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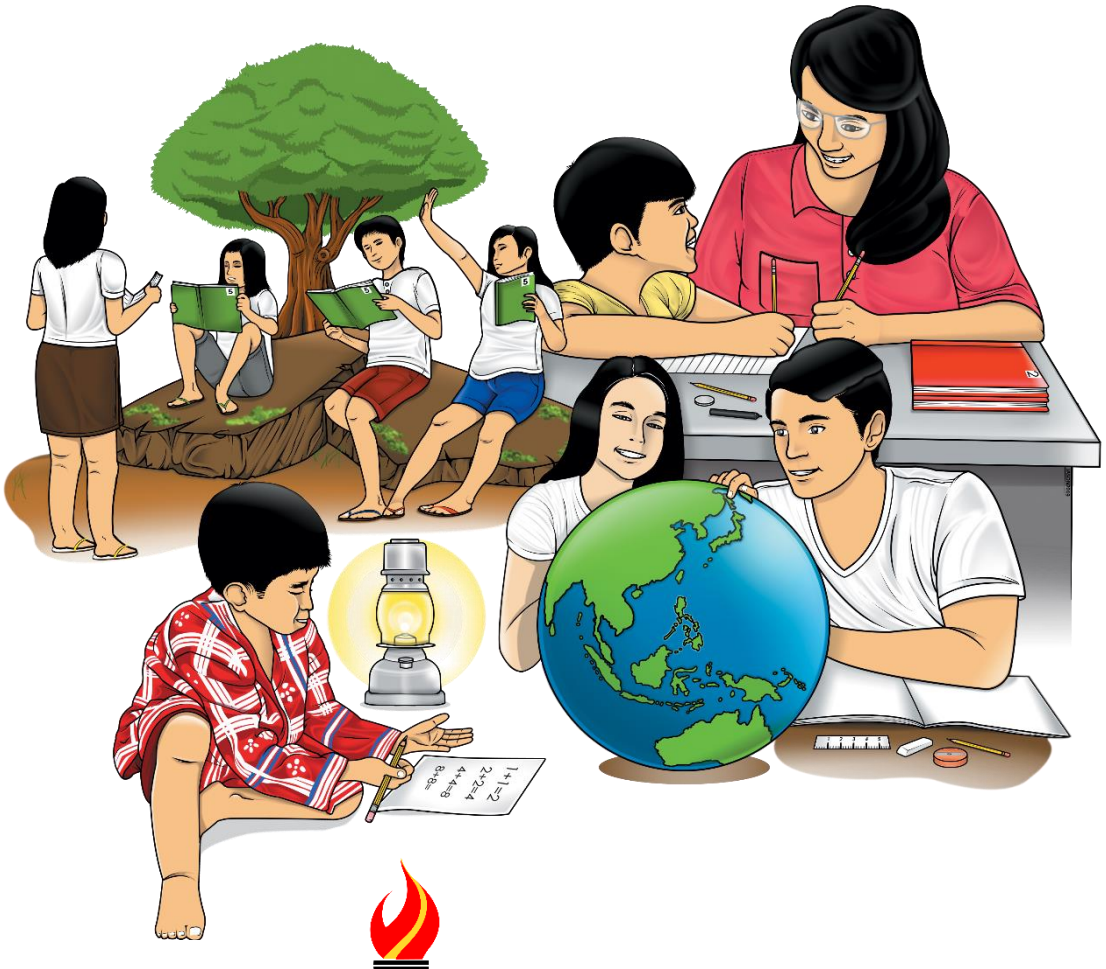
Science

Quarter 1 – Module 4: Effect of Temperature to Speed of Sound



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Development Team of the Module

Author:	Sharon Mae R. Plaza
Editor:	Estella Marie R. Lagleva
Reviewers:	Bernabe L. Linog, Relyn D. Raza, Kevin Hope Z. Salvaña, Delia C. Pioco, Jonas F. Saldia, Lydia F. Lavares,
Illustrator:	Rosa Mia L. Pontillo
Layout Evaluators:	Celeste Faith R. Almanon, Jay S. Ayap
Management Team:	Francis Cesar B. Bringas Isidro M. Biol, Jr. Maripaz F. Magno Josephine Chonie M. Obseñares Gregoria T. Su Marvilyn C. Francia Jay S. Ayap Nonita C. Patalinghug

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Department of Education – Caraga Region
Office Address: Teacher Development Center
J.P. Rosales Avenue, Butuan City, Philippines 8600
Telefax: (085) 342-8207/ (085) 342-5969
E-mail Address: caraga@deped.gov.ph

8

Science

Quarter 1 – Module 4: Effect of Temperature to Speed of Sound

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using them.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

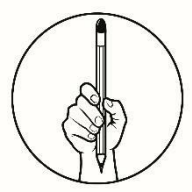
Thank you.

