Chapter 27  Light

Exercises

27.1 Early Concepts of Light (page 533)

Match the scientist with his idea about the nature of light. An idea may be used more than once.

<table>
<thead>
<tr>
<th>Scientist</th>
<th>Idea About Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Einstein</td>
<td>a. Light is a wave.</td>
</tr>
<tr>
<td>2. Empedocles</td>
<td>b. Light consists of tiny particles.</td>
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<tr>
<td>3. Euclid</td>
<td>c. Vision results from streamers or filaments emitted by the eye making contact with an object.</td>
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<tr>
<td>4. Huygens</td>
<td></td>
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<tr>
<td>5. Plato</td>
<td></td>
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<tr>
<td>6. Socrates</td>
<td></td>
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</tbody>
</table>

7. Is the following sentence true or false? The idea that light consists of tiny particles was first proposed in the early 1900s. __________ false

8. What characteristic of light did Huygens provide evidence of?
   Light spreads out as waves do.

9. What phenomena did Einstein explain in the theory he published in 1905? __________ the photoelectric effect

10. Photons are massless bundles of concentrated electromagnetic energy.

11. What is the modern theory of light?
   Light has a dual nature, particle and part wave.

27.2 The Speed of Light (pages 534–535)

12. Is the following sentence true or false? Roemer’s measurement of discrepancies in the position of Jupiter’s moon Io was the first demonstration showing that light travels at a finite speed. __________ true

13. How did Huygens interpret the discrepancy in Roemer’s measurement?
   He said the light was late, not the moon.

14. Circle the letter beside the correct speed of light.
   a. 300,000 m/s  b. 300,000,000 m/s
   C. 300,000 km/s  d. 300,000,000 km/s

15. Albert Michelson received the Nobel Prize for using a system of mirrors to measure __________ the speed of light

16. How much time does it take light to travel from the sun to Earth?
   __________ 8 minutes

17. What is a light-year?
   __________ the distance light travels in one year
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27.3 Electromagnetic Waves (page 536)

18. What is the source of the energy in light?
   accelerating electric charges

19. The energy in an electromagnetic wave is part ________ electric ________ and
    part ________ magnetic ________.

20. Name the different waves that make up the electromagnetic spectrum.
    a. ________ radio waves ________ e. ________ ultraviolet rays ________
    b. ________ microwaves ________ f. ________ X-rays ________
    c. ________ infrared waves ________ g. ________ gamma rays ________
    d. ________ visible light ________

21. Electromagnetic waves of frequencies slightly lower than the red waves
    of visible light are called ________ infrared waves ________.

22. Electromagnetic waves of frequencies slightly higher than the violet
    waves of visible light are called ________ ultraviolet rays ________.

27.4 Light and Transparent Materials (pages 537–538)

23. Is the following sentence true or false? How a receiving material
    responds when light is incident upon it depends only on the frequency
    of the light. ________ false ________

24. Is the following sentence true or false? Electrons are able to respond to
    the ultrafast vibrations of visible light because the electrons have a small
    enough mass to vibrate that fast. ________ true ________

25. How do the atoms in a transparent material interact with light?
    They absorb the energy and immediately reemit it as light.

26. The natural vibration frequencies of an electron depend on how strongly
    it is attached to ________ a nearby nucleus ________.

27. What two things can happen to the energy received by an atom in glass
    when ultraviolet light shines on the glass?
    a. ________ It can be passed on to neighboring atoms by collisions ________.
    b. ________ It can be reemitted as light ________.

28. Why does resonance occur when ultraviolet light shines on glass?
    Electrons in glass have a natural frequency in the ultraviolet range.

29. What happens when electromagnetic waves with frequencies lower than
    ultraviolet light shine on glass?
    The energy is held for a short time before being reemitted as transmitted light.

30. Is the following sentence true or false? Infrared waves vibrate only the
    electrons in glass. ________ false ________
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27.5 Opaque Materials (page 539)

31. What are opaque materials?
   materials that absorb light without reemission, allowing no light through them

32. Is the following sentence true or false? In opaque materials, any coordinated vibrations given by light to the atoms and molecules are turned into random kinetic energy, or internal energy.  
   true

33. Explain why metals reflect light and appear shiny.
   Light that shines on metal sets free electrons into vibration. The energy does not pass from atom to atom but instead is reemitted as visible light that we see as reflection.

34. Our atmosphere is transparent to visible light and some infrared light, but almost opaque to ultraviolet light.

35. Why is it possible to get a sunburn on a cloudy day?
   Clouds are semitransparent to ultraviolet rays.

27.6 Shadows (pages 540-541)

36. What is a light ray?  
   a thin beam of light

37. Generally, shadows form where light rays cannot reach

38. Would you position a light source close or far from an object in order to produce a sharp shadow? close to the object

39. Is the following sentence true or false? Most shadows have clearly defined edges. false

40. A total shadow is called a(n) umbra

41. Where are two places a penumbra can form?
   where light from one source is blocked and light from another source fills in or where light from a broad source is only partially blocked

42. During a solar eclipse, the shadow of the moon falls on Earth

43. What will you observe if you stand in an umbra during a solar eclipse?
   brief darkness during the day

44. What will you observe if you stand in a penumbra during a solar eclipse?
   a partial eclipse in which the sunlight is dimmed

45. What is a lunar eclipse?
   Earth's shadow falls on the moon.

46. Is the following sentence true or false? Shadows cannot occur when light is bent while passing through a transparent material. false
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27.7 Polarization (pages 542–543)

47. Is the following sentence true or false? Polarization is a characteristic of transverse waves and not longitudinal waves. True

48. Define polarization.
   The aligning of vibrations in a transverse wave, usually by filtering out waves of other directions.

49. If you shake a rope up and down, it becomes vertically polarized.

50. If you shake a rope from side to side, it becomes horizontally polarized.

51. Write P if the source emits polarized light or NP if the source emits unpolarized light.
   P a. vibrating electron   NP c. the sun
   NP b. incandescent bulb   NP d. a candle flame

52. Describe what happens to light from an unpolarized source that falls on a polarizing filter.
   The light that is transmitted is polarized light.

53. Each of the figures below is an analogy for the effect of crossed sheets of polarizing material. Explain what happens if the ropes are light and the picket fences are polarizing filters.

   Light will pass through a pair of polarizing filters when their polarization axes are aligned.

   Light will not pass through a pair of polarizing filters when they are crossed at right angles.

54. How are the axes of polarized sunglasses aligned in order to eliminate glare from horizontal surfaces? Vertically aligned
27.8 Polarized Light and 3-D Viewing (pages 544–546)

55. How do your eyes perceive vision in three dimensions?
   Each eye views a scene from a slightly different angle, so that both eyes give impressions simultaneously.

56. Is the following sentence true or false? The combination of views you see from both eyes gives depth to what you see. __true__

57. Explain the effect that allows you to see a hidden message in a stereogram.
   As your eyes move away from the stereogram, your eye-brain system combines the view you see with your left eye and the view you see with your right eye to produce depth.

58. The figure above shows a person watching a 3-D slide show.
   a. How are the photographs taken in order to be used in the 3-D slide show?
      The photographs are taken a short distance apart (about average eye spacing).

   b. How are the photographs used in the slide show projected?
      Their polarization axes are at right angles to each other. The filter used on the left projector is aligned horizontally. The filter on the right projector is aligned vertically.

   c. How is the viewer able to see the 3-D effect in the show?
      The viewer wears polarizing eyeglasses with the lens axes also at right angles. Each eye sees a separate picture that the brain interprets as one to give a feeling of depth.