8

Science

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

ALTERNATIVE DELIVERY MODE

ADM

8

Science

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

Introductory Message

For the facilitator:

Welcome to the **Science 8** Alternative Delivery Mode (ADM) Module on **Effect of Temperature to Speed of Sound!**

This module was collaboratively designed, developed and reviewed by educators both from public and private institutions to assist you, the teacher or facilitator in helping the learners meet the standards set by the K to 12 Curriculum while overcoming their personal, social, and economic constraints in schooling.

This learning resource hopes to engage the learners into guided and independent learning activities at their own pace and time. Furthermore, this also aims to help learners acquire the needed 21st century skills while taking into consideration their needs and circumstances.

In addition to the material in the main text, you will also see this box in the body of the module:

> ### *Notes to the Teacher*
> This contains helpful tips or strategies that will help you in guiding the learners.

As a facilitator you are expected to orient the learners on how to use this module. You also need to keep track of the learners' progress while allowing them to manage their own learning. Furthermore, you are expected to encourage and assist the learners as they do the tasks included in the module.

For the learner:

Welcome to the **Science 8** Alternative Delivery Mode (ADM) Module on **Effect of Temperature to Speed of Sound!**

The hand is one of the most symbolized parts of the human body. It is often used to depict skill, action and purpose. Through our hands we may learn, create and accomplish. Hence, the hand in this learning resource signifies that you as a learner is capable and empowered to successfully achieve the relevant competencies and skills at your own pace and time. Your academic success lies in your own hands!

This module was designed to provide you with fun and meaningful opportunities for guided and independent learning at your own pace and time. You will be enabled to process the contents of the learning resource while being an active learner.

This module has the following parts and corresponding icons:

	What I Need to Know	This will give you an idea of the skills or competencies you are expected to learn in the module.
	What I Know	This part includes an activity that aims to check what you already know about the lesson to take. If you get all the answers correct (100%), you may decide to skip this module.
	What's In	This is a brief drill or review to help you link the current lesson with the previous one.
	What's New	In this portion, the new lesson will be introduced to you in various ways such as a story, a song, a poem, a problem opener, an activity or a situation.
	What is It	This section provides a brief discussion of the lesson. This aims to help you discover and understand new concepts and skills.
	What's More	This comprises activities for independent practice to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module.
	What I Have Learned	This includes questions or blank sentence/paragraph to be filled in to process what you learned from the lesson.

	What I Can Do	This section provides an activity which will help you transfer your new knowledge or skill into real life situations or concerns.
	Assessment	This is a task which aims to evaluate your level of mastery in achieving the learning competency.
	Additional Activities	In this portion, another activity will be given to you to enrich your knowledge or skill of the lesson learned. This also tends retention of learned concepts.
	Answer Key	This contains answers to all activities in the module.

At the end of this module you will also find:

References	This is a list of all sources used in developing this module.

The following are some reminders in using this module:

1. Use the module with care. Do not put unnecessary mark/s on any part of the module. Use a separate sheet of paper in answering the exercises.
2. Don't forget to answer *What I Know* before moving on to the other activities included in the module.
3. Read the instruction carefully before doing each task.
4. Observe honesty and integrity in doing the tasks and checking your answers.
5. Finish the task at hand before proceeding to the next.
6. Return this module to your teacher/facilitator once you are through with it.

If you encounter any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator. Always bear in mind that you are not alone.

We hope that through this material, you will experience meaningful learning and gain deep understanding of the relevant competencies. You can do it!

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 Biology. 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.

This module contains:

- Lesson 1: Effect of Temperature to the Speed of Sound

After going through this module, you are expected to:

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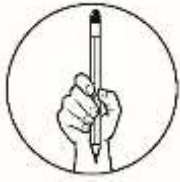
What I Know

Choose the letter of the correct answer. Write your answers 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 0C?

    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 1C0 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

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 in order 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 dependent 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.
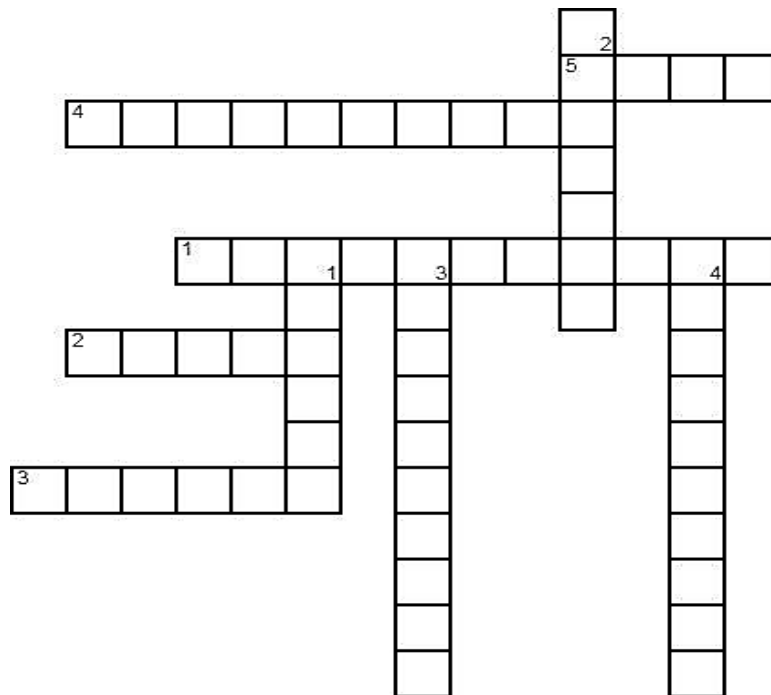
What's In