What I Need to Know

This module was designed and written with you in mind. It is here to help you master the nature of sound. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

After going through this module, you are expected to:

1. Investigate the effect of temperature to the speed of sound. *(MELC Week 4)*



What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following does the speed of sound wave depend?

   A. loudness
   B. pitch
   C. temperature
   D. thickness

2. Which of the following is true about the effect of air temperature on the speed of sound?

   A. The lower the temperature the faster the speed.
   B. The higher the temperature the faster the speed.
   C. The higher the temperature the slower the speed.
   D. The temperature does not affect the speed of sound.

3. What is the speed of sound in dry air at 0 ^{0}C?

   A. 31 m/s
   B. 331 m/s
   C. 3000 m/s
   D. 300000 m/s

4. How much is the increase in the speed of sound in the air for every $1C^0$ increase in temperature?

   A. 0.06 m/s
   B. 0.6 m/s
   C. 6 m/s
   D. 60 m/s

5. Which of the following statements is true about the speed of sound?

   A. Sound travels faster in dry air than in wet air.
   B. Molecules move faster so sound travels faster in warmer air.
   C. Sound travels at a constant speed even if air temperature changes.
   D. When comparing two media with the same phase, the sound will travel faster in a denser material.

6. Which factor does not affect the speed of sound?

   A. density
   B. distance
   C. elasticity
   D. temperature

7. Which wave property is observed when a boy shouts and hears his own voice inside the church?

   A. echolocation
   B. reflection
   C. refraction
   D. both reflection and refraction

8. Which of the following describes refraction?

   A. turning back of waves
   B. meeting of sound waves
   C. bending of waves around edges of barriers
   D. changing the speed and direction of waves

9. Which room temperature of air does sound travel faster?

   A. 20 ^{0}C
   B. 23 ^{0}C
   C. 25 ^{0}C
   D. 28 ^{0}C

10. Which of the following explains why echo is heard in an empty gym?

    A. Sound travels in waves.
    B. Sound is unpredictable.
    C. Sound has nowhere to go.
    D. There are only hard surfaces so sound only reflects.

11. A sound wave travels through the air and hits a glass of water. Which of the following happens when the sound wave moves from the air into the glass?

    A. It gets louder.
    B. It gets quieter.
    C. It travels faster.
    D. It travels slower.

12. Speed of sound depends on the _____.

    A. pressure of the medium
    B. temperature of the medium
    C. temperature of source producing sound
    D. temperature and humidity of the medium

13. The reverberation of sound is used in

    A.  megaphone

    B.  stethoscope

    C.  trumpet

    D. all of these

For nos.14 and 15:

Below is the data of air temperature of the four cities at the same time:

Metro Manila	29 ^{0}C
Cebu City	27 ^{0}C
Davao City	26 ^{0}C
Butuan City	25 ^{0}C

14. Which city does sound travel the fastest?
    A. Butuan City
    B. Cebu City
    C. Davao City
    D. Metro Manila

15. Which city does sound travel the slowest?
    A. Butuan City
    B. Cebu City
    C. Davao City
    D. Metro Manila

Lesson 1 Effect of Temperature to the Speed of Sound

Sounds are caused by vibrations, referring to the back-and-forth movement of objects. As you speak, vibrations are produced by the vocal cords inside the throat. You can hear the vibrations when sound waves reach your ear. When an object vibrates, it creates sound energy.

Sound energy travels in the form of sound waves. These waves are examples of longitudinal waves where the vibrations are parallel to the direction of the wave. They are also known as mechanical waves since sound waves need a medium inorder to propagate.

