Lecture Notes

I. Chapter 6 – Thermal energy and heat

a. Temperature – a measure of the AVERAGE kinetic energy of the individual particles of a substance.

b. Temperature scales:

i. Fahrenheit, Celsius and Kelvin

ii. Absolute zero- that temperature where the individual particles contain no more energy. The particles (atoms and/or molecules) cease vibrating. No movement occurs. Absolute zero occurs at -460^{o} F, -273^{o} C and at 0^{o} K

iii. "Need-to-Know" Table:

Scale	Abbreviation	Absolute Zero	Water Freezes	Water Boils
Fahrenheit	^{o}F	-460	32	212
Celsius	^{o}C	-273	0	100
Kelvin	^{o}K	0	273	373

c. Thermal energy – TOTAL energy of all of the particles

d. Heat – thermal energy moving from a warmer object to a cooler object

e. Heat is transferred in one of three ways:

i. Conduction, Convection and Radiation

1. Conduction – heat is transferred from one particle to the next particle w/out the particles actually moving or changing place. Examples include: a metal spoon in hot water gets hot or a pot gets hot as it sits on an electric stove.
2. Convection – movement that transfers heat by movement of currents within the particles. The particles actually are moving and thereby transferring the heat. Examples include: a pot of boiling water sets up convection currents to move the hot water at the bottom of the pot being heated to the cooler water at the top of the pot and the convection zone in the sun.
3. Radiation Zone – transfer of energy by electromagnetic waves. Examples include: the Sun's energy traveling thru space and heating up the Earth w/out heating space itself, Heat lamps used at fast food restaurants, and the radiator of a car dissipating the heat of an engine.

f. Heat is transferred (moves) in only one direction: from a warmer object to a cooler object.

i. Hot coffee cools to room temp because the heat of the coffee is transferred to the cooler temperature of the room.

ii. A cold glass of Iced tea soon warms up to the surrounding room temperature because the warmer temperature of the room's surroundings is transferred to the colder glass of iced tea thereby warming it up.

g. Conductor – a material that transfers heat well: metal, tile, glass

h. Insulator – a material that does not transfer heat well: air, carpet, wood

i. Tile floor and carpet are both the same temperature in the morning but when you step on them bare foot the tile feels cold because tile transfers the heat from your foot well. The carpet feels "not cold" because it doesn't transfer the heat well.

i. Specific Heat – the amount of energy required to raise the temperature of 1 kg of the object 1degree K. the unit is Joules/ Kg x ^{o}Kelvin

j. Change in energy = Mass x Specific Heat x change in Temp

i. Shorthand way of writing:
$\triangle E = MxSpx \triangle K$

ii. How much heat is required to raise the temperature of 5Kg of water 10^{o}K? Specific heat of water is 4,180 J/Kg^{o}K

iii. $\triangle$E = 5Kg x 4,180 J/Kg^{o}K x 10 K
E = 209,000 J

k. Thermal Energy and States of Matter
   i. Solid – atoms are in a fixed position, they only vibrate back and forth. Solids have both a definite shape and definite volume.
   ii. Liquid – atoms are free to slide over and upon each other. Liquids have a definite volume but not a definite shape.
   iii. Gas – atoms are free to move independently of other atoms of the substance. Gases have neither a definite shape or volume.
   iv. Matters change from one state to the next depending on if thermal energy is added or removed.
      1. terms: melting point, boiling point, freezing, melting, sublimation, condensation, Vaporization: evaporation and boiling
      2. Vaporization: two types
         a. Evaporation- surface vaporization only
         b. Boiling – vaporization at and below the surface of the liquid.

II. Chapter 7: Characteristics of waves
   a. What are waves?
      i. Wave – a disturbance that transfers energy from place to place.
      ii. Medium – the material thru which a wave passes
      iii. Mechanical wave – a wave that requires a medium to travel through. Examples include sound waves and earthquake seismic waves
      iv. Waves travel trough the medium without actually moving the medium with it. Basically the medium stays put while the wave moves some distance
   b. What causes waves?
      i. A source of energy causes a medium to vibrate: a pebble dropped into a pond causes a circular wave to generate away from the point the pebble strikes the water.
   c. Types of waves: three main types that are classified according to how they move – transverse, longitudinal and surface waves
      i. Transverse Waves: waves that move the medium at right angles to the direction in which the waves are traveling. Examples include a rope attached to a door and moved up and down, transverse waves have a crest and a trough
      ii. Longitudinal Waves: move particles parallel to the direction the wave is moving, "push-pull" waves. These waves have compressions and rarefactions. Example: slinky
      iii. Surface waves are combinations of both transverse and longitudinal waves.
   d. Properties of Waves – 4 basic properties: amplitude, wavelength, frequency and speed
      i. Amplitude – in a transverse wave – the height away from the "rest" position. The amplitude in a longitudinal wave is the measure of how compressed or rarefied the medium becomes.
      ii. Wavelength – the distance between two corresponding parts of a wave.
      iii. Frequency – the number of complete waves that pass a given point in a certain period of time. Frequency is measured in HERTZ, one Hz is a wave that occurs once every second.
      iv. Speed = wavelength x frequency
      v. Wavelength = speed / Frequency
      vi. Frequency = speed / Wavelength
   e. Interactions of waves
      i. Reflection – Bounce back wave

1. Angle of incidence is the angle of the wave coming into the object reflecting the wave.
2. Angle of Reflection is the angle bouncing off and going away from the object.

ii. Refraction – The bending of a wave due to the wave moving from one type of medium into another.

