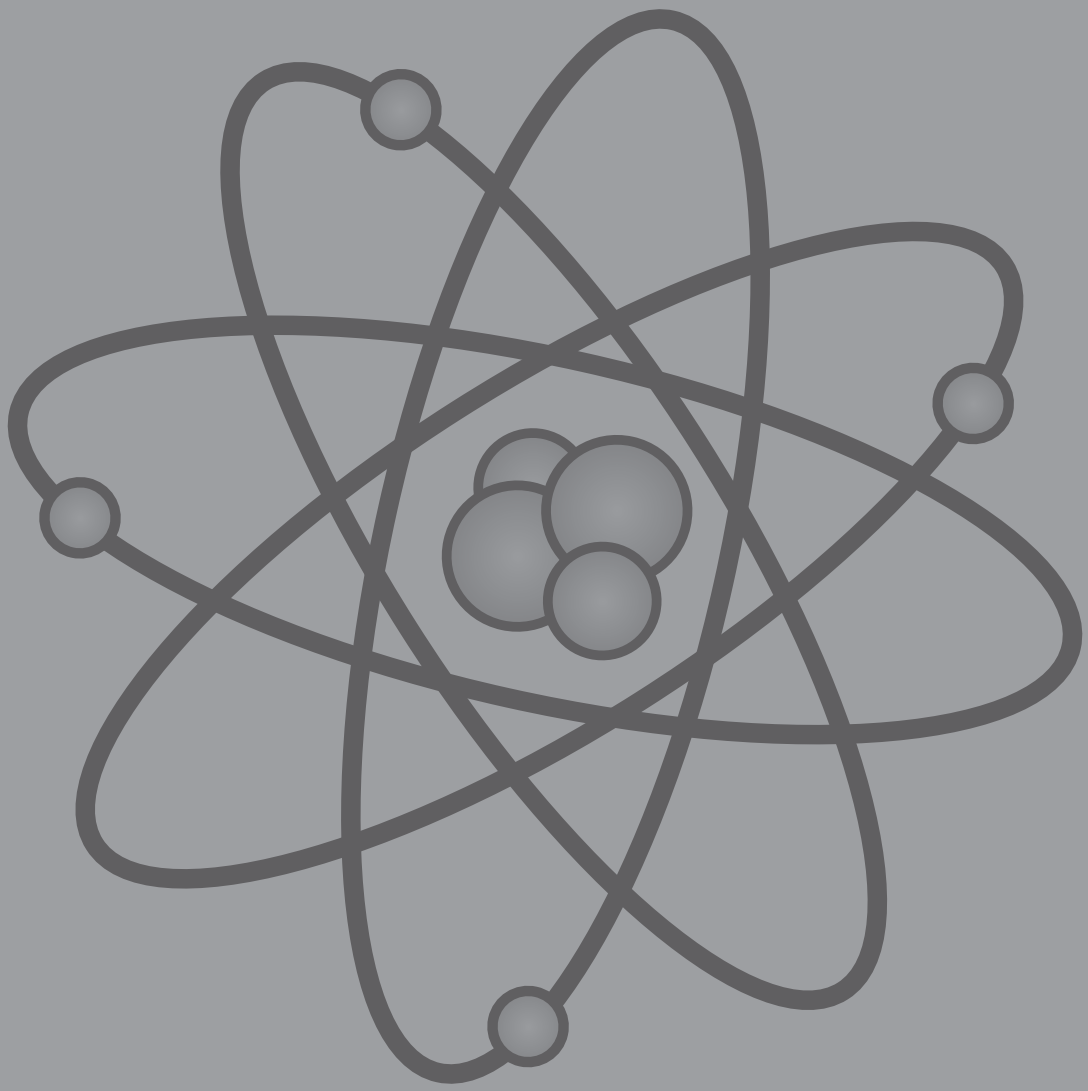


Mission Invisible

YEAR NINE STUDENTS

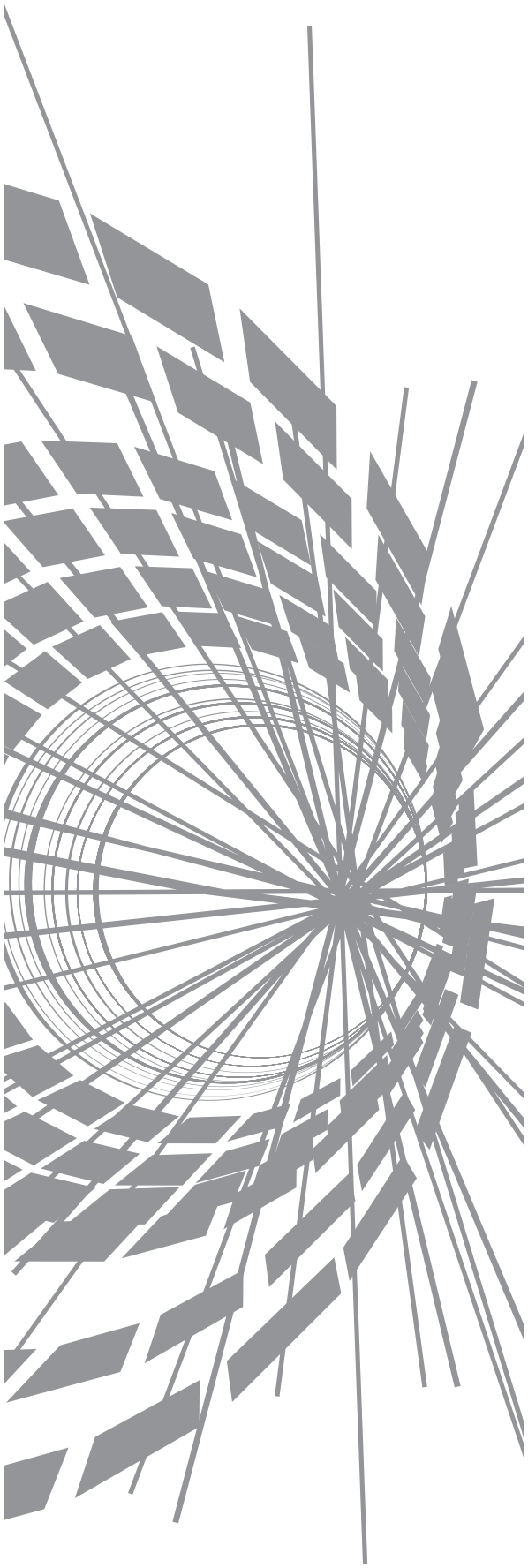
QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government

Contents

This resource has been developed to support the touring exhibition *Hadron Collider: Step Inside the World's Greatest Experiment*, created by the London Science Museum, and installed at the Queensland Museum and Sciencentre from 9 December 2016–25 April 2017. The exhibition was made possible through the support of presenting partner, QGC.

For further information on the creation of the exhibition visit: London Science Museum

To discover the latest findings, and research more about the Hadron Collider visit: CERN



Detector Experiments: Large Hadron Collider

A journey beyond the Planetary Model of the Atom

Your Mission

You are about to take a journey through a series of activities that will further develop your ideas about Atomic Theory beyond the Planetary Model of the atom.

The processes of detection of sub-atomic particles are introduced by looking at some historical methods that Scientists have used to discover more about matter and the universe. You will then move on to look at current technologies to find out what Scientists are learning from the Large Hadron Collider experiments.

Learning from what Scientists are doing, you will have the skills to finally undertake an investigation of your own, using detector instruments to find evidence of the nature of particles in a sealed container.

Key Questions

- How can we see the invisible?
- How can Scientists detect the invisible to find out more about matter and the universe?

THE UNSEEN WORLD

What do you already know about particles that you can't see?

In small groups, or as a class, discuss answers to these questions:

1. What type of objects can we normally see? Why?
2. What type of objects can't we normally see? Why?
