Physics 126 Discussion #13: Chapter 25.1-25.6

1. A 179-cm tall boy wants to buy a mirror that is tall enough so he can see himself full length in the mirror. What is the minimum height of such a mirror?

2. You hold a plane mirror 1.0 m in front of your eyes and are able to see a 15 m high tree behind you. If the mirror is 20.0 cm high, and the tree image completely fills the mirror, how far are you standing from the tree?

3. An object is placed 35 cm in front of a convex mirror of focal length -25 cm. Find the location and magnification of the image.

4. A concave makeup mirror is designed so the virtual image is twice the size of the object, when the distance between the object and mirror is 15 cm. Determine the radius of curvature of the mirror.
Use the following information in questions 22–27:

We view an object at various distances using a mirror with focal length 12 m. (See figure.)

22. If the object is 5 m in front of the mirror, where is the image?
   A. 6 m in front of the mirror.
   B. 6 m behind the mirror.
   C. 12 m in front of the mirror.
   D. 12 m behind the mirror.

23. If the object is 6 m in front of the mirror, what is its magnification?
   A. It is half as large, and the image is upright.
   B. It is half as large, and the image is inverted.
   C. It is twice as large, and the image is upright.
   D. It is twice as large, and the image is inverted.

24. If the object is 24 m away from the mirror, where is the image?
   A. 12 m in front of the mirror.
   B. 12 m behind the mirror.
   C. 24 m in front of the mirror.
   D. 24 m behind the mirror.

25. If the object is 24 m away from the mirror, what best characterizes the image?
   A. upright and real
   B. upright and virtual
   C. inverted and real
   D. inverted and virtual

26. If the object is an infinite distance away, where is the image?
   A. 6 m in front of the mirror.
   B. 6 m behind the mirror.
   C. 12 m in front of the mirror.
   D. 12 m behind the mirror.

27. What happens when a candle is placed at the focus?
   A. An image is formed 6 m in front of the mirror.
   B. An image is formed 6 m behind the mirror.
   C. Light rays end up parallel going to infinity.
   D. Light rays reconverge at the focus.
Use the following information in questions 28-31:
A light bulb is placed 12 m in front of a diverging mirror with focus 6 m. (See figure.)

28. Where is the resulting image?
   A. 4 m behind the mirror.
   B. 4 m in front of the mirror.
   C. 12 m behind the mirror.
   D. 12 m in front of the mirror.

29. What is the absolute magnification of the image?
   A. 0.333
   B. 1.5
   C. 2
   D. 3

30. The image is
    A. upright and real.
    B. upright and virtual.
    C. inverted and real.
    D. inverted and virtual.

31. What happens if a light bulb is placed 6 m in front of the mirror?
    A. An image is formed 6 m behind the mirror.
    B. An image is formed 3 m behind the mirror.
    C. An image is formed 6 m in front of the mirror.
    D. No image is formed and the rays end up traveling parallel to infinity.
Passage 1

Electromagnetic radiation from an incandescent source, such as a light bulb, is unpolarized, which means that the electric field of the wave points in random directions perpendicular to wave travel. One way to produce polarized radiation involves applying an alternating voltage to a straight piece of wire to form an antenna (see figure below). Radiation is emitted from the antenna perpendicular to the wire with a polarization which is parallel to the wire.

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In this diagram the small arrows show the direction of the electric field, and the large arrows show the direction of the wave.

Another way to obtain polarized radiation involves allowing unpolarized radiation to be incident on a film or material which transmits radiation of one polarization but absorbs radiation of the perpendicular polarization. Such a film is called a polarizer. If unpolarized light of intensity \( I_0 \) is incident on a vertical polarizer, the radiation that passes through is vertically polarized with intensity \( 1/2 \, I_0 \). The figure below shows this schematically.

vertical polarizer observer

unpolarized light vertically polarized light
If polarized radiation is incident on a polarizer, the amount of energy that is transmitted depends on the relative angle of the radiation polarization and the polarizer axis. If they are aligned, then all the radiation is transmitted. If the angles differ by $\theta$, then the intensity of the transmitted radiation is $\cos^2 \theta$ of the original intensity.

All of the foregoing refers to ideal polarizers. All manufactured polarizers have less than ideal efficiency which comes from reflection off the two surfaces and absorption of the parallel component.

In questions 1–4, an unpolarized radiation source is incident on a series of polarizers. Without the polarizers the intensity of the source is $I_0$. Assume the polarizers are ideal.

1. In the figure below, unpolarized light is incident on polarizers A and B in series. Polarizers A and B are both oriented vertically. What is the intensity of the resultant beam?

A. $I_0$
B. $\frac{1}{2}I_0$
C. less than $\frac{1}{2}I_0$ but greater than zero intensity
D. 0

2. In the figure below, unpolarized light is incident on polarizers A and B in series. Polarizer A is oriented vertically, while polarizer B is oriented horizontally. What is the intensity of the resultant beam?

A. $I_0$
B. $\frac{1}{2}I_0$
C. less than $\frac{1}{2}I_0$ but greater than zero intensity
D. 0

3. An optically active substance is a substance which rotates the plane of polarization of a beam. The figure shows a modification of the figure in Problem 2, with an optically active substance between the polarizers. What is the intensity of the resultant beam?

A. $I_0$
B. $\frac{1}{2}I_0$
C. It could have any intensity less than (or equal to) $\frac{1}{2}I_0$
D. 0

4. Where does the energy of the original beam go which is not in the resultant beam?

A. chemical energy
B. potential energy
C. heat
D. nuclear energy

5. A horizontal antenna is aligned along a north-south axis. This antenna has an alternating voltage applied to it, so it is emitting electromagnetic radiation. An observer is due north of the antenna. (See the figure.) What polarization does he detect from the antenna?

A. He observes horizontal polarization.
B. He observes vertical polarization.
C. He observes an unpolarized beam.
D. He observes no radiation.

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