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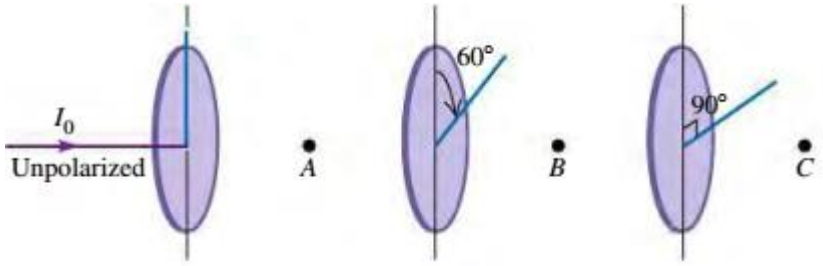
**Lecture 5. Polarization**

H1. Unpolarized light with intensity $I_0$ is incident on two polarizing filters. The axis of the first filter makes an angle of 60.0° with the vertical, and the axis of the second filter is horizontal. What is the intensity of the light after it has passed through the second filter?

H2. At what angle above the horizontal is the sun if sunlight reflected from the surface of a calm lake is completely polarized?

H3. A beam of unpolarized light of intensity $I_0$ passes through a series of ideal polarizing filters with their polarizing axes turned to various angles as shown in the figure.
(a) What is the light intensity (in terms of $I_0$) at points A, B, and C?
(b) If we remove the middle filter, what will be the light intensity at point C?



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H4. Light of original intensity $I_0$ passes through two ideal polarizing filters having their polarizing axes oriented as shown in the figure. You want to adjust the angle $\varphi$ so that the intensity at point P is equal to $I_0/10$.

(a) If the original light is unpolarized, what should $\varphi$ be?

(b) If the original light is linearly polarized in the same direction as the polarizing axis of the first polarizer the light reaches, what should $\varphi$ be?


H5. A parallel beam of unpolarized light in air is incident at an angle of 54.5° (with respect to the normal) on a plane glass surface. The reflected beam is completely linearly polarized.

(a) What is the refractive index of the glass? (b) What is the angle of refraction of the transmitted beam?

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H6. A beam of polarized light passes through a polarizing filter. When the angle between the polarizing axis of the filter and the direction of polarization of the light is $\theta$, the intensity of the emerging beam is I. If you now want the intensity to be I/2, what
should be the angle (in terms of $\theta$) between the polarizing angle of the filter and the original direction of polarization of the light?

H7. **Three Polarizing Filters**. Three polarizing filters are stacked with the polarizing axes of the second and third at 45.0° and 90.0°, respectively, with that of the first.
(a) If unpolarized light of intensity I0 is incident on the stack, find the intensity and state of polarization of light emerging from each filter.
(b) If the second filter is removed, what is the intensity of the light emerging from each remaining filter?

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H8. Three polarizing filters are stacked, with the polarizing axis of the second and third filters at 23.0° and 62.0°, respectively, to that of the first. If unpolarized light is incident on the stack, the light has intensity 55.0 W/cm$^2$ after it passes through the stack.

If the incident intensity is kept constant but the second polarizer is removed, what is the intensity of the light after it has passed through the stack?

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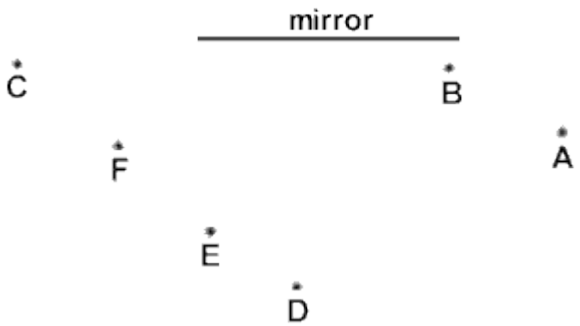
**Lecture 6 Plane Mirror**

H1. If you walk directly toward a plane mirror at a speed v, at what speed does your image approach you? **NOTE: Make your choice and prove it**.
(i) Slower than v;
(ii) v;
(iii) faster than v but slower than 2v;
(iv) 2v;
(v) faster than 2v.

Proof:

H2. An object placed ANYWHERE in front of a plane mirror always produces an image that is
(A) real, inverted, and larger than the object.
(B) real, upright, and the same size as the object.
(C) real, upright, and smaller than the object.
(D) virtual, inverted, and smaller than the object.
(E) virtual, upright, and the same size as the object.

H3. Refer to the following information for the next two questions. **NOTE: Make your choices and prove them graphically**.




(1) Who can A see? (A, B, C, D, E, or F)
(2) Who can B see? (A, B, C, D, E, or F)