These media can either be solids, liquids, or gases. Sound waves travel fastest in solids and slowest in gases. The speed of sound can be affected by the elasticity and density of the medium.

Elasticity is the ability of a material to return to its original form after a certain amount of force has been applied to it. An example of an elastic material is steel. Steel has the ability to return to its original shape after it has been bent. Sound travels faster within more elastic objects. This is due to the atoms and molecules of the elastic materials having a relatively strong attraction towards each other and responding faster to each other's movement. As a result, sound energy is transferred more quickly. Generally, solids are the most elastic, followed by liquids, and then by gases. Thus, sound travels fastest in solids and slowest in gases. Imagine talking to someone who is a hundred meters away, you would have to shout if you would use the air as the medium of the sound. However, if you allow the sound to travel through a solid, such as the string of improvised phones made from tin cans, you would be able to send the message across just by whispering.

Density is an intrinsic property that is determined by the amount of mass per area of space or volume of the material. Recall that an intrinsic property is a property of the material itself which does not depend on how much material is present. Denser objects have more mass per volume, and they have more compact atoms and molecules. The neighboring atoms and molecules in denser objects are less responsive to each other's motions and interactions, making the sound wave travel slower. This factor applies when comparing media of the same phase. For example, sound travels faster in helium than it does in air, as helium is less dense than the gases that make up air. You can observe that helium is less dense than air because balloons are filled with helium float, whereas those filled with air are not.

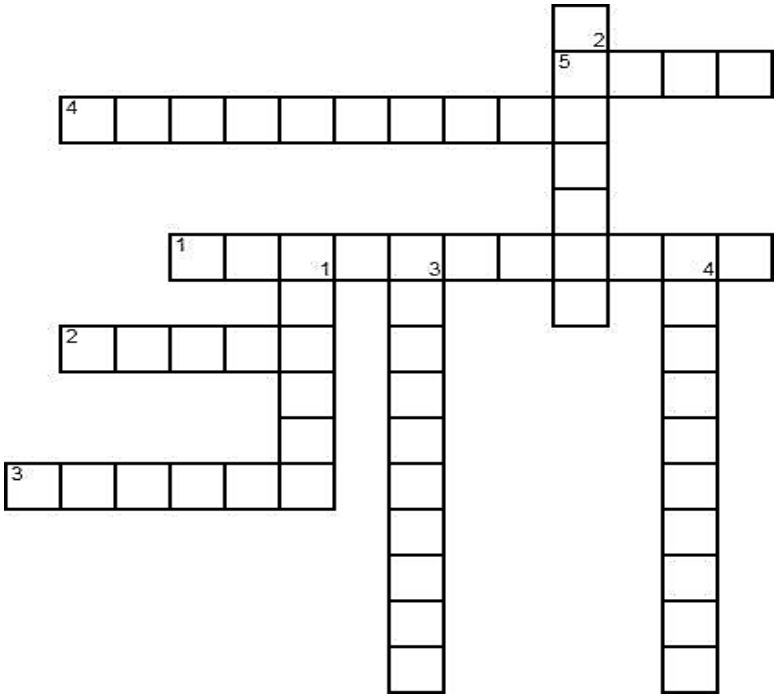
This lesson deals with the temperature of the medium as another factor affecting the speed of sound. In the quest to explore more about sound, you will be acquainted with the properties of waves, specifically reflection and refraction.

What's In

Activity: Word puzzle about sound waves

Objective: At the end of this activity, you are expected to recall the words associated with sound waves.

Directions: Complete the puzzle below. Write your answers on a separate sheet of paper.



Across

1. The degree of hotness or coldness of a material
2. A medium in which sound travels the fastest
3. Space where sound waves are unable to travel
4. It involves a change in the direction of waves as they pass from one medium to another.
5. Repetition of sound caused by the reflection of sound waves

Down

1. Material through which sound waves can travel
2. The amount of mass per space or volume of the material

3. The ability of a material to return to its original shape after certain force is applied to it
4. Turning back or bouncing back of a wave as it hits a barrier

