1.

A sound source emits 30.0 W of sound power spread equally in all directions. What is the sound intensity level 30.0 m from the source?

A) 94.2 dB B) 83.2 dB C) 2.65×10^{-3} dB D) 2.65×10^{-3} W E) -25.8 dB

2.

The beat frequency of two frequencies f_1 and f_2 is

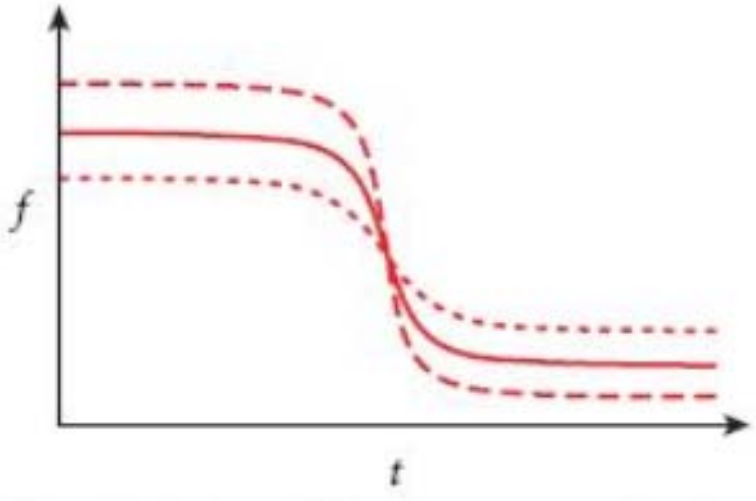
a) the absolute value of the sum of the frequencies, $|f_1 + f_2|$.
b) the absolute value of the difference of the frequencies, $|f_1 - f_2|$.
c) the average of the two frequencies.
d) half of the sum of the two frequencies.
e) half of the absolute value of the difference of the two frequencies.

NOTE: The beat frequency usually refers to the frequency at which the *intensity* of the sound oscillates.

3.

A driver sits in her car at a railroad crossing. Three trains go by at different (constant) speeds, each emitting the same sound. Bored, the driver makes a recording of the sounds. Later, at home, she plots the frequencies as a function of time on her computer, resulting in the plots shown in the figure. Which of the three trains had the highest speed?

a) the one represented by the solid line
b) the one represented by the dashed line
c) the one represented by the dotted line
d) impossible to tell



4. An open pipe of length L is resonating at its fundamental frequency. Which statement is correct?

A. The wavelength is 2L and there is a displacement node at the pipe's midpoint.

B. The wavelength is 2L and there is a displacement antinode at the pipe's midpoint.

C. The wavelength is L and there is a displacement node at the pipe's midpoint.

D. The wavelength is L and there is a displacement antinode at the pipe's midpoint.

E. The wavelength is 3L/2 and there are two displacement antinodes located inside the pipe.

5. If a length of lucite that is being used as a light pipe gets wet, the critical angle

A) decreases.
B) is unaffected.
C) doubles.
D) is meaningless since lucite cannot be used as a light pipe.
E) increases.

6. What would you expect to happen to the magnitude of the power of a lens when it is placed in water ($n = 1.33$)?

a) It would increase.
b) It would decrease.
c) It would stay the same.
d) It would depend if the lens was converging or diverging.

7. Is it possible to see a virtual image?

A) No, since the rays that seem to emanate from a virtual image do not in fact emanate from the image.

B) No, since virtual images do not really exist.

C) Yes, the rays that appear to emanate from a virtual image can be focused on the retina just like those from an illuminated object.

D) Yes, since almost everything we see is virtual because most things do not themselves give off light, but only reflect light coming from some other source.

E) Yes, but only indirectly in the sense that if the virtual image is formed on a sheet of photographic film, one could later look at the picture formed.

8. An unknown lens forms an image of an object that is 24 cm away from the lens, inverted, and a factor of 4 larger in size than the object. Where is the object located?

a) 6 cm from the lens on the same side of the lens
b) 6 cm from the lens on the other side of the lens
c) 96 cm from the lens on the same side of the lens
d) 96 cm from the lens on the other side of the lens
e) No object could have formed this image.

9. The eyepiece for the Yerkes telescope has a focal length of approximately 10 cm. The Hubble Space Telescope can reach an effective angular magnification factor of 8000. What would the focal length of the objective lens at Yerkes need to be in order to reach the same factor of 8000?

a) 8 m
b) 80 m
c) 0.125 m
d) 0.00125 m
e) 800 m

10. Consider the image formed by a refracting telescope. Suppose an opaque screen is placed in front of the lower half of the objective lens. What effect will this have?