Activity: Word puzzle about sound waves

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

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

Note to the Teacher
Provide extra copies of this activity for students' use.
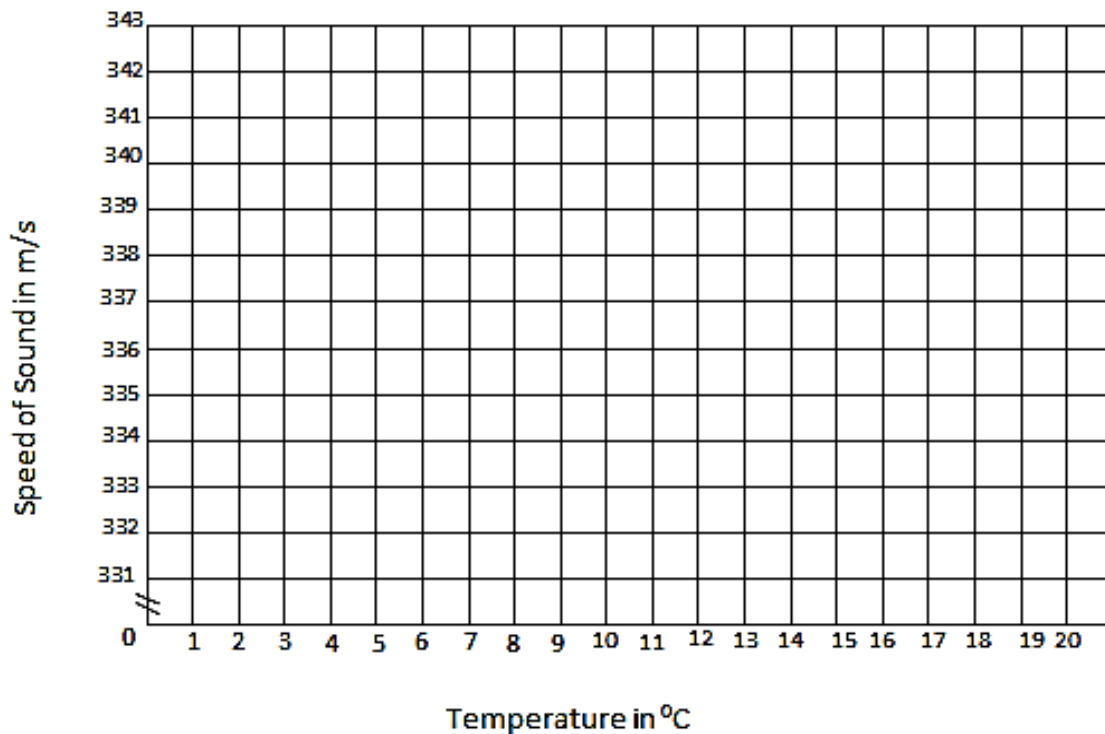
Temperature in ^{0}C

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 °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°. This can be expressed as:

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

where: v = speed

T = temperature in °C

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°C?

Given: T = 30 °C

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

$= 331\frac{m}{s} + \left(0.6\frac{\frac{m}{s}}{°C}\right) \cdot 30°C$ 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 °C 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: $v = 331\frac{m}{s} + \left(0.6\frac{\frac{m}{s}}{°C}\right) \cdot T$

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

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

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

$\dfrac{15\frac{m}{s}}{0.6\frac{\frac{m}{s}}{°C}} = T$ simplify

$25\ °C = T$

The temperature of the air is at 25 °C.

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 night time, 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.
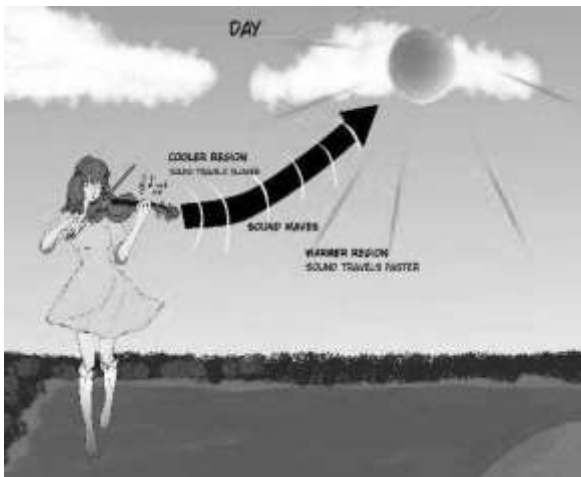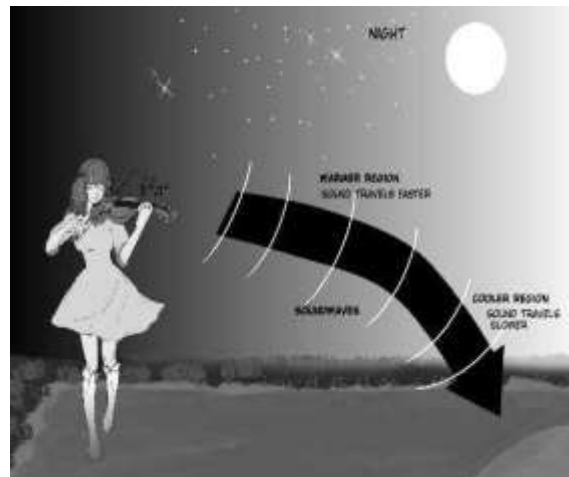

Figure 1: Sound refraction at day time

Figure 2: Sound refraction at night time

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.

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 night time?
    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 night time 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 day time.
    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 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

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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