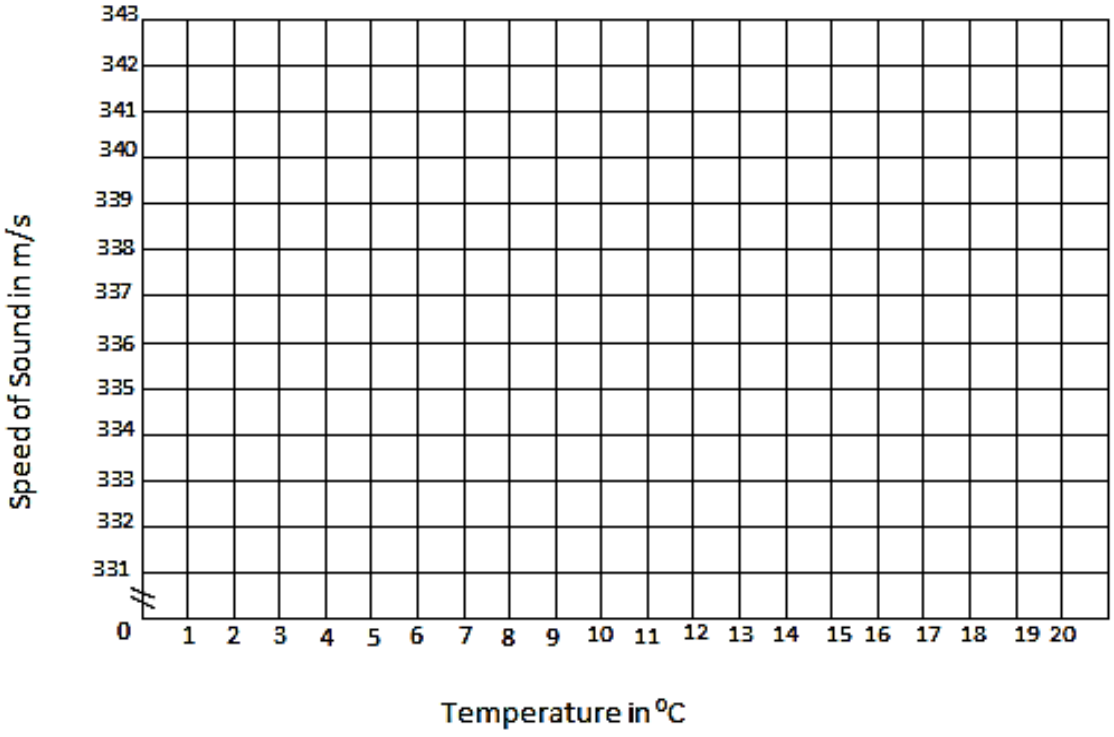
What's New

Activity: Speed of Sound

Objective: At the end of this activity, you are expected to determine the effect of temperature on the speed of sound.

The table below shows the speed of sound in air at various temperatures. Plot the data on the graph provided and answer the questions that follow.

SPEED OF SOUND IN AIR	
Temperature (^{0}C)	**Speed (m/s)**
0	331
5	334
10	337
20	343



Questions:

1. Based on the graph, what is the relationship of temperature to the speed of sound in air?

   _____
   _____

2. From your graph, find the interval where the speed of sound at 15°C is located.

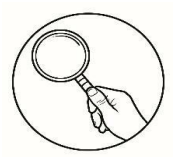
   _____
   _____

3. Extend the line of your graph and find the interval where the speed of sound at 25°C is located.

   _____
   _____

4. Use your graph to determine how much does the speed of sound change for the given change in temperature.

   _____
   _____



What is It

Speed of Sound in Air

The speed of sound in dry air, which is at 0 ^{0}C, is around 331 m/s. This speed, however, gets faster when the temperature is increased with the presence of water vapor. In warmer air, or air with moisture, molecules move faster and bump into each other more often, so sound can travel faster. The speed of sound increases by 0.60 m/s with every increase of 1C^0. This can be expressed as:

$$v = 331\frac{m}{s} + \left(0.6\frac{\frac{m}{s}}{℃}\right)\cdot T$$

where: v = speed
T = temperature in ℃

Study how you can use this equation with the following sample problems.

Example 1: What is the speed of sound in the air if the temperature is 30^{0}C?

