Name: _____

The Nature of Sound Waves

Read from **Lesson 1** of the **Sound and Music** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/sound/u11l1a.html
http://www.physicsclassroom.com/Class/sound/u11l1b.html
http://www.physicsclassroom.com/Class/sound/u11l1c.html

MOP Connection: Sound and Music: sublevel 1

TRUE or **FALSE**: Identify the following statements as being either true (T) or false (F).

T or F?

_____ 1. Sound waves are longitudinal waves.

_____ 2. As the teacher talks, students hear the voice because particles of air move from the mouth of the teacher to the ear of the student.

_____ 3. Sound waves are mechanical waves.

_____ 4. All sound waves are produced by a vibrating object.

_____ 5. A sound wave does not consist of crests and troughs.

6. Mac is talking to Kate. The dot at A represents a particle of air. Describe the motion that this particle must undergo in order for Kate to hear Mac. Then show the motion by placing arrows on the diagram.

7. Tosh is holding one end of a slinky; the opposite end is attached to a wall. Tosh wishes to produce a longitudinal wave in the slinky. Describe how Tosh must move his hand in order to produce a longitudinal wave. Then place arrows on the diagram to show the way in which Tosh must move his hand.

8. A sound wave is moving through air. The diagram below represents a snapshot of the air particles at a given instant in time. Several regions are labeled with a letter. Use the letters to identify the compressions and rarefactions.

Compressions: _____ Rarefactions: _____

9. A science fiction film depicts inhabitants of one spaceship (in outer space) hear the sound of a nearby spaceship as it zooms past at high speeds. Critique the physics of this film.

Properties of Sound Waves

Read from **Lesson 2** of the **Sound and Music** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/sound/u11l2a.html
http://www.physicsclassroom.com/Class/sound/u11l2b.html
http://www.physicsclassroom.com/Class/sound/u11l2c.html

MOP Connection: Sound and Music: sublevel 2

Review:
Match the following wave quantities to the *mini-definition*. Place the letter in the blank.
A. Frequency B. Period C. Speed D. Wavelength E. Amplitude

_____ 1. **How fast** the wave moves through the medium.

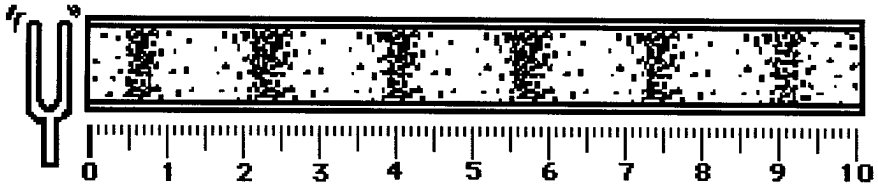
_____ 2. **How long** the wave is.

_____ 3. **How often** the particles vibrate about their fixed position.

_____ 4. **How much time** it takes the particles to complete a vibrational cycle.

_____ 5. **How far** the particles vibrate away from their resting position.

6. A sound wave with its characteristic pattern of compressions and rarefactions is shown below. A centimeter ruler is included below the pattern. The wavelength of this sound wave is _____ cm.



7. The pitch of a sound is directly related to the _____ of the sound wave.
a. frequency b. wavelength c. speed d. amplitude

8. High pitched sounds have relatively large _____ and small _____.
a. period, wavelength
b. speed, period
c. frequency, wavelength
d. period, frequency
e. amplitude, wavelength
f. amplitude, speed

9. As the frequency of a sound increases, the wavelength _____ and the period _____.
a. increases, decreases
b. decreases, increases
c. increases, increases
d. decreases, decreases

10. A sound wave is described as being 384 waves/s. This quantity describes the wave's _____.
a. frequency b. period c. speed d. wavelength

11. The speed of a sound wave depends upon the _____.
a. frequency of the wave
b. wavelength of the wave
c. amplitude of the wave
d. properties of the medium through which it moves

12. If a person yells (as opposed to whispering), then it will cause _____.
a. air molecules to vibrate more frequently
b. the sound wave to travel faster
c. air molecules to vibrate with greater amplitude

13. If a person yells (as opposed to whispering), then it will cause _____.
a. the pitch of the sound to be higher
b. the speed of the sound to be faster
c. the loudness of the sound to be louder