3. How do we know these invisible things exist?
4. What is the largest object we can see?
5. What is the smallest particle that we can see?
6. How could we see smaller particles?

HOW HAVE SCIENTISTS MADE DISCOVERIES ABOUT THE ATOM?

Key Question

What are some more ways scientists might use to detect the invisible?

Your teacher will advise you which videos or parts of videos you should view to help answer these questions.

Watch the videos as directed by your teacher and complete the table below.

What was detected?	Detector used	What was detected?
X-rays		
Radiation		
Cathode rays		
Nucleus of the atom		
Sub-atomic particles		

Introducing the Large Hadron Collider

What is the smallest particle that can be detected?

Scientists working at the Large Hadron Collider are researching and seeking answers to this question.

You will now take a journey to their research laboratory which is based on a large underground collider ring that collides particles at close to the speed of light!

The collider was set up to look for evidence of the smallest particles. Among them is the Higgs Boson which is considered as a fundamental particle.

But is it the smallest? Let's find out.

Large Hadron Collider Exhibition at the Queensland Museum

Visit the museum or watch the Queensland Museum Hadron Collider Exhibition videos to find answers to the following questions:

Key questions

1. What types of particles are Scientists looking for, and what have they found so far?

2. Why are they looking for these particles?

3. How do scientists accelerate the particles in the Large Hadron Collider, and how does this principle work?

4. Why are several detectors needed?

5. Why do scientists do more than one experiment (e.g. more than one particle collision?)

6. Do you think Scientists will keep finding smaller particles? Why? This is a big question and will take some thought and explanation to give a good response.