Given: T = 30 ^{0}C

Solution: $v = 331\frac{m}{s} + \left(0.6\frac{\frac{m}{s}}{℃}\right)\cdot T$

$= 331\frac{m}{s} + \left(0.6\frac{\frac{m}{s}}{\cancel{℃}}\right)\cdot 30\cancel{℃}$ substitute the given value of T and simplify

$= 331\frac{m}{s} + \left(18\frac{m}{s}\right)$ multiply 30 and 0.6 and add the product to 331

$v = 349\frac{m}{s}$

The speed of sound in air at 30 ℃ is approximately 349 m/s.

Example 2: What is the temperature of air if the speed of sound is 346 m/s?

Given: v = 346 m/s

Solution: $v = 331\frac{m}{s} + \left(0.6\frac{\frac{m}{s}}{℃}\right) \cdot T$

$346\frac{m}{s} = 331\frac{m}{s} + \left(0.6\frac{\frac{m}{s}}{℃}\right) \cdot T$ substitute the given speed

$346\frac{m}{s} - 331\frac{m}{s} = \left(0.6\frac{\frac{m}{s}}{℃}\right) \cdot T$ combine quantities with the same unit

$15\frac{m}{s} = \left(0.6\frac{\frac{m}{s}}{℃}\right) \cdot T$ simplify

$\frac{15\frac{\cancel{m}}{\cancel{s}}}{0.6\frac{\frac{\cancel{m}}{\cancel{s}}}{℃}} = T$ simplify

$25\ ℃ = T$

The temperature of the air is at 25 ℃.

Properties of Sound

Like any wave, a sound wave does not just stop when it reaches the end of the medium or when it encounters an obstacle in its path. Rather, a sound wave will undergo certain behavior when it encounters the end of the medium or an obstacle. Possible behavior includes reflection and refraction.

Reflection

Just like any other wave, sound also exhibits reflection. **Reflection** is usually described as the *turning back of the wave as it hits a barrier*. The echo is an example of a *reflected sound*. **Reverberation**, on the other hand, refers to *multiple reflections or echoes in a certain place*. This best fits the bathroom which enhances the voice.

In theaters and movie houses, there are also reverberations and echoes. But these are not pleasing to the ears during a play or a movie. To lessen these, designers use curtains and cloth covers for the chairs and carpets.

Another application of sound reflection is **echo sounding**. This is used by scientists to map the seafloor and to determine the depth of the ocean or sea. This is just the same as how bats use sound to detect distances.

Refraction

The refraction of sound waves involves a change in the direction of waves as they pass from one medium to another. Sound waves travel slower in cooler air than in warmer air. When a sound wave propagates in the air with temperature which changes with altitude, refraction happens. A sound wave travels from air of higher temperature to lower temperature. During the daytime, as illustrated in figure 1, sound travels faster at the earth's surface since the air molecules are hotter due to the energy absorbed from the earth's ground. The air molecules at the higher altitude are cooler than those at the earth's surface, causing sound waves to refract upward. On the other hand, during nighttime, as illustrated in figure 2, the earth's surface is cooler and the layer of air immediately above it is also cooler. As a result, sound travels faster at the higher altitude and is refracted or bent towards the ground.

