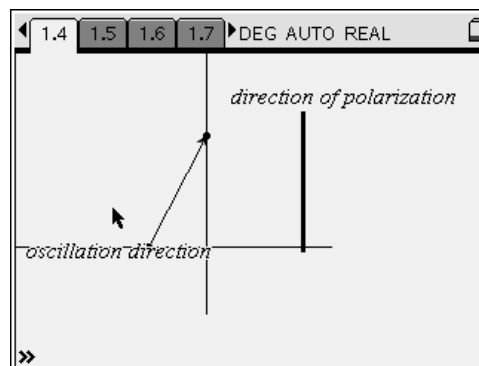
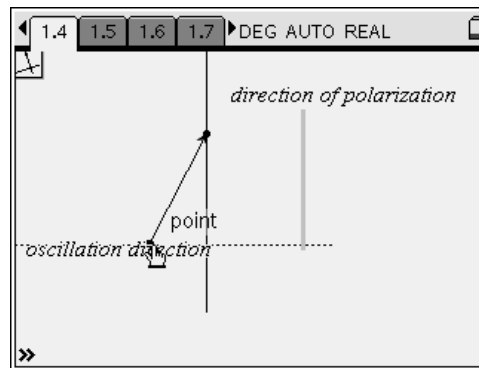
- How does a polarizing filter reduce the intensity of light?
- Under what conditions does a polarizing filter cause no change in intensity?

Students will use vectors to represent light waves and polarizing filters. They will explore the effects of changing the angle of the filter on the intensity of the light that is able to pass through the filter.

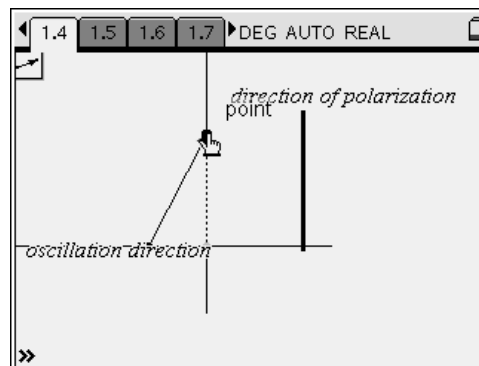
Step 1: Students should open the file **PhysBR_week26_polarizing_filters.tns** and read the first three pages. They should then move to page 1.4, which shows a vector (representing a specific light wave) and a line segment (representing a polarizing filter direction). Students can move the labels by clicking and dragging them to a new location. Students should construct a vector to represent the light that is able to pass through the filter. To construct the vector, students should first construct a line parallel to the filter direction using the **Parallel** tool (**Menu > Construction > Parallel**). (To use the **Parallel** tool, students should click once on the filter line and then on one of the two endpoints of the vector. The line should be drawn automatically.) If you wish, you may add a vector representing the direction of propagation of the light ray. It should be perpendicular to the *oscillation direction* vector. Adding this vector may help students better understand that the *oscillation direction* vector represents the direction of oscillation, not the direction of propagation of the light ray.



