Name: _____ Date: _____ Class: _____

How Do Sunglasses Work? Homework Answers

Instructions: Answer each question to the best your ability on a separate sheet of paper. Fully explain your responses. You may need to do some research to answer the questions. If you do, cite your sources.

1. You are shopping for sunglasses and have narrowed your options down to two pairs. The pairs are similar in style, but one uses a light polarizing lens while the other does not. The sunglasses with the polarizing lens cost $5 more than the unpolarized lenses. Both pairs protect against ultraviolet rays. In detail, explain which pair you would choose and why. Remember to provide citations for any research resources you use to answer the question.

   ***Example answer*: I would choose the one with polarizing lens because it reduces light intensity while reducing glare. The unpolarized glasses only reduce the light intensity. When driving or surrounded by water, the glare would make it harder to see.**

   Source information: Morgan, Erinn. "Planning an Outdoor Adventure This Month? Make Sure You Have the Right Sunglasses." *All About Vision*. N.p., April 2017. Web. 24 July 2017. http://www.allaboutvision.com/sunglasses/polarized.htm

2. All electromagnetic waves experience attenuation differently through different mediums. Identify the range of electromagnetic frequencies that nearly completely attenuate through the each material listed below:

   A. A lead vest
      x-ray, gamma ray

   B. Human bodies
      microwaves and up

   C. Concrete block walls
      microwaves and up

   D. Zinc oxide (the active ingredient in many sunscreens)
      UV light and up

3. Vertically polarized light of intensity 75 W/m^2 is incident on a polarizing filter whose axis is rotated 26° to the vertical. Calculate the intensity of the transmitted light.

   $I = I_0\cos^2\theta$
   $I=75\cos^2 26°$
   61 /m^2

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4. Horizontally polarized light enters a polarizing filter whose axis is rotated 78.0° to the vertical. Assume the transmitted light has an intensity of 18.0 W/m^2. Determine the intensity of the incident beam.

$I = I_0\cos^2\theta$
$18.0 = I_0\cos^2 78.0°$
$416.40380\ W/m^2$

5. Use Malus' law to prove that when a polarized light beam is incident on a polarizing filter rotated 90° to its original polarized axis, the transmitted intensity is 0 W/m^2.

$I=I_0\cos^2\theta$
$0=I_0\cos^2(90°)$
$0=I_0(0)$
Any # multiplied with 0 equals 0

6. A polarized light beam of 90 W/m^2 is incident on a polarizing filter. The beam is transmitted through a second filter with an intensity of 20 W/m^2. Calculate through which angle the second polarizing filter is rotating with respect to the original polarization.

$I = I_0\cos^2\theta$
$20 = 90\cos^2\theta$
61.87°

7. Engineers are designing a new pair of sunglasses that are able to reduce glare, reduce light intensity, and protect eyes from UVA and UVB radiation. Pretend you are hired as engineers to design this lens and package it in a unique style of sunglasses. Explain what materials you would use, and how you would fabricate the lens. Do not worry about the frame design, yet! Fully explain your response.

***Example answer*: I would need a polarizing filter, some film to block UV light, and a lens. I will put a polarizing filter on each side of the lens and adjust the angle depending on the amount of sunlight consumers want to block. I will also attach the UV film to the lens.**