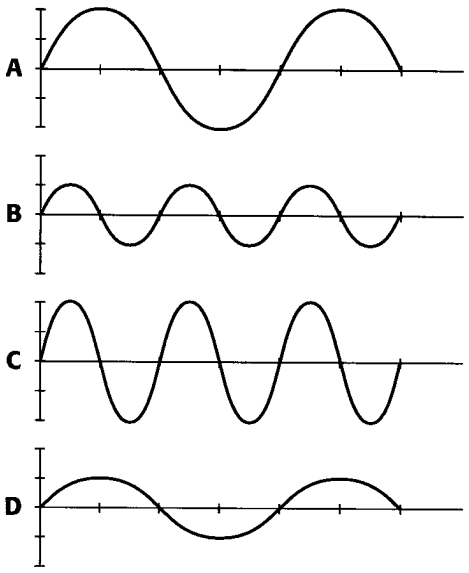
Name _____ Date _____ Class _____

REVIEW

11 CHAPTER 11

Mixed Review

1. **Interpreting Graphics** Study the four transverse waves shown here. Compare the properties of waves B, C, and D to that of wave A, and complete the following statements:



   a. Wave _____ has the same wavelength but a smaller amplitude.

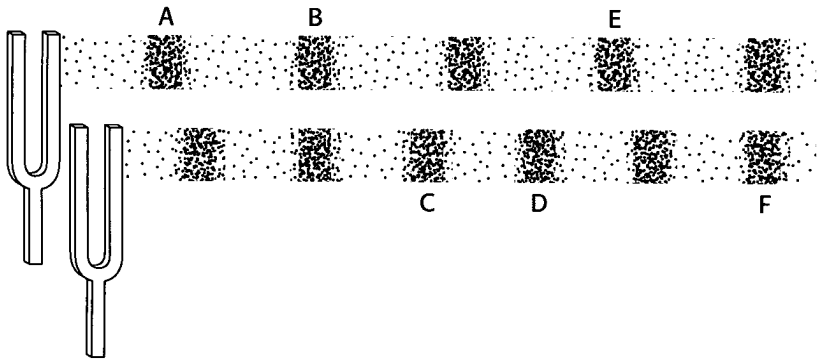
   b. Wave _____ has a shorter wavelength but the same amplitude.

   c. Wave _____ has a shorter wavelength and a smaller amplitude.

   d. Wave _____ has the same period and frequency.

   e. Waves _____ and _____ have shorter periods and greater frequencies.

2. **Interpreting Graphics** Examine the diagram below that shows the interference pattern of two sound sources of slightly different frequencies.



   a. At what point(s) in the pattern is a loud sound heard?

   _____

   b. At what point(s) in the pattern is a soft sound heard?

   _____

   c. Overall, what would a person hear?

   _____

The Speed of Sound

Read from **Lesson 2** of the **Sound and Music** chapter at **The Physics Classroom:**

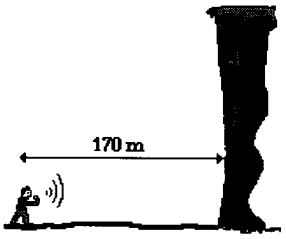
http://www.physicsclassroom.com/Class/sound/u11l2c.html

1. When the C4 key on a piano keyboard is pressed, a string inside the piano is struck by a *hammer* and begins vibrating back and forth at approximately 260 cycles per second.
   a. What is the frequency in Hertz of the sound wave?

   b. Assuming the sound wave moves with a velocity of 345 m/s, what is the wavelength of the wave? **PSYW**

2. An automatic focus camera is able to focus on objects by use of an ultrasonic sound wave. The camera sends out sound waves that reflect off distant objects and return to the camera. A sensor detects the time it takes for the waves to return and then determines the distance an object is from the camera. If a sound wave (speed = 345 m/s) returns to the camera 0.115 seconds after leaving the camera, how far away is the object? **PSYW**

3. Miles Tugo is camping in Glacier National Park. In the midst of a glacier canyon, he makes a loud holler. The sound (v = 345 m/s) bounces off the nearest canyon wall (which is located 170 meters away from Miles) and returns to Miles. Determine the time elapsed between when Miles makes the holler and the echo is heard. **PSYW**



4. Suppose that sound travels at a speed of 345 m/s on the evening of a thunderstorm. There is a lightning strike some distance from your home. The light reaches you nearly immediately. Yet the thunder is heard 3.5 seconds later. How many miles from your home did the lightning strike? (1609 meters = 1 mile) **PSYW**