You are now ready to take on the Mission Invisible Challenge!

Mission Invisible Challenge: What is in the box?

Your challenge is to find out the nature of the particles inside a sealed box, as these particles give the box special properties when moved. You must work out a way to detect the particles inside the box so they can be described. You cannot open the box to see inside, instead you must rely on all your senses and other powers of detection.

To complete your mission you will need to identify what you think is inside the box by describing:

a. Number of particles in the box

b. The shape of the particles

c. The mass of the particles

d. The hardness of the particles

Getting started

- Your teacher will give your group a sealed box.
- Do not attempt to open or look inside the box!
- Use your senses to make a best guess of the number and nature of the particles inside the box. Write down your best guess.
- Discuss your thinking with other members of your group.
- Record your predictions here:

Be prepared to share your ideas with the whole class.

In your group discuss answers to the following questions:

- How can you better detect what is inside the box?
- What senses can you use?
- Can you use other detectors to help us make a better guess? What detectors will you use?

Using the Test Box

- Your teacher will provide you with an open box similar to the sealed box that will allow you to perform some tests on sample particles.
- Your group needs to devise some experiments on the sample particles in the test box to obtain data that might help you identify the unknown particles in the sealed box.

Test procedure

- Decide how your group will perform your experiments and keep this procedure the same for all experiments on both the opened test box and the sealed box.
- Place one object in the test box and perform the first experiment. You will need to observe what the object is doing and then describe what you notice using senses other than your eyes.

Example test data:

Test	Test particle	What did you do?	Describe what happened?
Shape	*Squash ball*	*Placed the ball at one end and then tilted the box.*	*The ball rolled slowly to the other end making a rolling sound before hitting the end with a soft clunk.*
Shape	*Squash ball*	*Placed the ball at one end and then tilted the box at a very slight angle.*	*The ball started to move slowly. We could hear when it started to move.* *It took more than 3 seconds to reach the other end of the box.*

Enter your data:

Data Table

Test	Test particle	What did you do?	Describe what happened?

Repeat the Test Procedure

You should use the same procedure as before except this time you will work backwards from the "Describe what happened" to try and match it to one of your test particles. Good luck as this step is the most important.

Remember to think about your data obtained from your experiments with the test box, and how it helps you make better guesses about the particles in the sealed box.

Also remember:

1. Investigate one property at a time. For example, shape.
2. You are not trying to identify the object by name (e.g. Squash ball) only its properties. (e.g. Sphere).

What detectors will you use this time?

Recording results

Key questions you are trying to answer:

1. How many objects in the box?
2. What is the shape of each object? (Sphere, Cylinder, Cube or Prism)
3. What is the mass of each object? (Heavy, Medium, Light)
4. What forces can the object detect? (Magnetic, Gravitational, Electric, etc.)

Record your results about the types of particles you identify are in the sealed box in the tables below:

Data table

1. How many OBJECTS in the box?

What did you do?	Describe what happened?	Number of objects?	Why do you think this?

2. What is the SHAPE of each object?

What did you do?	Describe what happened?	Shape of objects?	Why do you think this?

Data tables

3. What is the MASS of each object? (Heavy, Medium, Light). Predictions:

What did you do?	Describe what happened?	Mass of objects?	Why do you think this?

Data tables

4. What FORCES can the object detect? (Magnetic, Gravitational, Electric, etc.)

Predictions:

What did you do?	Describe what happened?	Number of objects?	Why do you think this?

CONCLUSION

What did you find out?

Mission Accomplished?

Now write a paragraph which describes your findings and conclusion

- Think about what you have found out and what you now believe to be in the box.
- Remember you have to describe the particles in terms of their shape, the number, mass and hardness. Do not identify them as a particular type of ball or toy.
- Did your findings match your predictions? Can you explain why/why not?

CONFIDENCE IN RESULTS

Confidence scale

This identifies the confidence that you have in your results.

Your confidence is based on what others who perform the same tests will find.

How confident are you that:

- They will make the same conclusions that you did, or
- You will be able to argue that your results are better?

Very high confidence	90%
High confidence	70% - 90%
Medium confidence	40% - 70%
Low confidence	20% - 40%
Very low confidence	<20%

Then record your answers to the following questions:

1. Using the above scale, what level of confidence would you give your best guess now? Why do you think this?

2. To improve this confidence level, what detector would you like to have to use for more tests? How would this detector help you make a better guess?

3. Scientists would not rate their confidence at 100%. Why do you think this is so?

4. Then discuss your results with the rest of your class.