

Quander Games: Buried Treasure

Use multiple measurements to find buried treasure!



1 Player

Ages 12+



60-90 minutes

Learning Goals



Understand that each measurement provides partial information



Understand that using multiple measurements increases precision.

Quantum Computing Connection

Quantum sensors can detect and measure a physical property with high precision. Measuring one thing can limit how well we measure other things. Making multiple measurements increases precision.

Game Overview

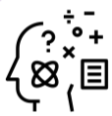
In Buried Treasure, players explore **measurement** and **sensing**. Players leverage the teamwork of the vampire Molly Cule (in bat form) and her friend Wane the werewolf (in wolf form) to find buried treasure hidden under tombstones in a foggy graveyard.

Acting as Molly, players fly into a graveyard with a grid layout. When Molly sees a tombstone, she turns away from the stone and exits the graveyard. Molly and Wane mark the entrance and exit points of each flight path with different symbols.

The flights in and out of the graveyard acts like a measurement. Each measurement only gives the player partial information as to where the tombstones are. Likewise, in quantum systems, measurements only provide partial information. By using multiple measurements, Molly is acting a sensor, trying to increase her precision so she can indicate to Wane where the tombstones are.

Once Molly is confident she knows where the tombstones are, she marks the locations with lanterns, so Wane can run through the fog and dig up whatever treasure is hidden in the graveyard.





Background Knowledge for Facilitators

Quantum Sensors: Quantum sensors utilize quantum states to measure physical properties of things with the highest precision allowed by quantum mechanics. These sensors are so precise they can detect a single photon (unit of light) and changed how we define standard units in science. Previously, very uniform objects defined how far one meter is. Now, using quantum sensors we can define how far one meter is using how far light travels in a vacuum for $1/299,729,458$ of a second!

Measurement: Usually when something is measured, it is the same before and after we measure it. If you measure the length of a book using a ruler, the book is the same before and after measurement. Sometimes, however, measurement can affect the thing we are measuring. In quantum, measuring one attribute of an object can limit how well we measure another attribute of that same object. Additionally, measuring an object once only gives a scientist partial information about that object. To increase precision, quantum scientists take multiple measurements.

Molly's Challenge:

What does Molly have to do to retrieve all of Tangle's quantum computer parts back from the Quander villagers?

Guiding Question:

How does using multiple measurements help Molly and Wane search for quantum computer parts in the foggy graveyard?



Engage

1. Begin by telling your students that they will be playing a game that introduces concepts critical to quantum computing, like **quantum sensors** and **measurement**.
2. Start by asking students questions about the following concepts:
 - a. Has anyone heard of the term sensor?
 - b. What comes to your mind when you hear the word sensor? What sort of objects might include sensors? What do sensors do?
 - c. What do you think measurement means?
 - d. What are some things you have measured? How did you measure it?
 - e. What ways can you think of to measure every property of a book (length, weight, number of pages, etc.) all at once with only one tool?





Explore

1. Give the students ~5 minutes to play Level 1 of Buried Treasure
 - a. Once the timer is up, give students 5 minutes to discuss the following questions:
 - i. Did you place all of the lanterns correctly?
(Student answers may vary)
 - ii. How many tries did it take you to place the lanterns correctly?
(Student answers may vary)
 - iii. How many times did you need to fly in and out of the graveyard before you placed a lantern?
(Student answers may vary)
2. Next, give the students ~15-20 minutes to play Levels 2-5.
 - a. Once the timer is up, give students 10 minutes to discuss the following questions:
 - i. Which levels did you win? Which levels did you lose?
(Student answers may vary)
 - ii. Were these levels more challenging than previous levels? How so?
(Student answers may vary)
 - iii. What were your strategies for deciding where to place the lanterns in these levels?
(Student answers may vary)
 - iv. **(Referencing the Terms: see page 6)** What do you think flying in and out of the graveyard represents?
(Answer: Flying into the graveyard is one measurement.)
 - v. **(Referencing the Terms)** What is the benefit of flying into the graveyard multiple times?
(Answer: Each time you fly in you reveal more information about where to place the lanterns)

Explore cont.

