

Lesson Topic: Digital Signals**Objective:**

Students will be able to:

1. Differentiate between analog and digital signals.
2. Understand what is meant by encoding.
3. List uses for digital signals.
4. Describe advantages of digital signals for storing and transmitting information.

Time Required: 90 minutes**Materials Needed:**

- Printer paper
- Printer
- Teacher computer with internet access
- Projector/interactive whiteboard
- 1 computer/laptop/iPad per student with internet access
- Digital Signals Worksheet (attached)

Teacher Preparation:

- Assign a Legends of Learning Instructional [Quick Play](#) playlist for the day(s) you will be teaching the lesson.
 - Instructional – Middle School – Digital Signals
- Assign a Legends of Learning Content Review [Quick Play](#) playlist for the day(s) you will be teaching the lesson.
 - Content Review – Middle School – Digital Signals
- Make copies of Digital Signals Worksheet (1 per student)
- Cut mock digital sequence into a strip and fold it so the writing is hidden (attached)
- Print copy of mock digital sequence for demonstration (attached)
- Draw an illustration of analog and digital waves on whiteboard/interactive whiteboard (attached)

Engage (20 minutes):

1. Explain to students that today they will be learning the difference between two ways of transmitting and storing information, which is called encoding.
2. Write the word, encoding, on the board.
3. Tell students they are about to play a game that will help them determine if analog encoding or digital encoding is a better way to store and transmit information.
4. Explain that one student will receive a coded message from you and will pass that information to another student, who will pass it to another student, etc. until it reaches the last student in the room. The final student to receive the message will repeat it to the class. (Use a string of random letters, at least 7 characters long)
5. Explain that the second part of the game will be the delivery of a second, typed message. This message will be folded and handed to the first student, then passed from student to student until it reaches the last student in the room. The final student

to receive the folded, typed message will read it to the class.

6. While the game is proceeding, play the first 30 seconds of this video of the earliest recorded sounds: [The First Recorded Sounds](#)
7. Explain to students that this recording represents an analog recording. Show students the analog wave on the board.
8. Ask students to describe the recording quality. (scratchy, eerie, hard to hear, etc.)
9. Play the first 30 seconds of this video of Vivaldi's Four Seasons (Winter): [Antonio Vivaldi - Four Seasons \(Winter\)](#)
10. Explain to students that this recording represents a digitally encoded recording.
11. Ask students to describe the recording quality. (clear, crisp, etc.)
12. Draw students' attention to the analog and digital waves on the board.
13. Ask students to describe the differences between the two waves. (analog is continuous; digital is straighter, linear. etc.)
14. Ask students what might happen if a recording was abruptly interrupted. Which type of recording would be easier to pick up without missing information? (digital because you could pick up where you left off with less difficulty)
15. Explain to students that their phones, tablets, and computers all use digitally stored information that is converted to make the sounds, images, and text that they see and hear daily.
16. Ask the last student to relay the verbal message received from their classmate.
17. Reveal the correct message to the class.
18. Ask students why the original message and the final message were different. (hard to hear other students, noise in the room, forgot a letter)
19. Now have the final student read the typed message.
20. Reveal that this message is correct.
21. Ask students why this message was error free. (it was written, so you could not forget a letter, it did not matter if it was noisy or hard to hear)
22. Ask students to guess which message represented a digital signal and which message represented an analog signal. (typed – digital, verbal – analog)
23. Ask students to consider both the recordings and the game. Conduct a class poll to determine which means: digital or analog is a more effective means of transmitting and storing information.

Explore (35 minutes):

1. Have your students [sign in to Legends of Learning](#). Instruct students to complete the Instructional playlist.
2. As students complete the assigned games, students will complete the Digital Signals Worksheet.
3. Circulate as students work through the playlist and complete the handout. Listen for evidence of understanding and use this opportunity to correct any misconceptions.

Explain (20 minutes):

1. Review answers to the Digital Signals Worksheet by constructing a labeled two-column chart on the board. Ask for student volunteers to assist in completing the chart. Finish the review by asking a student volunteer to draw an analog and a digital signal.
2. Relate student knowledge to the demonstration at the beginning of the lesson.

- a. What does it mean to encode information? (storing information or transmitting information)
- b. Which means of encoding information is more reliable? (digital)
- c. What are some advantages of digital signals? (they do not break down over long distances, information is consistent, images and sound have greater clarity)
- d. What does it mean when we say that a digital wave transmits as a pulse? (digital waves are either on or off, they are not continuous like an analog wave)
- e. What are some examples of how digital signals are used in our daily life? (music recordings, cell phones, computers, video games, storing information)

Elaborate (5 minutes):

1. Remind students of the many items from their daily life that use digital signals. In addition to modern conveniences such as cell phones and tablets, digital signal processing is also important in other fields, including health care. Magnetic resonance imaging (MRI) uses digital signals and is an important diagnostic tool in medicine.
2. Show this video of a real-time MRI of a human heart: [Real-time MRI of a human heart](#)
3. Ask students to list some advantages of using digital technology to record the heart's activity.
 - a. Answer: The information will not degrade over time, so doctors can go back and review it. The recording is more reliable. The image is more precise.

