

s101cq2

Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question.

1. The Doppler shift of ultrasonic waves can measure the speed of blood in an artery. If the frequency of the stationary source is 100 kHz and the reflected sound has a Doppler shift of 200 Hz, what is the blood flow speed? (The speed of sound inside the body is 1 500 m/s.)

- a. 1.0 m/s
 - b. 1.5 m/s
 - c. 2.2 m/s
 - d. 3.3 m/s
 - e. 4.5 m/s
- There are TWO doppler shifts!
 $f_b = \left(\frac{c+v_b}{c}\right) f_o$
 $f_r = \left(\frac{c}{c-v_b}\right) f_b = \frac{c+v_b}{c-v_b} f_o \Rightarrow v_b = c \frac{f_r - f_o}{f_r + f_o} = 1.498 \text{ m/s}$

2. A standing wave is set up in a 2.0-m string fixed at both ends. The string vibrates in 5 distinct segments when driven by a 120-Hz source. In how many distinct standing wave segments will the string vibrate if the tension is increased by a factor of 4?

- a. 3
 - b. 10
 - c. 20
 - d. 30
 - e. No standing wave pattern occurs.
- Originally $f_1 = 120 \text{ Hz} / 5 = 24 \text{ Hz}$
 Increasing the Tension by a factor of 4 double f_1 ,
 So f_1 becomes 48 Hz. Since 120 is not an integer multiple of 48, no standing waves develop.

3. A radio wave transmits 1.2 W/m² average power per unit area. What is the peak value of the associated magnetic field? ($\mu_0 = 4\pi \times 10^{-7} \text{ T}\cdot\text{m/A}$ and $c = 3.00 \times 10^8 \text{ m/s}$)

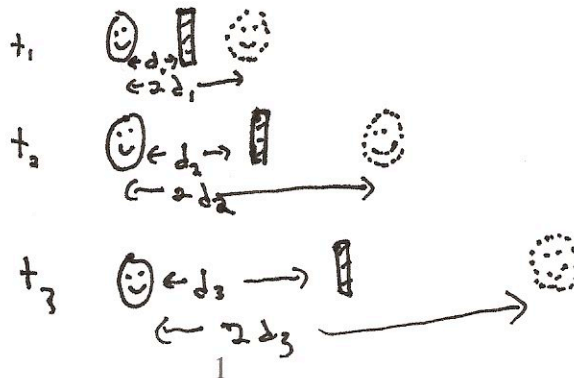
- a. $1.0 \times 10^{-7} \text{ T}$
 - b. $8.4 \times 10^{-3} \text{ T}$
 - c. 1.2 T
 - d. 30 T
 - e. 51 T
- $\bar{I} = \frac{c}{2\mu_0} B_{\text{max}}^2 \Rightarrow B_{\text{max}} = \sqrt{\frac{2\mu_0 \bar{I}}{c}} = 1 \times 10^{-7} \text{ T}$

4. How is the direction of propagation of an electromagnetic wave oriented relative to the associated \vec{E} and \vec{B} fields?

- a. parallel to both \vec{E} and \vec{B}
- b. perpendicular to both \vec{E} and \vec{B}
- c. parallel to \vec{E} , perpendicular to \vec{B}
- d. parallel to \vec{B} , perpendicular to \vec{E}
- e. Both choices a and c are valid.

5. When viewing your image in a hand-held mirror, if you move the mirror away at a speed v , the image appears to:

- a. also move away at v .
- b. move away at $2v$.
- c. move away at $v/2$.
- d. not move.
- e. move away at $v/3$.



6. A ray of light strikes a thick sheet of glass ($n = 1.5$) at an angle of 25° with the normal. Find the angle of the refracted ray within the glass with respect to the normal.

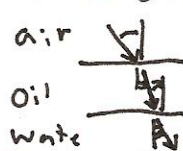
a. 56°
 b. 46°
 c. 25°
 Ⓓ 16°
 e. 12°

$$n_1 \sin(\theta_1) = n_2 \sin(\theta_2)$$

$$\Rightarrow \theta_2 = \sin^{-1} \left(\frac{n_1}{n_2} \sin(\theta_1) \right) = \sin^{-1} \left(\frac{1}{1.5} \sin(25^\circ) \right) = 16^\circ$$

7. An oil film floats on a water surface. The indices of refraction for water and oil, respectively, are 1.333 and 1.466. If a ray of light is incident on the air-to-oil surface at an angle of 37.0° with the normal, what is the angle of the refracted ray in the water?

- a. 18.1°
 b. 24.2°
 Ⓒ 26.8°
 d. 37.0°



$$\theta_{oil} = \sin^{-1} \left(\frac{1}{1.466} \sin(37^\circ) \right) \approx 24.24^\circ$$

$$\theta_{water} = \sin^{-1} \left(\frac{1.466}{1.333} \sin(24.24^\circ) \right) = 26.9^\circ$$

8. An optical fiber is made of clear plastic with index of refraction $n = 1.50$. For what angles with the surface will light remain within the plastic "guide"?

- a. $\phi < 66.6^\circ$
 b. $\phi < 57.1^\circ$
 c. $\phi < 51.7^\circ$
 Ⓓ $\phi < 48.2^\circ$
 e. $\phi < 29.9^\circ$

$$n_1 \sin(\theta_c) = n_2 \sin(90^\circ) = n_2$$

$$\theta_c = \sin^{-1} \left(\frac{n_2}{n_1} \right) = 41.8^\circ$$

$$\phi = 90^\circ - 41.8 = 48.2$$

