Unit 5: Mechanical Waves, Sound, and the Electromagnetic Spectrum Student Notes

I. Characteristics of Waves
   A. Waves
      ➢ Waves are rhythmic disturbances that carry ___________________ through ___________________ or space.
      ➢ Medium is the material through which a wave transfers ____________________.
      ➢ Medium can be ________________, liquid, ____________________, or a combination.
      ➢ Do all waves require a medium? ______________
      ➢ Electromagnetic waves __________________ require a medium. (Example: Visible Light)

   B. Waves and Energy
      How are waves and energy alike? How are they different?

      | Waves | Energy |
      |-------|-------|
      | Carry | Waves carry | Waves carry ___________________ |
      | Waves are caused by | Vibration is a transfer of | Vibration is a transfer of ___________________ |
      | Can do | As waves carry energy the particles in the medium move | As waves carry energy the particles in the medium move |
      | Move objects | | The direction of the motion determines the type of wave. |

   C. Categories of Waves

      | Category | Characteristic |
      |----------|---------------|
      | Mechanical Waves | _______ travel through a ________ _______ travel through a vacuum |
      | | Examples: sound, ocean waves |
      | Electromagnetic Waves | Does______ require a ________ |
      | | Can be ________ through a vacuum |
      | | Example: light, UV rays, Visible light |
Types of Waves

D. Transverse Waves
- Medium vibrate_________________ to the direction of the wave motion
- Example: Water waves, electromagnetic waves
- Anatomy of the wave: wavelength, amplitude, crest, trough, nodes

E. Longitudinal Waves
- Medium moves in the_________________ as the wave’s motion
- Examples: Sound wave, spring, slinky
- Anatomy of the wave: wavelength, compression, rarefaction, amplitude
- AKA: ________________________ waves

F. Measuring Waves
- Frequency \( (f) \) is the____________________________ of waves passing a point in 1 second.
- SI unit for frequency is measured in____________________ (Hz)
- The____________________ the wavelength \( \rightarrow \) the____________________ the frequency \( \rightarrow \) higher the energy
- Which wave below would have the highest frequency? Why? _____ _________________________

<table>
<thead>
<tr>
<th>Equation</th>
<th>Variables</th>
<th>Units</th>
<th>Circle diagram</th>
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</thead>
<tbody>
<tr>
<td>Frequency = 1/period</td>
<td># of ______ passing a point in 1 second</td>
<td></td>
<td></td>
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<tr>
<td>Velocity = ( \lambda ) x f</td>
<td>Speed of a _____ as it moves forwards</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Depends on wave type and medium</td>
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- Solid – molecules are ______ together so waves travel very ________.
- Liquid – molecules are ______ apart but can slide past one another so wave does not travel as fast.
- Gas – molecules are very ________ apart so a molecule has to travel far before it hits another molecule, so waves travel ________ in gases.
Example: Find the velocity of a wave in a wave pool if its wavelength is 3.2 m and its frequency is 0.60 Hz.

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<th>Equation and Work</th>
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Example: An earthquake produces a wave that has a wavelength of 417 m and travels at 5000 m/s. What is its frequency?

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II. Wave Behavior

- Wave interaction occurs when a wave meets an ______________ or another wave.
- Wave interaction also occurs when a wave passes into another ______________. Examples: ______________, diffraction, refraction, ______________, resonance

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<th>Wave Behavior</th>
<th>Definition</th>
<th>Illustration</th>
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<td>A. Reflection</td>
<td>When a wave strikes an object and __________ off. When a wave bounces off a surface it cannot pass through</td>
<td>Specular Reflection (smooth surfaces)</td>
</tr>
<tr>
<td>B. Refraction</td>
<td>The __________ of a wave as it passes from one medium to another at an angle. Caused by a ________ in speed Depends on... speed of light in the medium ______________ of the light; shorter wavelengths bend more</td>
<td>Slower Faster</td>
</tr>
<tr>
<td>C. Diffraction</td>
<td>The __________ of a wave as it moves __________ an obstacle or passes through a __________ opening. Longer wavelengths bend _____ (opposite of refraction)</td>
<td></td>
</tr>
<tr>
<td>D. Interference</td>
<td>The interaction of _______ or _______ waves that combine in a region of overlap. Two types: __________ &amp; __________ (brighter) (dimmer)</td>
<td></td>
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### Wave Behavior

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<td>E. Constructive Interference</td>
<td>Two or more waves interacting. _______ the energies of the two waves into a _________ amplitude. (Brighter Light)</td>
<td><img src="image" alt="Constructive Interference" /></td>
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<tr>
<td>F. Destructive Interference</td>
<td>Two or more waves interacting. _______ the energies of the two waves into a _________ amplitude. (Dimmer Light)</td>
<td><img src="image" alt="Destructive Interference" /></td>
</tr>
<tr>
<td>G. Doppler Effect</td>
<td>A change in wave frequency caused by __________ of sound source, motion of the listener, or both.</td>
<td><img src="image" alt="Doppler Effect" /></td>
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### III. The Nature of Sound (Mechanical Waves)

#### A. Speed of Sound depends on:
- Type of _____________________________
  - Travels better through ______________ than through _____________________________
  - Require a medium
  - Cannot travel through a _____________________________
- Temperature of _____________________________
  - Travels faster at _____________________________ temperatures

#### B. Human Hearing
- Pitch is highness or lowness of a sound
  - Depends on the _____________________________ of the sound wave.
  - Human range: 20 – 20,000 Hz
- Intensity is the volume of sound
  - depends on energy ( _____________________________ ) of the sound wave
  - measured in decibels (db)

#### C. Doppler Effect
- change in wave _____________________________ caused by a moving wave source
- moving toward you - pitch sounds _____________________________
- moving away from you - pitch sounds _____________________________
D. Seeing with Sound

- Ultrasonic waves - above 20,000 Hz

IV. Electromagnetic Radiation

A. Electromagnetic radiation

- _______________________________ waves produced by the motion of electrically charged particles
- does not require a ____________
- speed in a vacuum = 300,000 km/s
- electric and magnetic components are perpendicular

B. Electromagnetic Spectrum – The full range of light

- The longer the _____________, the _______________ the frequency, the _______________ the energy.

- Wavelength
- Frequency
- Energy
C. **Types of Electromagnetic (EM) Radiation**

- **Radio waves**
  - have the lowest _______________ EM radiation
  - FM - frequency modulation  AM - amplitude modulation

- **Microwaves**
  - penetrate food and vibrate water & fat molecules to produce _______________ energy

- **Infrared Radiation (IR)**
  - Slightly _______________ energy than visible light
  - Can raise the thermal energy of objects

- **Visible Light**
  - the small part of the _______________ that we can see.
  - ROY G. BIV - colors in order of increasing energy (red, orange, __________, green, __________, indigo, __________)

- **Ultraviolet radiation (UV)**
  - slightly _______________ energy than visible light
  - Types: UVA (tanning, wrinkles), UVB (______________, cancer), UVC (most harmful, sterilization)
  - Ozone layer depletion = UV _______________

- **X-rays**
  - _______________ energy than ultraviolet (UV)
  - can _______________ soft tissue, but not bones

- **Gamma Rays**
  - _______________ energy on the EM spectrum
  - emitted by radioactive atoms
  - used to kill cancerous cells