5. A male vocalist with a bass voice can sing as low as 85 Hz. Given that the speed of sound is 345 m/s, what is the wavelength of the sound waves? **PSYW**

6. A female vocalist with a soprano voice can sing as high as 1000 Hz. Given that the speed of sound is 345 m/s, what is the wavelength of the sound waves? **PSYW**

Sound Intensity and the Decibel System

1. The decibel system is a system used to express the intensity of a sound. It is based on the powers of 10. A decibel is 1/10-th of a Bel. The sound level in Bels describes the power on 10 by which that sound is more intense than the so-called *threshold of hearing* (TOH). A 1-Bel sound is 10^1 times more intense than the TOH; it is a 10-decibel sound. A 2-Bel sound is 10^2 times more intense than the TOH; it is a 20-decibel sound. Use your understanding of the powers of 10 to complete the following table. (NOTE: different literature sources cite different intensity levels.)

2. Compare the decibel level of the following sounds.

a. If Sound B is 10 times the intensity of Sound A, then its decibel level is _____ higher.

b. If Sound C is 100 times the intensity of Sound A, then its decibel level is _____ higher.

c. If Sound D is 1000 times the intensity of Sound A, then its decibel level is _____ higher.

d. If Sound I is 10000 times the intensity of Sound A, then its decibel level is _____ higher.

1. A mosquito's *buzz* is often rated with a decibel rating of 40 dB. Normal conversation is often rated at 60 dB. How many times more intense is normal conversation compared to a mosquito's *buzz*?

a. 2 b. 20 c. 100 d. 200 e. 400

2. The table at the right represents the decibel level for several sound sources. Use the table to make comparisons of the intensities of the following sounds.

How many times more intense is the front row of a Smashin' Pumpkins concert than ...

a. ... the 15th row of the same concert?

b. ... the average factory?

c. ... normal speech?

d. ... the library after school?

e. ... the sound that most humans can just barely hear?

Sound Source	Level (dB)
Smashin' Pumpkins concert (front row)	110
Smashin' Pumpkins concert (15th row)	100
Average factory	90
Normal Speech	60
Library	40
Threshhold of hearing	0

3. On a good night, the front row of the Twisted Sister concert would surely result in a 120 dB sound level. An IPod produces 100 dB. How many IPods would be needed to produce the same intensity as the front row of the Twisted Sister concert?

The Doppler Effect

Read from **Lesson 3** of the **Sound and Music** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/sound/u11l3b.html

MOP Connection: Sound and Music: sublevel 4

1. **TRUE** or **FALSE**:

   Ken Fused is standing on a corner when a police car passes by with its siren on. Ken hears a different pitch when the police car is approaching him than when it is past him. This is because the siren on the front of the car is set to a higher pitch than the siren on the back of the car.

2. Describe the real reason Ken Fused observes what he does.

3. **TRUE** or **FALSE**:

   The Doppler shift is a phenomenon that is observed only of sound waves.

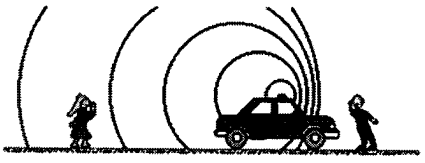
   Explain your answer:

4. **TRUE** or **FALSE**:

   As the source of a sound approaches an observer, the loudness of the sound increases. This is an example of the Doppler Shift.

   Explain your answer:

An automobile is traveling away from Jill and towards Jack. The horn is *honking*, producing a sound wave consisting of the familiar pattern of alternating compressions and rarefactions which travel from their origin through the surrounding medium. The circles on the diagram at the right represent wave fronts; you can think of the wave fronts as the compressions. Observe that the compressions are closer together in front of the car compared to behind the car.



5. Towards which person do the sound waves travel the fastest?
   a. Jack b. Jill c. Both the same.

6. Who will hear the highest frequency?
   a. Jack b. Jill c. Both the same.

7. The Doppler effect can be described as the difference between the frequency at which sound waves are produced and the frequency at which they are observed by the hearer. It occurs when the distance between the source of a sound and the observer is changing. As the source approaches an observer, the observer hears the pitch (or frequency) to be _____ (higher, lower). As the source moves away from an observer, the observer hears the pitch (or frequency) to be _____ (higher, lower).