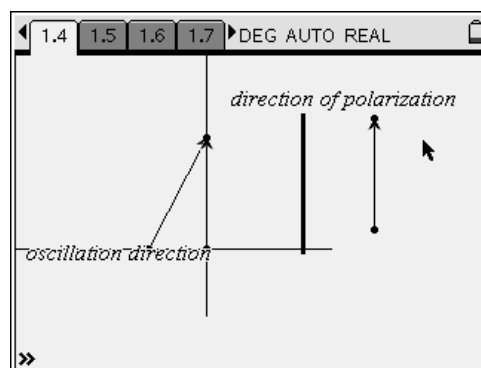
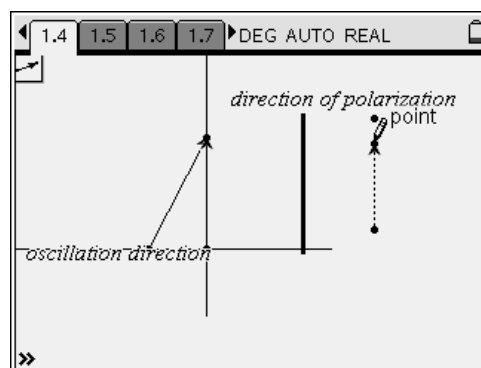
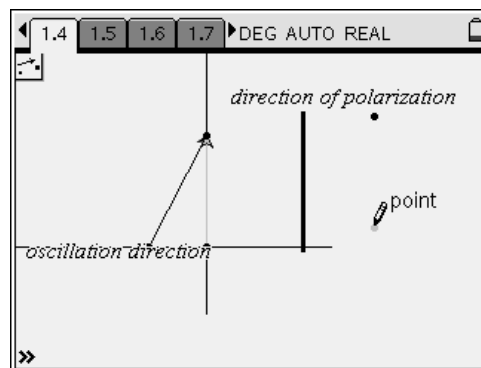
Step 2: Next, students should construct a line perpendicular to the filter direction using the **Perpendicular** tool (**Menu > Construction > Perpendicular**). (To use the **Perpendicular** tool, students should click once on the line they just drew, and then once on the end of the vector that they did not click in step 1.



Step 3: Next, students should use the parallel and perpendicular lines to draw the component of the light vector that is parallel to the filter vector. They should use the **Vector** tool (**Menu > Points & Lines > Vector**) to draw the vector.



Step 4: Once students have drawn the vector, they should use the **Translation** tool (**Menu > Transformation > Translation**) to “move” it to the other side of the filter so it is easier to see. To use the **Translation** tool, students should click once on the vector and then use the NavPad to move the cursor to the other side of the filter. They should click once to place the two endpoints of the vector on the screen. They should then draw a vector connecting the two points. Once students have constructed the vector, they can hide the construction lines by selecting the **Hide/Show** tool (**Menu > Actions > Hide/Show**) and clicking on the lines to hide. After students have constructed the vector, they should answer questions 1 and 2.

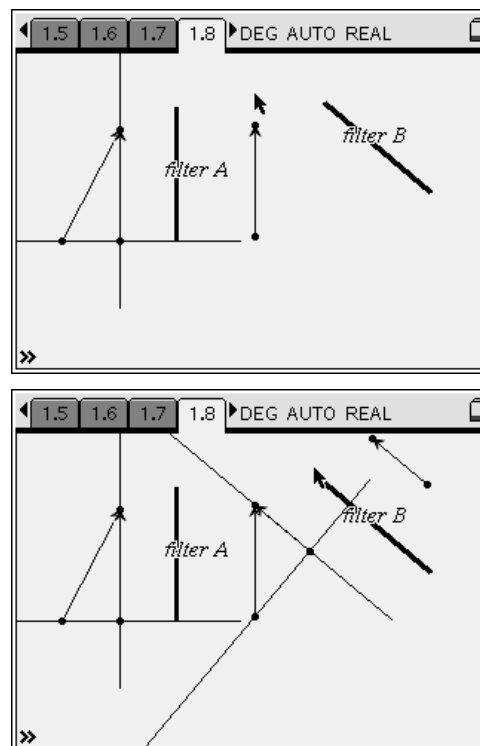


- Q1.** How does the magnitude (length) of the final vector compare to the magnitude of the initial vector? What does this imply about the intensity of the light after it passes through the filter?
- A.** *The final vector should be shorter than the initial vector, indicating a decrease in light intensity. If they wish, students can use the **Length** tool (**Menu > Measurement > Length**) to compare the lengths of the vectors. To use the tool, students should click on the object they want to measure.*

Q2. Is there any orientation of the filter that would not change the intensity of the light? Explain your answer.

- A.** *If the filter were parallel to the light vector, the entire light vector would pass through the filter, and there would be no decrease in intensity.*

Step 5: Next, students should read page 1.7 and then move to page 1.8, which shows a light vector and two filters. Students should construct the component of the initial vector that passes through filter A using the same method they used in steps 1–4. They should then repeat those steps to construct the component of that vector that passes through filter B. Once they have constructed both vectors, they should answer questions 3–5.