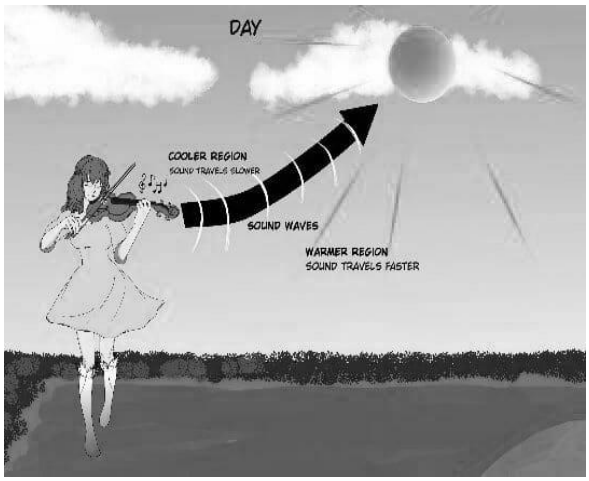


Figure 1: Sound refraction at daytime
Illustrated by: Rosa Mia L. Pontillo

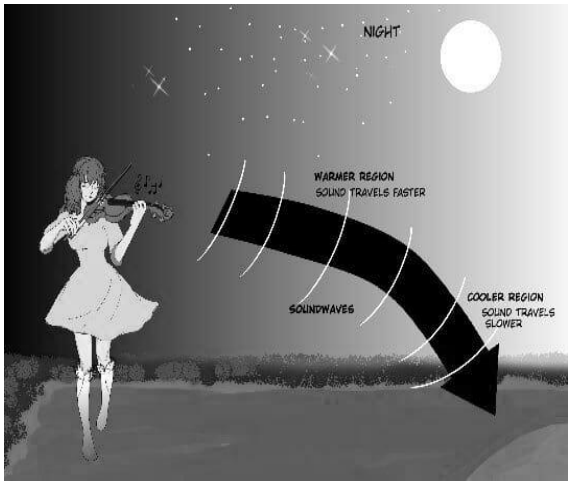
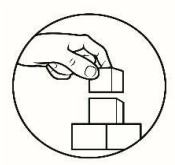


Figure 2: Sound refraction at nighttime
Illustrated by: Rosa Mia L. Pontillo



What's More

Activity: Calculating the Speed of Sound

Objective: At the end of this activity, you are expected to determine the speed of sound at a given temperature, and vice versa.

Direction: Solve the problems below. Write your answers on a separate sheet of paper.

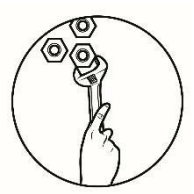
1. The atmospheric temperature in Baguio City is 20℃. How fast does sound travel in the air?

2. What is the temperature of air if the speed of sound is 348.40 m/s?

What I Have Learned

Fill in the blanks to complete the statements. Write your answers on a separate sheet of paper.

1. The speed of sound in dry air at 0^0C is around _____.
2. The speed of sound in air increases by _____ with every increase of $1C^0$.
3. Sound exhibits the following properties: _____ and _____.
4. The turning back of the wave as it hits the barrier is called _____.
5. The reflected sound is known as _____.
6. _____ refers to the multiple reflections or echoes in a certain place.
7. An application of sound reflection used by scientists to map seafloor and to determine the depth of the ocean or sea is _____.
8. The _____ of sound involves a change in the direction of waves as they pass from one medium to another.
9. Sound waves travel _____ in cooler air than in warmer air.



What I Can Do

Activity: Situational Analysis

Directions: Read, analyze, and answer the given situations. Write your answers on a separate sheet of paper.

1. Why would you hear the siren sound of a fire truck clearly in a nearby barangay during nighttime than daytime?

   _____

   _____

2. Why is it quieter in areas with high elevation such as Tagaytay and Baguio than in lowlands?

   _____

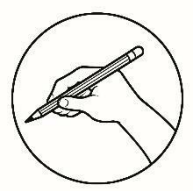
   _____

Scoring Rubrics:

2: Discussion is complete with no misconception.

1: Discussion is incomplete with minor misconception.

0: There is no discussion shown.



Assessment

Choose the letter of the correct answer. Write your answers on a separate sheet of paper.

1. Which of the following factors does the speed of sound depend?
   A. density
   B. elasticity
   C. temperature
   D. all of the above

2. An echo occurs when a sound wave is _____.
   A. absorbed
   B. reflected
   C. refracted
   D. transmitted

3. What happens to the speed of sound as the temperature increases?
   A. constant
   B. decreases
   C. increases
   D. cannot be determined

4. Which phenomenon explains why sound is heard at longer distances at night than in day?
   A. echolocation
   B. reflection
   C. refraction
   D. reverberation

5. How fast does sound travel if the air temperature is 20 ^{0}C?
   A. 334 m/s
   B. 340 m/s
   C. 343 m/s
   D. 345 m/s

6. Which of the following is true about the effect of air temperature on the speed of sound?
    A. The lower the temperature the faster the speed.
    B. The higher the temperature the faster the speed.
    C. The higher the temperature the slower the speed.
    D. The temperature does not affect the speed of sound.

