Name Key Hour

(1) 1 Hz = $\frac{1}{\text{sec}}$
(2) molecules closer
(3) move faster together
(4) Alexander Graham Bell

Sound Notes

Sound

1. Sound is a longitudinal wave caused by vibrating molecules.
2. How are vibrations turned into sound?
   ears collect vibrations → vibrates eardrums → changes into signals sent to brain
3. Would there be sound if there was no air? (like in space) NO
4. Sound waves move at a constant velocity 330 m/s = 740 mph
5. Something that is moving faster than the speed of sound is called supersonic
   Ex. whip, bullet, planes, Concord (crashed 2000 France) mach 2 Paris → NYC 3.5 hr vs. 8
   (Blackbird) mach-3 manned ← (unmanned) mach 9.6
   guy jumping from space ≈ 800 mph
6. The speed of sound is referred to as Mach-1, twice the speed of sound is Mach 2
7. A loud noise created when an object travels faster that the speed of sound is a sonic boom
8. Chuck Yeager: First person to break the sound barrier in 1947 – repeated on 10/14/2012 at age 89
9. The loudness of sound is measured in decibels
10. Common frequencies of sound waves

	infrasonic-	audible-	ultrasonic-
Hz:	Less than 20	20 - 20,000	Greater than 20,000
Ex:	earthquake, thunder, lizards, elephants	we hear	dog whistles, ultrasounds, bats, dolphins, frogs, moths, mice

Variables that Affect the Speed of Sound

1. Medium: What the sound travels through

   Why do sounds travel faster in solids than in air?
   molecules closer together

   Sound travels about 4.5 times faster in water than in the air at 0° C.

2. **TEMPERATURE**
   As the temperature increases the speed of sound increases

   $v = 330 \text{ m/s} + (0.6 \times \text{temp in °C})$
   ** The temperature must be in degrees Celsius

   $°C = \frac{(°F - 32°F)}{1.8}$

   Why do sounds travel faster in warmer weather? molecules move faster

   Example: Calculate the speed of sound on a 10° F day. (322.7 m/s)

   $°C = \frac{10-32}{1.8} = -12.2°C$ $\quad v = 330 + (.6 \times -12.2) = 322.7 \text{ m/s}$

Name _____ Hour _____

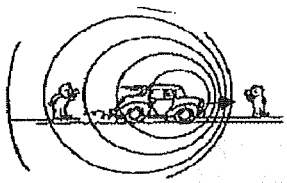
Doppler Effect

1. Doppler Effect: The frequency shift that is a result of motion between the source of waves and an observer.
   *Reminder...higher frequencies have higher pitches

***F.Y.I. This can occur with sound waves, light waves, radio waves for weather forecasting (Doppler radar).

*A moving car honking its horn sketch:

Observer hears a lower pitch as it moves away because the frequency (waves/sec) is lower



Observer hears a HIGHER pitch as it moves toward you because the frequency (waves/sec) is greater

2. *Equation for the Doppler Effect :* $f' = f \frac{v}{v \pm v_s}$

f' = *Frequency heard by observer in* Hz

f = *Original frequency in* Hz

V = *Speed of sound in* m/s

Vs = *Speed of source of the sound in* m/s

Add - away Takeaway - toward

Example:
A train moving at 20 m/s sounds a horn of frequency 200 Hz. Assuming that the speed of sound is 340 m/s, what is the frequency heard by

a) a person the train is moving toward?

f' = x
f = 200 Hz
V = 340
Vs = 20

$f' = 200\left(\frac{340}{340-20}\right) = 212.5$ Hz (should be higher)

b) a person the train is moving away from?

$f' = 200\left(\frac{340}{340+20}\right) = 188.9$ Hz (should be lower)

Resonance: The condition that occurs when the frequency of an applied force matches the natural frequency of an object creating maximum energy transfer.

- Frequency that most efficiently turns sound waves into physical motion.

Examples of resonance:

1. Singing/Lexus exhaust shatters wine glass:

2. Tacoma Narrows Bridge; Opened for 4 months before it collapsed in 1940
   freq & speed of wind matched natural freq. of bridge creating max. energy transfer & movement!