



Communicating with Morse Code

Learning Goals

Students will:

- Explore alternative modes of communication, such as Morse Code
- Design and test a protocol to send messages via light or sound using Morse Code
- Explore the idea that a variety of hardware platforms and protocols can be used to transmit the same information

Materials

- ❑ Class set(s) of [slide whistles](#), [LED keyring flashlights](#), or similar devices
- ❑ *Morse Code Slide Deck*
- ❑ *Morse Code Worksheet*
- ❑ *Morse Code Exit Ticket*

Importance in Quantum Computing

Quantum Computing is still so new that researchers are still exploring many different technologies to represent information as quantum bits (qubits). Each type of qubit has strengths and weaknesses, but they must all be able to perform the same basic functions.

Preparation

- Print *Morse Code* worksheet
- Print *Morse Code* Exit Ticket
- Check that you can project the slides



Background Knowledge

While humans are used to communicating by speaking, alternative methods are needed when speaking does not make sense (e.g., sign language for those who are hard of hearing, light signals to direct airplanes on runways, and hand signals in baseball). Morse Code encodes letters as dashes and dots to communicate messages over a long distance via radio signals, light, sound, or any other method that can be sensed by humans.

A quantum computer is a new type of computer that represents information in the form of quantum bits (qubits) rather than bits like a classical computer (i.e., an ordinary, non-quantum computer.) Because quantum computing is in such early stages, researchers are exploring different types of underlying technologies. That is fine, as long as each technology implements the required elements of a quantum computer. For each one, engineers need to figure out how to implement data storage and quantum operations for qubits, just like students in this activity are going to figure out how to use different technologies (light and sound) to implement protocols for the same communication method (dot and dash of Morse Code) (dot and dash of Morse Code). Right now, because it is not clear which technology will be the best long term, different engineers work on different technologies, trying to make them more reliable and faster so quantum computing can become feasible.

Facilitating the Activity

In this activity, students explore methods of communicating that do not involve speaking. Students design and test a protocol to transmit messages using Morse Code via light or sound.

ENGAGE (15 minutes)

Tell students that they are going to explore methods of communicating information that can be used when speaking is not an option.

ASK: What are some ways that people communicate without using words?

Students: *Sign language, facial expressions, hand gestures/signals*

If your classroom uses hand signals for common classroom requests (e.g., to sharpen a pencil), your students may make that connection here.

ASK: What are some advantages or disadvantages of those communication methods?

Students: *Sign language is helpful because you don't need to hear, but you do need to be able to see the person; Facial expressions can have more than one interpretation (e.g., you can mistake fatigue for boredom).*

ASK: What are some ways that people communicate with computers?

Students: *mouse or keyboard input; facial or fingerprint recognition; voice-to-text*

ASK: Before telephones and computers, how did people communicate over long distances?

Students: *Physical mail, Word-of-mouth (while reliable, these methods are slow)*

ASK: But, how did people communicate **QUICKLY** over long distances (before telephones and computers)?

Students: *Telegraph using Morse Code.*

For students that may not be familiar with Morse Code, explain that Morse Code is a method for communicating that encodes numbers and letters using sequences of dots and dashes and was an important means of communication for ships throughout the 20th century.

ASK: In what circumstances is communication via Morse Code useful?

Students: *over long distance; light - anywhere with a clear visual path; sound - somewhere without a clear visual path (especially under water since sound travels so well under water).*

ACTIVITY

In this activity, students encode/decode messages in Morse Code, and work in pairs to design and test a protocol to communicate with Morse Code using light or sound.

Distribute Morse Code worksheet and discuss details about Morse Code with students:

- *Morse Code can be used to communicate information across a long distance using light, sound, or any other method that can be sensed or detected.*
- Letters are represented via sequences of *dots* (•) and *dashes* (—); spaces between words are represented by a slash (/)

EXAMPLE

H	E	L	L	O	/	W	O	R	L	D
....	---	/	---	---	---

TRY MORSE CODE

Use Morse Code to encode the text :

M	O	R	S	E	/	C	O	D	E
---	---	/	---	---	.

Decode the Morse Code :

Q	U	A	N	T	U	M
---.	..-	..	--	-	...-	--

MORSE CODE									
A	•—	K	—•—	U	••—	1	•— — — —		
B	—....	L	•—••	V	•••—	2	•• — — —		
C	—•—•	M	— — —	W	• — — —	3	••• — —		
D	—••	N	—•	X	—••—	4	•••• —		
E	•	O	— — — —	Y	—• — — —	5	•••••		
F	•• — •	P	• — — •	Z	— — — •	6	—••••		
G	— — •	Q	— — — •			7	— — —••		
H	••••	R	• — •			8	— — — — •		
I	••	S	•••			9	— — — — •		
J	• — — —	T	—			0	— — — — —		

Students first practice using Morse Code, and then work in pairs to design a protocol for using Morse Code to send messages using light or sound (e.g., slide whistles, LED flashlights). To design their protocol, students must determine: (1) What is a dash?; (2) What is a dot?; and (3) Anything else that is needed for the protocol to be useful.

Distribute a light or sound device (LED flashlight, slide whistle) to each pair. Students work in pairs to (1) design a protocol; (2) test their protocol by trying to send a known message (the practice words on the first side of the worksheet) to their partner, making changes to the protocol, if necessary; (3) create new messages to send to their partners using their protocol.

DISCUSSION

Facilitate a discussion about the activity. Invite students to share their protocol, how they decided on the protocol, and the experience of using it to communicate.

ASK: How did you distinguish between a dot and a dash?

Did you use pitch? Volume? Duration?

ASK: What challenges did you encounter?

Did you need to adjust your protocol after testing it? If so, how?

ASK: Do you think your protocol would work with a different device?

Would it work if they used a slide whistle or hand claps *instead of a flashlight*?

Would it work if they used a flashlight *instead of a slide whistle*?

If there is time, consider having students try using their protocol to communicate using a different device (e.g., slide whistle or hand claps instead of an LED flashlight).



Use the *Communicating With Morse Code* slide deck to connect what students learned about communicating with Morse Code with the new field of quantum computing.

If you are interested in an informal assessment to use with your students, an exit ticket is available. The answer key is included here.

1. Use Morse Code to encode the text :

E	N	C	O	D	E
.	— .	— . . .	— — —	— . .	.

2. Decode the Morse Code :

Q	U	B	I	T	S
— — . —	. . —	—	—	. . .

1. Your sister wants to use Morse Code to communicate by knocking on the wall between your bedrooms.

Design a protocol to use knocks to communicate with Morse Code:

Answers will vary, because each student designs a unique protocol.

Example protocol:

dot (•) = LIGHT knock

dash (—) = HARD knock

Exit Ticket Answer Key

Connections to Standards

Next Generation Science Standards*

Crosscutting Concept: Patterns

Science and Engineering Practices: Constructing Explanations and Designing Solutions

Disciplinary Core Ideas:

PS4: Waves and Their Applications in Technologies for Information Transfer

PS4.A: Wave Properties

- Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa.

PS4.C: Information Technologies and Instrumentation

- Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa.
- Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.

QIS K-12 Key Concept

4. Qubits

The quantum bit, or qubit, is the fundamental unit of quantum information, and is encoded in a physical system, such as polarization states of light, energy states of an atom, or spin states of an electron.

7. Quantum Computing

Quantum computers, which use qubits and quantum operations, will solve certain complex computational problems more efficiently than classical computers.

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