3. Next, give the students ~20-25 minutes to play Levels 5-10.

a. Once the timer is up, give students 10 minutes to discuss the following questions:

i. Which levels did you win? Which levels did you lose?

(Student answers may vary)

ii. Were these levels more challenging than previous levels? How so?

(Student answers may vary)

iii. What were your strategies for deciding where to place the lanterns in these levels?

(Student answers may vary)

iv: What did you notice about the levels (difficulty, board layout, and flight paths)

(Student answers may vary)

4. Next, give the students ~20-25 minutes to play Levels 11-15.

a. Once the timer is up, give students 10 minutes to discuss the following questions:

i. Which levels did you win? Which levels did you lose?

(Student answers may vary)

ii. Were these levels more challenging than previous levels? How so?

(Student answers may vary)

iii. What were your strategies for deciding where to place the lanterns in these levels?

(Student answers may vary)

iv: What did you notice about the levels (difficulty, board layout, and flight paths)

(Student answers may vary)

v. **(Referencing the Terms)** In what ways is Molly acting like a sensor?

(Answer: Molly is acting like a sensor by revealing information about an object)





Explain

1. Give students ~5 minutes to explore the Reward Area (See page 7) and review the reward cards they earned while playing the game.
 - a. Cards are double-sided. Students must click on the enlarged card (displayed on the right side of the screen to flip it).
2. Have students write a 3-5 sentence response to the guiding question:
 - a. **Guiding Question:** How does using multiple measurements help Molly and Wane search for quantum computer parts in the foggy graveyard?
 - b. **Word Bank** for students to use in their responses: Molly, Wane, Tombstone, Graveyard, Measurement, Lantern.

Quantum Information Science Connections

Concept	Definition	In-Game Representation
Quantum Sensing	Quantum sensing uses quantum states to measure physical properties of objects with high precision. Quantum sensors are so sensitive they can measure a single photon.	Molly and Wane's teamwork acts as a sensor, detecting where tombstones are.
Measurement	Measuring an object tells us information about that object,. In quantum, measuring an object can change it. Quantum scientists take multiple measurements to increase precision.	Each time Molly flies into and out of the graveyard, she is taking a measurement.

How To Play

Click on a perimeter stone to move Molly to that stone. Click again to send her flying down that path.

The green cells show how many times Molly can fly in and out of the graveyard.

Back to level select screen

Tutorials repeat the dialogue for that level

Drag and drop lanterns into the graveyard to indicate where a tombstone is.

Hearts show how many tries you have left

Each flight path is marked with a different color and shape combination, and the information learned that flight.

Click "Send Wolfie" to check if you placed lanterns correctly



Characters & World



Molly: The main character of the Quander games. In Buried Treasure she helps Wane find tombstones.



Wane: One of Molly's good friends. Wane is a werewolf but also a scaredy-cat!



Molly & Wane animal forms: Molly can turn into a bat because she is a vampire and Wane can turn into a wolf because he is a werewolf.



Buried Treasure game circled in red
Reward Area circled in white

Buried Treasure Flight Path Reference Sheet

Direct Hit

This symbol indicates the path Molly took caused her to fly directly into a tombstone. A tombstone will be in this row or column.



Straight Through

This symbol indicates that there are no tombstones in the row or column Molly flew through. There are also no tombstones in the row or columns on either side of this path.



One turn

This symbol indicates that Molly saw a tombstone in a row or column adjacent to the path she flew through. When she saw the tombstone she turned to exit the graveyard.



Multi Turn

This symbol indicates that Molly encountered a tombstone in a row or column adjacent to her flight path. When she turned to exit the graveyard, she encountered another tombstone and turned again.



