

## Chapter 7 Notes

### Wave Motion

A **wave** is a periodic disturbance – a back-and-forth change of some kind that is repeatedly regularly as time goes on – that spreads out from a source and carries energy with it

### 2 Categories

- **Mechanical Waves**
  - o Travel only through matter
  - o Involve the motion of particles of matter they pass through
    - Water and Sound
- **Electromagnetic Waves**
  - o Consist of varying electric and magnetic fields
  - o Can travel through a vacuum as well as through matter
    - Light and Radio Waves

### 7.1 Water Waves

#### Waves Carry Energy

- All mechanical waves behave the same way
  - o Carry energy but not matter

### 7.2 Transverse and Longitudinal Waves

#### Transverse

- Particles move perpendicular to the direction in which the wave moves
- A medium, without interaction or attachments between particles cannot transmit transverse waves

#### Longitudinal

- Motion of particles is along the same line that the wave travels
- On a spring cause a series of **compressions** (loops of spring pressed together) and **refractions** (loops are stretched apart)

#### Water Waves

- Pure transverse mechanical waves can occur only in solids
  - o Longitudinal waves can travel in any medium, solid or fluid
- Longitudinal motion merely requires that each particle push on its neighbors
  - o Can happen as easily in a gas, liquid, or solid

### 7.3 Describing Waves

#### Key properties

- **Wavelength:** distance from crest to crest
- **Speed:** the rate at which each crest moves
- **Frequency:** the number of crests that pass a given point each second
  - o Unit of frequency is Hz (c/s)
- **Period:** is the time needed for a complete wave to pass a given point
- **Amplitude:** height of the crest above the undisturbed level

## Sound Waves

### 7.5 Sound

We perceive **Sound** as a series of pressure changes that cause our eardrums to vibrate

- Sound waves are longitudinal because the molecules in their paths move back and forth in the same direction as that of the waves
  - o The air (or other material) in the path of the sound waves becomes alternately denser and rarer, and the resulting pressure changes cause our eardrums to vibrate, which produces the sensation of sound

### Inaudible Sounds

- Infrasound about 20Hz; Ultrasound 20,000 Hz
  - o Dogs = 45,000 Hz

### The Decibel

- The more energy a sound wave carries, the louder the sound
- Exposure to sounds of 85 dB or more can lead to permanent hearing damage

### 7.6 Doppler Effect

Higher Pitch When Approaching; Lower Pitch When Receding

- **Doppler effect** – changes in sound from a moving object

### In Astronomy

- Can be used to detect and measure motions of the stars
  - o Red and blue light stuff that you learned in ASTR

### 7.8 Electromagnetic Waves

#### Relationship

- A change in the electric field will affect the associated magnetic field and vice-versa

### 7.9 Types of EM Waves

#### Radio

- A radio signal is sent by means of em waves produced by electrons that move back and forth 100s of 1,000s to millions of times per second
- Frequencies
  - o Ordinary radio waves = 2 MHz
  - o Long-range short-wave communication = 30MHz

### 7.10 Light “Rays”

#### Reflection and Refraction

- We see most objects by reflected light, light that has been turned sharply on striking a surface
- When light is **refracted** when light is bent from a straight path

### 7.12: Refraction

#### Index of refraction

- The ratio between the speed of light  $c$  in free space and its speed  $v$  in a medium
  - o  $n = c/v$ 
    - Index of Refraction = Speed of light in free space / speed of light in medium
- The greater the value of  $n$ , the more light is deflected
  - o Water = 1.33; glass and clear plastics = 1.52; Diamond = 2.42

### 7.13 Lenses

A **lens** is a piece of glass (or other transparent material) shapes so that it can produce an image by refracting light that comes from an object

#### Two Kinds

- **Converging**
  - o Thicker in the middle than at the rim
  - o Brings parallel beam of light into a single focal point called the **real focal point**
    - The distance from the lens to the real focal point is called the **focal length**
- **Diverging**
  - o Thinner in the middle than at the rim
  - o Spreads out a parallel beam of light so that the rays seem to have come from a focal point behind the lens, called the **virtual focal point**
  - o Image of a real object produced by a diverging lens is always virtual, erect, smaller than the object, and closer to the lens than the object is

#### Ray Tracing

- A simple way to find the properties of the image formed by a lens

### 7.14 – The Eye

#### Dispersion

- The separation of light into different colors sorted by wavelength
- When hitting a glass prism, dispersion occurs, red light is bent the least and violet light is bent the most

#### Structure

- **Cornea** (Transparent outer membrane) and the **Lens** (jellylike) together focus incoming light on the sensitive **retina** (converts what is seen into neural impulses that are carried to the brain by the **optic nerve**)
- Focusing on objects different distances away is done when the **ciliary muscle** changes the shape and hence the focal length of the lens
- The colored **iris** acts like the diaphragm of a camera to control the amount of light entering the **pupil** (the opening of the iris)
  - o Pupil is small in bright and large in dim; fully opened pupil lets in about 16x as much light as a fully contracted one

#### The Retina

- Millions of tiny structures called **cones** and **rods**
  - o Cones – specialized for color vision, occur in three types that respond to red, green, and blue light