Evaluate (10 minutes):

1. Have your students [sign in to Legends of Learning](#). Instruct students to complete the Content Review playlist.
2. [Analyze student results](#) to determine what concepts need to be a focus for reteaching.

Additional Lesson Strategies:

- To use Legends for additional instruction, create a [custom playlist](#) with an [instructional game](#) and pre and post [assessment](#).
- To use Legends for a quick formative assessment, create a 5-question [assessment](#) in a [playlist](#).
- To use Legends for a student-directed experience, create a [targeted freeplay](#) playlist.
- Encourage students to play on their own at home in [Legends of Learning: Awakening](#) for a student-driven experience including avatars, battling, and quests all centered around topics they are covering in class.



Mock Digital Sequence for Engagement Demonstration

Instructions: Print this paper and cut the sequence into a strip. Fold the strip so the students cannot read the information. This strip will be passed around the classroom to represent the integrity of digital encoded information.

P Q Z B L G S D F

Analog Signal



Digital Signal



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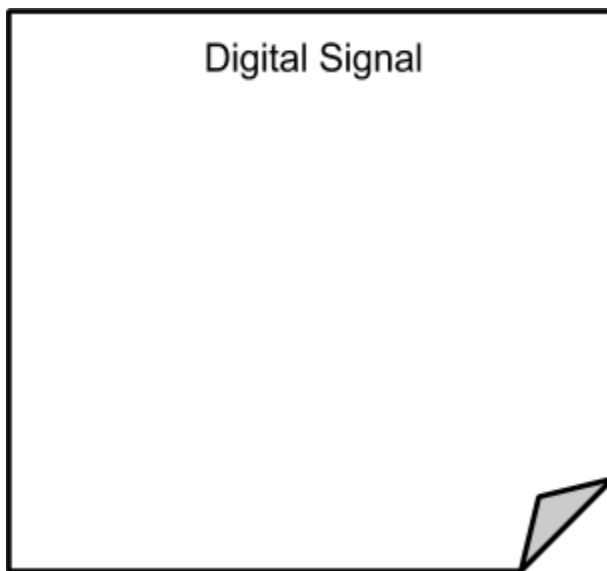
Digital Signals

Name: _____

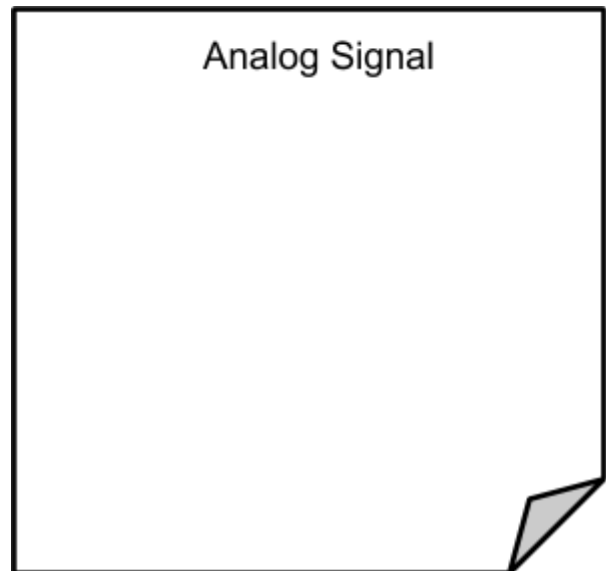
Directions: While playing the games in Legends of Learning, use what you learn to answer the questions below.

Part 1: The phrases below describe either a digital signal or an analog signal. Sort the phrases into the correct column. Some phrases may be used in both columns.

Digital Signal



Analog Signal



<i>degrade over long distances</i>	<i>used in earliest recordings</i>	<i>used in communications</i>	
<i>continuous waves</i>	<i>wave pulses</i>	<i>either "on" or "off"</i>	<i>vary with time</i>
<i>coded as "0"s and "1"s</i>	<i>can travel long distances</i>	<i>used in cell phones</i>	

Part 2. In the box below, draw and label a digital signal and an analog signal.



Digital Signals

Name: _____ *KEY* _____

Directions: While playing the games in Legends of Learning, use what you learn to answer the questions below.

Part 1: The phrases below describe either a digital signal or an analog signal. Sort the phrases into the correct column. Some phrases may be used in both columns.

Digital Signal

used in communications

wave pulses

either "on" or "off"

coded as "0"s and "1"s

can travel long distances well

used in cell phones

Analog Signal

degrade over long distances

used in earliest recordings

used in communications

vary with time

continuous waves


degrade over long distances *used in earliest recordings* *used in communications*

continuous waves *wave pulses* *either "on" or "off"* *vary with time*


coded as "0"s and "1"s *can travel long distances well* *used in cell phones*

Part 2. In the box below, draw and label a digital signal and an analog signal.

Analog Signal



Digital Signal



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