7. What is the relationship of temperature to the speed of sound?
    A. equal
    B. no relationship
    C. directly proportional
    D. inversely proportional

8. Sound travels faster through warm materials than cold materials because _____.
    A. warm particles move slowly
    B. gas particles are packed tightly
    C. warm particles are moving quickly
    D. sound does not travel faster through a warm substance

9. Ships use echolocation to measure the _____.
    A. size of fish
    B. area of ocean
    C. depth of water
    D. density of water

10. When the direction of a wave changes as it passes from one medium to another, it is called _____.
    A. density
    B. echo
    C. reflection
    D. refraction

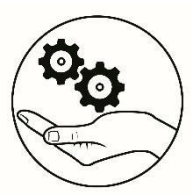
11. What happens to the speed of sound when it travels in warmer objects?
    A. constant
    B. faster
    C. slower
    D. cannot be determine

12. When a boy yells his name inside a cave, the sound reflects off the walls of the cave and travels back to his ears. What do you call the reflected sound?
    A. density
    B. echo
    C. echolocation
    D. refraction

13. What is the reason for hearing noises in the distance while standing near a body of water during nighttime?
    A. There are fewer noises at night.
    B. Water conducts sound better at night.
    C. Sound bounces off water better at night.
    D. Sound waves are bent towards the cool air over the water.

14. Concerts usually take place during nighttime where everyone has a chance to see and to enjoy the live show. Why does sound contribute to the concert schedule?
    A. Sound is more audible at night due to minimal noise.
    B. Sound propagates faster in air at night than at daytime.
    C. Sound is heard well in far areas during nighttime than during daytime.
    D. Sound changes and refracts when it encounters a medium of different density.

15. Which is quieter, a room with hanging curtains or one with bare concrete walls? Why?
    A. Both rooms have the tendency to be peaceful and to be quiet depending on the location.
    B. It is quieter in a room with concrete walls because sound travels faster in medium with the higher elastic property at the molecular level.
    C. It is quieter in a room with curtains because the bare concrete wall brings about multiple reflections of sound.
    D. It is quieter in a room with bare walls because hanging curtains enhance the effect of sound reverberation.



Additional Activities

Activity: It is My Turn

Provide what is asked. Write your answers on a separate sheet of paper.

1. Give practical applications of the reflection of sound waves.

_____

_____

_____

_____

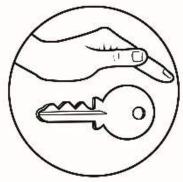
_____

Scoring Rubrics:

2: Discussion is complete with no misconception.

1: Discussion is incomplete with minor misconception.

0: There is no discussion shown.



Answer Key

What I know

1. C
2. B
3. B
4. B
5. B
6. B
7. B
8. D
9. D
10. D
11. B
12. B
13. D
14. D
15. A

What's In

Across

temperature
solid
vacuum
refraction
echo

Down

medium
density
elasticity
reflection

What's New

Speed of Sound and Temperature

Check students' graphs to see that axes are correctly labeled and the data in the table is accurately plotted.

1. As temperature increases, the speed of sound increases.
2. 340 m/s
3. 346 m/s
4. 0.6 m/s

What's More

1. Given: T = 20 ^{0}C

Solution:

The speed of sound at 20 ^{0}C is approximately 343 m/s.

2. Given: v = 348.4m/s

Solution:

The temperature is at 29.

What I Have Learned

1. 331 m/s
2. 0.6 m/s
3. Reflection, refraction
4. Reflection
5. Echo
6. Reverberation
7. Echo sounding
8. Refraction
9. Slower

What I Can Do

1. Sound travels faster at the higher altitude and is refracted or bent towards the ground.

2. It is quieter in places located in mountainous area such as Tagaytay and Bagiuo because it has cooler temperature.

Assessment

1. D
2. B
3. A
4. C
5. C
6. B
7. C
8. C
9. C
10. D
11. A
12. B
13. D
14. D
15. C

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Nora F. Nalda, Leah L. Salvaleon, Josefina Ll. Pabellon. *Physics Textbook.* Quezon City: SD Publications, Inc., 2004.

For inquiries or feedback, please write or call:

Department of Education - Bureau of Learning Resources (DepEd-BLR)

Ground Floor, Bonifacio Bldg., DepEd Complex
Meralco Avenue, Pasig City, Philippines 1600

Telefax: (632) 8634-1072; 8634-1054; 8631-4985

Email Address: blr.lrqad@deped.gov.ph * blr.lrpd@deped.gov.ph