Resonance

Read from **Lesson 4** of the **Sound and Music** chapter at **The Physics Classroom:**

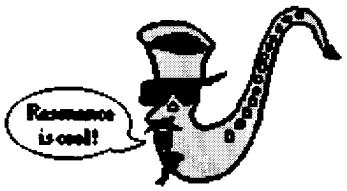
http://www.physicsclassroom.com/Class/sound/u11l4a.html
http://www.physicsclassroom.com/Class/sound/u11l4b.html
http://www.physicsclassroom.com/Class/sound/u11l4c.html
http://www.physicsclassroom.com/Class/sound/u11l4d.html

MOP Connection: Sound and Music: sublevel 5

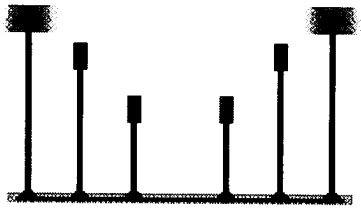
1. Define or describe the significance of the following terms:
   a. Natural frequency:

   b. Forced vibration:

   c. Resonance:

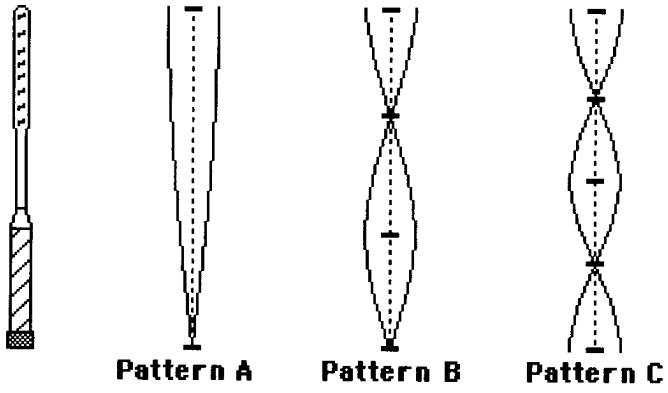


2. Three pairs of wooden dowel rods are mounted on a wooden platform. Small plastic cylinders are attached to their ends; the cylinders are colored red, green and blue. Each pair of dowel rods has a different length. One of the red cylinders is pulled back and let go of, causing it to begin vibrating back and forth with one complete cycle every two seconds. The natural frequency of this dowel rod is _____ Hz.
   a. 0.25 b. 0.50 c. 1.0 d. 2.0



   As the red cylinder vibrates, it forces the other red cylinder to vibrate. This occurs because the two cylinders have the same _____ (color, composition, natural frequency). When two objects vibrate together like this _____ is occurring.

3. When a tennis racket strikes a tennis ball, the racket begins to vibrate. There is a set of selected frequencies at which the racket will tend to vibrate. Each frequency in the set is characterized by a particular standing wave pattern. The diagrams below show the three of the more common standing wave patterns for the vibrations of a tennis racket. In each diagram, hash marks are placed at the positions of all nodes and antinodes; label these nodes (**N**) and antinodes (**AN**).



   Compare the wavelength of pattern A to the wavelength of pattern B. Make your comparison both qualitative and quantitative. Repeat for pattern C.

   λ_A _____ λ_B (<, >, =) λ_A _____ λ_C (<, >, =)

   λ_A = _____ • λ_B (2, 3, 4, etc.) λ_A = _____ • λ_C (2, 3, 4, etc.)

   When the racket vibrates as in pattern A, its frequency of vibration is approximately 30 Hz. Determine the frequency of vibration of the racket when it vibrates as in pattern B and pattern C.

   f_B = _____ Hz f_C = _____ Hz

Resonance

1. A 256-hertz vibrating tuning fork is brought near a nonvibrating 256-hertz tuning fork. The second tuning fork begins to vibrate. Which phenomena causes the nonvibrating tuning fork begin to vibrate?

a. resistance

b. resonance

c. refraction

d. reflection

2. Sound waves strike a glass and cause it to shatter. This phenomenon illustrates

a. resonance

b. refraction

c. reflection

d. diffraction

3. Resonance occurs when one vibrating object transfers energy to a second object causing it to vibrate. The energy transfer is most efficient when, compared to the first object, the second object has the same natural

a. frequency

b. Loudness

c. Amplitude

d. Speed

4. There are places where the reflected sound waves reinforce each other as well as places where the reflected sound waves produce near silence. This phenomenon is known as

a. refraction

b. diffraction

c. amplitude

d. interference

5. An opera singer's voice is able to break a thin crystal glass when the singer's voice and the vibrating glass have the same

a. frequency

b. speed

c. amplitude

d. wavelength