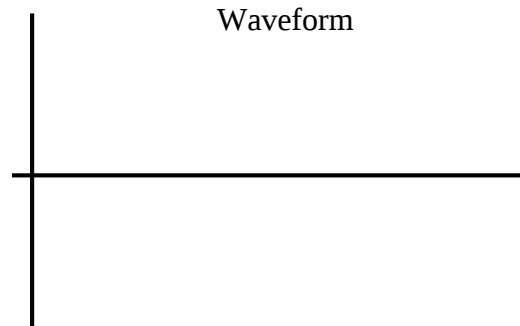
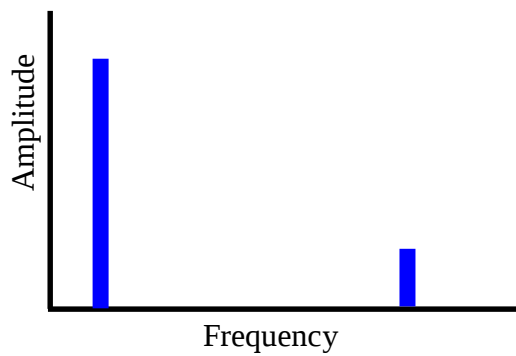


- If the following four sinusoidal waveforms were combined, 50 Hz, 100 Hz, 200 Hz, and 300 Hz, the resulting complex waveform would be PERIODIC APERIODIC (circle one) and its fundamental frequency would be 25 Hz 50 Hz 100 Hz NONE (aperiodic) (circle one)
- Sketch the waveform of the frequency spectrum shown at left.



- An ultrasonic velocity sensor (that is at rest) emits an $f_{\text{sensor}} = 30.00\text{-kHz}$ sound wave that encounters a baseball that is moving directly toward the sensor. The sound waves reflect off the baseball and return to the sensor, and the sensor determines the speed of the baseball by measuring the Doppler shift of the reflected wave. This process involves *two* Doppler shifts.

- First, the ball is a “listener” that is moving toward the velocity sensor. What frequency would be measured by a tiny observer on the ball? Write a symbolic expression for f_{listener} in terms of f_{sensor} , c_{air} , and v_{ball} .

- Second, the ball is a “source” of sound waves that is moving toward the velocity sensor, which is now the “listener”. In this case the f_{source} is the frequency detected by the ball from part (a). Write an expression for the frequency f_{received} that is detected by the sensor from this moving source of sound. Your expression should be in terms of f_{sensor} , c_{air} , and v_{ball} .

- With a little bit of algebra, you can take your expression from part (b) and solve it for v_{ball} . I’ll spare you the effort and give you the expression below. If the sensor detects $f_{\text{received}} = 38.85\text{ kHz}$, how fast (in m/s) is the baseball moving? Let $c_{\text{air}} = 343\text{ m/s}$.

$$v_{\text{ball}} = c_{\text{air}} \left(\frac{f_{\text{received}} - f_{\text{sensor}}}{f_{\text{received}} + f_{\text{sensor}}} \right)$$

4. Find the sound pressure level in units of dB if the amplitude of pressure oscillation is:
- a) $20 \mu\text{Pa}$ Answer: _____ dB SPL
- b) $2000 \mu\text{Pa}$ Answer: _____ dB SPL
5. Find the intensity level in units of dB if the intensity I is:
- a) $8.0 \times 10^{-9} \text{ W/m}^2$ Answer: _____ dB IL
- b) $8.0 \times 10^{-5} \text{ W/m}^2$ Answer: _____ dB IL
6. If 16 loudspeakers (each one producing an equal sound intensity level) are producing a combined 74.0 -dB sound level, what will be new combined sound level when 8 loudspeakers are turned off?
7. If 16 loudspeakers (each one producing an equal sound intensity level) are producing a combined 74.0-dB sound level, what is the sound level produced by each loudspeaker?
8. a) A firecracker explodes, emitting 0.15 W of acoustic power. Ignoring atmospheric absorption, what will be the sound level in dB IL to an observer that is 50 m from the firecracker?
- (b) If you account for atmospheric attenuation of 200 dB/km, what will be the sound level in dB IL to the same observer?