A) The top half of the image will be blacked out.
B) The lower half of the image will be blacked out.
C) The entire image will be blacked out, since the entire lens is needed to form an image.
D) The image will appear as it would if the objective were not blocked, but it will be dimmer.
E) There will be no noticeable difference in the appearance of the image with the objective partially blocked or not.

11. If the wavelength of light illuminating a double slit is halved, the fringe spacing is

a) halved.
b) doubled.
c) not changed.
d) changed by a factor of $1/\sqrt{2}$.

12. Newton's rings are interference patterns caused by the reflection of light between two glass surfaces. What color is the center of Newton's rings produced with white light?

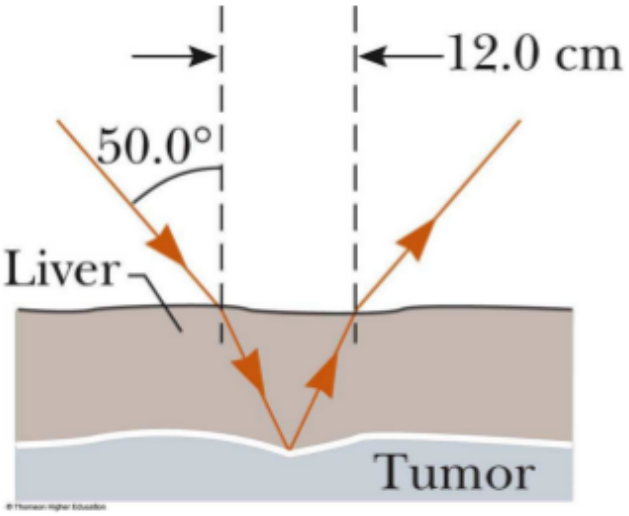
a) white
b) black
c) red
d) violet

13.

A policeman in a stationary car measures the speed of approaching cars by means of an ultrasonic device that emits a sound with a frequency of 41.2 kHz. A car is approaching him at a speed of 33.0 m/s. The wave is reflected by the car and interferes with the emitted sound producing beats. Find the frequency of the beats. The speed of sound in air is 330 m/s.

14.

A narrow beam of ultrasonic waves reflects off a liver tumor as illustrated in the figure below. The speed of the wave is 10% less in the liver than in the surrounding medium (located above the liver in the figure below). Determine the depth of the tumor.

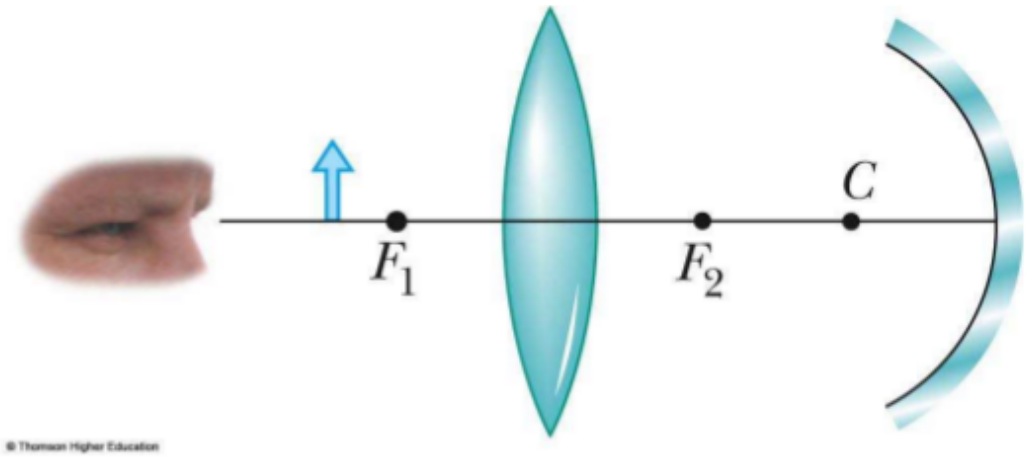


15.

A prism has a vertex angle of 60° and an index of refraction of 1.52. What is the minimum angle of incidence, measured away from the vertex, for a ray of light to emerge from the other side of the prism?

16.

The figure below depicts a thin converging lens and a concave mirror. The radii of curvature of the front surface and back surface of the lens are equal and each is given by 10 cm. The radius of curvature of the spherical mirror (whose center of curvature is denoted by C) is 8 cm. The focus points F_1 and F_2 of the lens are each 5 cm from the center of the lens.



(a) Determine the index of refraction of the lens material.

(b) The center of the lens and mirror are 20 cm apart, and an object (represented by the arrow in the above figure) is placed 8 cm to the left of the lens. Determine the position of the final image and its magnification as seen by the eye in the figure.

HINT: To determine the final image, note that light rays that originate from the object pass through the lens twice.

(c) Is the final image real or virtual? Is the final image inverted or upright?