Rewards Cards (Levels 1-5)

Card: Lantern

Type: Visual Representation

Level Earned: 2



Card: Bat Molly

Type: Character

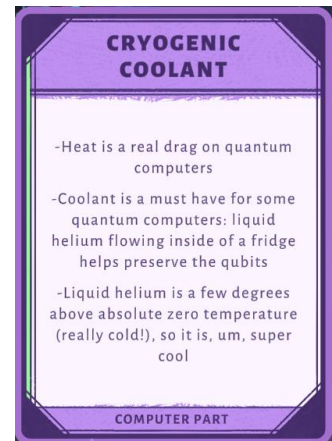
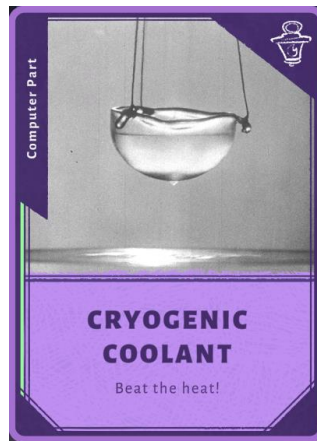
Level Earned: 3



Card: Cryogenic Coolant

Type: Computer Part

Level Earned: 5

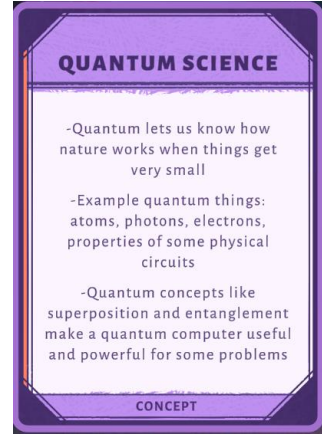
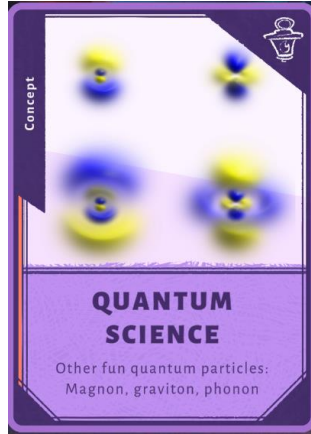


Rewards Cards (Levels 6-11)

Card: Quantum Science

Type: Concept

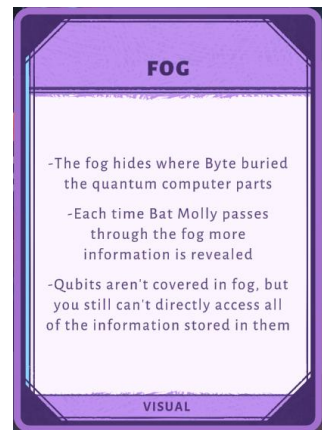
Level Earned: 7



Card: Fog

Type: Visual Representation

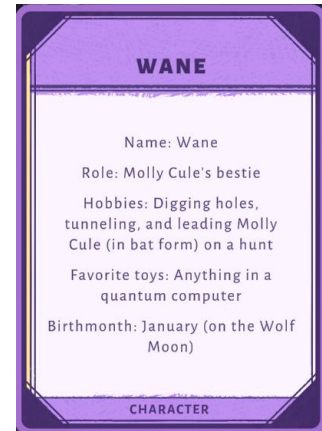
Level Earned: 9



Card: Wane

Type: Character

Level Earned: 11



Rewards Cards (Levels 12-15)

Card: Quantum Apps

Type: Concept

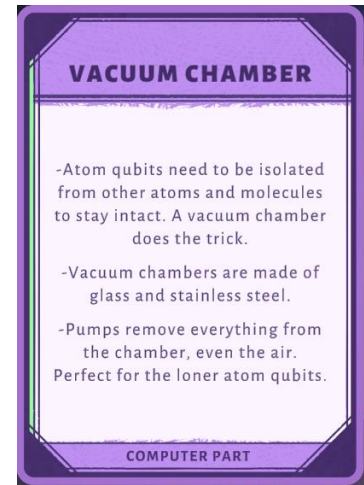
Level Earned: 13



Card: Vacuum Chamber

Type: Computer Part

Level Earned: 15



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