PHYSICS IN MOTION
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Unit 6G
Polarization
Practice Problems TEACHER

Work each of the following problems. SHOW ALL WORK.

1. **Which would cause a greater decrease in the intensity of a polarized light ray: a filter oriented at 15° or a filter oriented at 75° to the path of the light?**

The filter oriented at 75° would cause a greater decrease in intensity because the cosine of 75° is smaller than the cosine of 15°.

2. **A polarized ray with an intensity of 15 W/m² encounters a filter oriented at 60° to its path. What is the resulting intensity of the light ray?**

$$I_{outgoing} = I_{incoming} \cos^2\Theta$$
$$I_{outgoing} = (15\ {}^{W}\!/_{m^2}) \cos^2(60°)$$
$$I_{outgoing} = (15\ {}^{W}\!/_{m^2})(0.5)^2$$
$$I_{outgoing} = (15\ {}^{W}\!/_{m^2})(0.25)$$
$$I_{outgoing} = 3.75\ {}^{W}\!/_{m^2}$$

3. **A polarized ray with an intensity of 10 W/m² encounters a filter oriented at 30° to its path. What is the resulting intensity of the light ray?**

$$I_{outgoing} = I_{incoming} \cos^2\Theta$$
$$I_{outgoing} = (10\ {}^{W}\!/_{m^2}) \cos^2(30°)$$
$$I_{outgoing} = (10\ {}^{W}\!/_{m^2})(0.866)^2$$
$$I_{outgoing} = (10\ {}^{W}\!/_{m^2})(0.75)$$
$$I_{outgoing} = 7.5\ {}^{W}\!/_{m^2}$$

4. **At what angle is a polarization filter oriented relative to the motion of a polarized ray if it reduces the intensity of the light ray to 60% of its initial level?**

$$I_{outgoing} = I_{incoming} \cos^2\Theta$$
$$(0.60) I_{incoming} = I_{incoming} \cos^2\Theta$$
$$\sqrt{0.60} = \sqrt{\cos^2\Theta}$$
$$0.775 = \cos\Theta$$
$$\cos^{-1}(0.775) = \cos^{-1}(\cos\Theta)$$
$$\Theta = 39.2°$$

questions continued on next page

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Work each of the following problems. SHOW ALL WORK.

5. An unpolarized light ray has an intensity of 12 W/m².

a. What is the intensity of the light ray after it passes through a horizontally oriented filter?

When unpolarized light passes through a horizonally oriented filter, the intensity is reduced by half, so the outgoing intensity is 6 W/m².

b. What is the intensity of the light ray after it passes through a second filter that is oriented at a 45° angle to the first filter?

$$I_{outgoing} = I_{incoming} \cos^2\Theta$$
$$I_{outgoing} = (6\,{}^{W}\!/_{m^2})\cos^2(45°)$$
$$I_{outgoing} = (6\,{}^{W}\!/_{m^2})(0.707)^2$$
$$I_{outgoing} = (6\,{}^{W}\!/_{m^2})(0.50)$$
$$I_{outgoing} = 3\,{}^{W}\!/_{m^2}$$

c. What is the intensity of the light ray after it passes through a third filter that is vertically oriented?

A filter is vertically oriented at 45° to polarized light moving at a 45° angle:

$$I_{outgoing} = I_{incoming} \cos^2\Theta$$
$$I_{outgoing} = (3\,{}^{W}\!/_{m^2})\cos^2(45°)$$
$$I_{outgoing} = (3\,{}^{W}\!/_{m^2})(0.707)^2$$
$$I_{outgoing} = (3\,{}^{W}\!/_{m^2})(0.50)$$
$$I_{outgoing} = 1.5\,{}^{W}\!/_{m^2}$$