### UNIT 13 REVIEW: LEARNING TARGET 13.1

\[ T = \frac{2\pi}{\omega} = \frac{1}{f} \]

- \( f \) = frequency
- \( T \) = period
- \( \omega \) = angular speed

### UNIT 13 REVIEW: LEARNING TARGET 13.2

\[ x = A \cos(2\pi ft) \]

\[ T_s = 2\pi \sqrt{\frac{m}{k}} \]

\[ T_p = 2\pi \sqrt{\frac{\ell}{g}} \]

- \( A \) = amplitude
- \( f \) = frequency
- \( k \) = spring constant
- \( \ell \) = length
- \( m \) = mass
- \( T \) = period
- \( t \) = time
- \( x \) = position

### UNIT 13 REVIEW: LEARNING TARGET 13.3

\[ \lambda = \frac{v}{f} \]

\[ \lambda = \nu \tau \]

- \( \lambda \) = wavelength
- \( v \) = speed
- \( f \) = frequency

**Key Concepts**

- Sound is a pressure variation transmitted through matter as a longitudinal wave.
- A sound wave has frequency, wavelength, speed, and amplitude.
- The frequency of a sound wave is heard as its pitch.
- The pressure amplitude of a sound wave can be measured in decibels (dB).
- The loudness of sound as perceived by the ear and brain depends mainly on its amplitude.
13.4 Sound (ALL)

**Refraction**

Sound waves bend when parts of the wave fronts travel at different speeds. This bending of sound is called **refraction**.

**Speed of Sound**

<table>
<thead>
<tr>
<th>Medium</th>
<th>m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air (0°C)</td>
<td>331</td>
</tr>
<tr>
<td>Air (20°C)</td>
<td>343</td>
</tr>
<tr>
<td>Helium (0°C)</td>
<td>972</td>
</tr>
<tr>
<td>Water (25°C)</td>
<td>1493</td>
</tr>
<tr>
<td>Seawater (25°C)</td>
<td>1533</td>
</tr>
<tr>
<td>Copper (25°C)</td>
<td>3560</td>
</tr>
<tr>
<td>Iron (25°C)</td>
<td>5130</td>
</tr>
</tbody>
</table>

**The Doppler Effect**

The **Doppler Effect** describes the change in frequency of a wave for an observer moving relative to the source of the wave.
The Doppler Effect

\[ f_d = f_s \left( \frac{v - v_d}{v - v_s} \right) \]

\( V = 343 \text{ m/s} \)

d - detector
s - source

UNIT 13: IN-CLASS PROBLEMS

6. During a thunder storm, you see a flash of lightning. Five seconds later you hear the corresponding thunder. How far away was the lightning strike?

7. You drop a stone from rest into a well that is 7.35 m deep. How long does it take before you hear the splash?

8. A trumpet player sounds C above middle C (524 Hz) while traveling in a convertible at 24.6 m/s. If the car is coming toward you, what frequency would you hear?
UNIT 13: IN-CLASS PROBLEMS

6. During a thunder storm, you see a flash of lightning.
   Five seconds later you hear the corresponding thunder.
   How far away was the lightning strike?

   \[ x = v t \]
   \[ x = (343 \text{ m/s})(5 \text{ s}) \]
   \[ x = 1715 \text{ m} \]

UNIT 13: IN-CLASS PROBLEMS

7. You drop a stone from rest into a well that is 7.35 m deep. How long does it take before you hear the splash?

   \[ y = \frac{1}{2} g t^2 \]
   \[ t_1 = \frac{2y}{g} = 1.22 \text{ s} \]
   \[ d = v t_2 \]
   \[ t_2 = \frac{d}{v} = \frac{7.35 \text{ m}}{343 \text{ m/s}} = 0.0214 \text{ s} \]
   \[ t = t_1 + t_2 = 1.24 \text{ s} \]

UNIT 13: IN-CLASS PROBLEMS

8. A trumpet player sounds C above middle C (524 Hz) while traveling in a convertible at 24.6 m/s. If the car is coming toward you, what frequency would you hear?

   \[ f_0 = f_0 \left( \frac{v - v_d}{v - v_s} \right) \]
   \[ f_0 = 524 \text{ Hz} \left( \frac{343 \text{ m/s} - 0}{343 \text{ m/s} - 24.6 \text{ m/s}} \right) = 564 \text{ Hz} \]