

1. The intensity of a spherical wave 4.0 m from the source is 120 W/m<sup>2</sup>. What is the intensity at a point 9.0 m away from the source?

- A) 11 W/m<sup>2</sup>
- B) 24 W/m<sup>2</sup>
- C) 53 W/m<sup>2</sup>
- D) 80 W/m<sup>2</sup>
- E) 270 W/m<sup>2</sup>

$$I = \frac{P}{4\pi R^2}$$

*R is increased by  $\frac{9}{4}$*   
*I gets decreased by  $(\frac{9}{4})^2$*

$$I = \frac{120}{(9/4)^2} = 24$$

2. During a typical workday (eight hours), the average sound intensity arriving at Larry's ear is  $1.8 \times 10^{-5}$  W/m<sup>2</sup>. If the area of Larry's ear through which the sound passes is  $2.1 \times 10^{-3}$  m<sup>2</sup>, what is the total energy entering each of Larry's ears during the workday?

- A)  $1.8 \times 10^{-5}$  J
- B)  $2.2 \times 10^{-4}$  J
- C)  $7.4 \times 10^{-4}$  J
- D)  $1.1 \times 10^{-3}$  J
- E)  $4.1 \times 10^{-3}$  J

$$\text{Energy} = P \Delta t = I A \Delta t$$

$$= (1.8 \times 10^{-5} \frac{\text{W}}{\text{m}^2}) (2.1 \times 10^{-3} \text{ m}^2) (28800 \text{ s})$$

$$= 0.00109 \text{ J}$$

$$I = \frac{P}{A} \rightarrow P = I A$$

$$\Delta t = 8 \text{ hr} = 8.3600 \text{ s} = 28800 \text{ s}$$

3. The decibel level of a jackhammer is 130 dB relative to the threshold of hearing ( $1 \times 10^{-12}$  W/m<sup>2</sup>). Determine the sound intensity produced by the jackhammer.

- A) 1.0 W/m<sup>2</sup>
- B) 10 W/m<sup>2</sup>
- C) 13 W/m<sup>2</sup>
- D) 130 W/m<sup>2</sup>
- E)  $10^{13}$  W/m<sup>2</sup>

$$I = I_0 10^{\text{dB}/10} = (10^{-12} \frac{\text{W}}{\text{m}^2}) 10^{13.0} = 10 \text{ W/m}^2$$

4. The decibel level of a jackhammer is 130 dB. Determine the decibel level if two jackhammers operate side by side.

- A) 65 dB
- B) 130 dB
- C) 133 dB
- D) 144 dB
- E) 260 dB

*Two jackhammers  $\rightarrow$  I is doubled.*  
*This is a 3 dB increase.*  
*I is mult by 2*  
*dB is increased by adding 3.*

5. A person is talking in a small room; and the sound intensity level is 60 dB everywhere within the room. If there are eight people talking simultaneously in the room, what is the sound intensity level?

- A) 60 dB
- B) 79 dB
- C) 74 dB
- D) 64 dB
- E) 69 dB

*Factor of 8 is 2 · 2 · 2*  
*dB increase is 3dB + 3dB + 3dB*  
*60dB + 9dB = 69dB*

6. According to US government regulations, the maximum sound intensity level in the workplace is 90.0 dB. Within one factory, 32 identical machines produce a sound intensity level of 92.0 dB. How many machines must be removed to bring the factory into compliance with the regulation?

- A) 2
- B) 8
- C) 12
- D) 16
- E) 24

Need to decrease sound by 2 dB = 5dB - 3dB  
 Must decrease noise by  $\frac{3.2}{2} = 1.6$   
 $\# = \frac{32}{1.6} = 20$  machines are OK.

7. At a distance of 5.0 m from a point sound source, the sound intensity level is 110 dB. At what distance is the intensity level 95 dB?

- A) 5.0 m
- B) 7.1 m
- C) 14 m
- D) 28 m
- E) 42 m

dB change is 110dB - 95dB = 15 dB  
 This is a factor of 32.  
 I is decreased by a factor of 32.  $I = \frac{P}{4\pi R^2}$   
 R must be increased by 5.7

8. A car moving at 35 m/s approaches a stationary whistle that emits a 220 Hz sound. The speed of sound is 343 m/s. What is the frequency of sound heard by the driver of the car?

- A) 198 Hz
- B) 220 Hz
- C) 242 Hz
- D) 282 Hz
- E) 340 Hz

$f_o = f_s \left(1 + \frac{v_o}{v}\right) = 220 \text{ Hz} \left(1 + \frac{35 \text{ m/s}}{343 \text{ m/s}}\right) = 242.4 \text{ Hz}$   
 ← moving observer

9. A train moving at a constant speed is passing a stationary observer on a platform. On one of the train cars, a flute player is continually playing the note known as concert A ( $f = 440 \text{ Hz}$ ). After the flute has passed, the observer hears the sound as a G which has a frequency of 392 Hz. What is the speed of the train? The speed of sound in air is 343 m/s.

- A) 26 m/s
- B) 12 m/s
- C) 42 m/s
- D) 7.3 m/s
- E) 37 m/s

$f_s = 440 \text{ Hz}$     $f_o = 392 \text{ Hz}$     $v = 343 \text{ m/s}$     $v_s = ?$   
 $f_o = f_s \left(\frac{1}{1 - \frac{v_s}{v}}\right) \rightarrow \frac{f_o}{f_s} = \frac{1}{1 - \frac{v_s}{v}} \rightarrow \frac{f_s}{f_o} = 1 - \frac{v_s}{v} \rightarrow \frac{v_s}{v} = 1 - \frac{f_s}{f_o}$

Negative b/c train leaving.  $-42 \text{ m/s} = \left(1 - \frac{440}{392}\right) 343 = v_s = v \left(1 - \frac{f_s}{f_o}\right)$

10. A source moving through water at 10.0 m/s generates water waves with a frequency of 5.0 Hz. The speed of these water waves relative to the water surface is 20.0 m/s. The source approaches an observer who is at rest in the water. What wavelength would be measured for these waves by the stationary observer?

- A) 1.0 m
- B) 2.0 m
- C) 4.0 m
- D) 6.0 m
- E) 8.0 m

$f_s = 5 \text{ Hz}$     $v_s = 10 \text{ m/s}$     $v = 20 \text{ m/s}$   
 $f_o = f_s \left(\frac{1}{1 - \frac{v_s}{v}}\right) = 5 \left(\frac{1}{1 - \frac{10}{20}}\right) = 10 \text{ Hz}$

$$\lambda_o = \frac{v}{f_o} = \frac{20 \text{ m/s}}{10 \text{ Hz}} = 2 \text{ m}$$