Q3. How does the magnitude (length) of the final vector compare to the magnitude of the initial vector? What does this imply about the intensity of the light after it passes through both filters?

- A.** *The final vector is much shorter than the initial vector. This shows that the pair of filters reduces the light intensity much more than the single filter did.*

Q4. What would happen to the intensity of the light if the two filter directions were parallel to one another? Explain your answer.

- A.** *If the two filters were parallel, then all of the light that passed through the first filter would pass through the second filter. As a result, there would be no reduction in intensity between the first and second filters. Make sure students understand that the intensity of the final wave would still be less than that of the initial wave, because the first filter would reduce the intensity of the wave.*

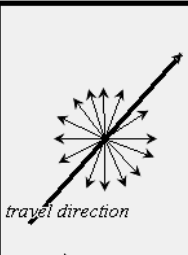
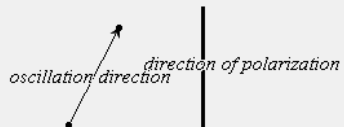
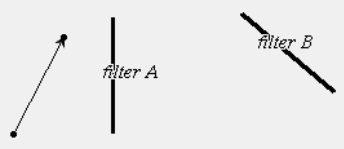
Q5. What would happen to the intensity of the light if the two filters were perpendicular to each other? Explain your answer.

A. *If the two filters were perpendicular, no component of the wave the passed through filter A would pass through filter B. As a result, no light would pass through the filter pair.*

Suggestions for Extension Activities: If you wish, you may have students construct additional wave-filter combinations and explore the relationship between the angle of the filter and the length (intensity) of the wave that passes through it.

Bell Ringer: Polarizing Filters – ID: 13706

(Student)TI-Nspire File: *PhysBR_week26_polarizing_filters.tns*

<p>1.1 1.2 1.3 1.4 DEG AUTO REAL</p> <p>POLARIZING FILTERS</p> <p>Physics</p> <p>Light and Optics</p>	<p>1.1 1.2 1.3 1.4 DEG AUTO REAL</p> <p>Visible light, like all electromagnetic radiation, travels as a wave. Typically, light waves oscillate in all directions perpendicular to their direction of travel. Vectors can be used</p> 	<p>1.1 1.2 1.3 1.4 DEG AUTO REAL</p> <p>A polarizing filter allows only waves with a certain orientation to pass through. It absorbs or reflects all other waves.</p> <p>On the next page, draw the component of the incident wave that passes through the filter.</p>
<p>1.1 1.2 1.3 1.4 DEG AUTO REAL</p> 	<p>1.2 1.3 1.4 1.5 DEG AUTO REAL</p> <p>1. How does the magnitude (length) of the final vector compare to the magnitude of the initial vector? What does this imply about the intensity of the light after it passes through the filter?</p>	<p>1.3 1.4 1.5 1.6 DEG AUTO REAL</p> <p>2. Is there any orientation of the filter that would not change the intensity of the light? Explain your answer.</p>
<p>1.4 1.5 1.6 1.7 DEG AUTO REAL</p> <p>Draw the light waves that pass through the filter pair on the next page.</p>	<p>1.5 1.6 1.7 1.8 DEG AUTO REAL ctrl</p> 	<p>1.6 1.7 1.8 1.9 DEG AUTO REAL</p> <p>3. How does the magnitude (length) of the final vector compare to the magnitude of the initial vector? What does this imply about the intensity of the light after it passes through both filters?</p>
<p>1.7 1.8 1.9 1.10 DEG AUTO REAL</p> <p>4. What would happen to the intensity of the light if the two filter directions were parallel to one another? Explain your answer.</p>	<p>1.8 1.9 1.10 1.11 DEG AUTO REAL</p> <p>5. What would happen to the intensity of the light if the two filters were perpendicular to each other? Explain your answer.</p>	