iii. Diffraction – Wave passing a barrier or going through a hole in a barrier bends and causes the wave to wrap around the barrier

iv. Interference – when two or more waves meet, they interact. This interaction is called interference.
1. Constructive interference – the combining of waves to cause higher amplitude of any of the original waves.
2. Destructive Interference – when the combining of the waves produce a new wave with a smaller amplitude than the beginning waves

v. Standing waves – the combining of the incoming and reflected wave so that the resultant appears to be standing still
1. node – the point where Constructive Interference and Destructive Interference cause an amplitude of zero on the standing wave.
2. antinode – the point where Constructive Interference and Destructive Interference of a standing wave are represented by the crest and the trough.
3. Resonance – the point where vibrations traveling thru and object matches the natural vibrations of an object.
a. Ie an opera singer hitting a note and shattering a crystal glass.

f. Seismic Waves – waves caused by the release of energy due to earthquakes composed of P primary waves, S secondary waves and the surface waves

i. P waves – Primary waves are the fastest moving waves, they travel thru solids and liquids, Push-Pull Waves AKA Longitudinal waves

ii. S Waves – Secondary Waves are slower than primary waves, they cannot travel thru liquid and are Longitudinal waves.

iii. Surface wave – the combination on the Earth's surface of Primary and Secondary waves

III. Chapter 8 - Sound

a. Sounds are longitudinal waves that require a medium to travel caused by the vibrations of an object.

b. The speed of sound depends on the elasticity, density and temperature of the medium.

i. Elasticity – the ability of an object to bounce back to its original shape. Sound travels faster in more elastic objects. Typically gasses are the least elastic, liquids are next and solids are the most elastic.

ii. Density – generally speaking, the denser the medium the slower the sound travels.

iii. Temperature – generally speaking the higher the temperature the faster the speed of sound.

iv. Chuck Yeager – first man to fly faster than the speed of sound

v. Andy Green – first man to drive a land vehicle faster than the speed of sound.

c. Properties of Sound

i. Intensity – the amount of energy the wave carries per second per meter squared
1. intensity = Watts / m^2

ii. Loudness – sound level is measured in decibels (dB)
1. whisper = 20 dB
2. rock concert = 115 dB
3. rocket engine = 200 dB

Vocabulary	Definition
Acoustics	The control of noise & the vibrations that cause noise
Compression	Area where the waves are pushed together
Compressional	Type of wave where medium vibrates in the same direction as the movement
Decibels	The intensity of sound is measured in these units
Doppler	The change in frequency caused by the motion of the object
Fundamental	The lowest frequency in a musical sound
Harmony	Overtones w/ whole number multiples frequencies of the fundamental
Interference	The combination of two or more sound waves
Loudness	As the amplitude increase, the loudness increases
Octave	Eight notes on the musical scale
Overtone	Has a higher frequency than the fundamental frequency
Pitch	Dependant on the frequency of the wave
Rarefaction	Area of a sound wave where the wave is pulled apart
Ultrasonic	Sounds too high to be heard by humans
Vacuum	Sound waves require a medium to travel & cannot travel through a vacuum

d. Human Sound

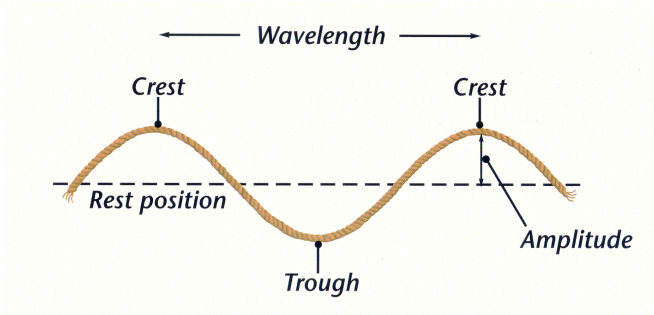
a. Converting sound waves (vibrations) into sensory impulses interpreted as sound.

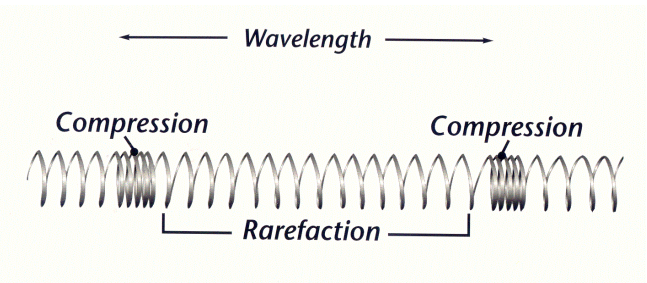
b. Three parts to your ear: Outer Ear, Middle Ear and Inner Ear

i. **Outer Ear**: The funnel shaped **ear flap (pinna)** and the **auditory canal** direct sound to the **eardrum (tympanum)** which separate the outer and middle ear

ii. **Middle Ear**: The sound waves vibrate the tympanum which causes the three smallest bones in the body to also vibrate. These bones (in order) are the **Hammer (Malleus), Anvil (Incus)** and **Stirrup (Stapes)**. The end of the stirrup vibrates a thin membrane, the **Oval Window**, covering the inner ear. The **Eustachian tube** connects the middle Ear with the back of the throat (Pharynx) to allow atmospheric pressures to equalize on each side of the **tympanum**.

iii. **Inner Ear**: The **Oval Window** separates the middle and inner ears. This membrane touches the fluid filled chamber of the **cochlea** causes the **Cochlea** to vibrate. The inner surface of the cochlea is lined with tiny nerve receptor **Hair Cells**. These receptors stimulate the neurons of the **auditory nerve** (**Vestibulocochlear Nerve**) which carries impulses to the cerebrum where it is interpreted as sound.





The Structure of the Human Ear