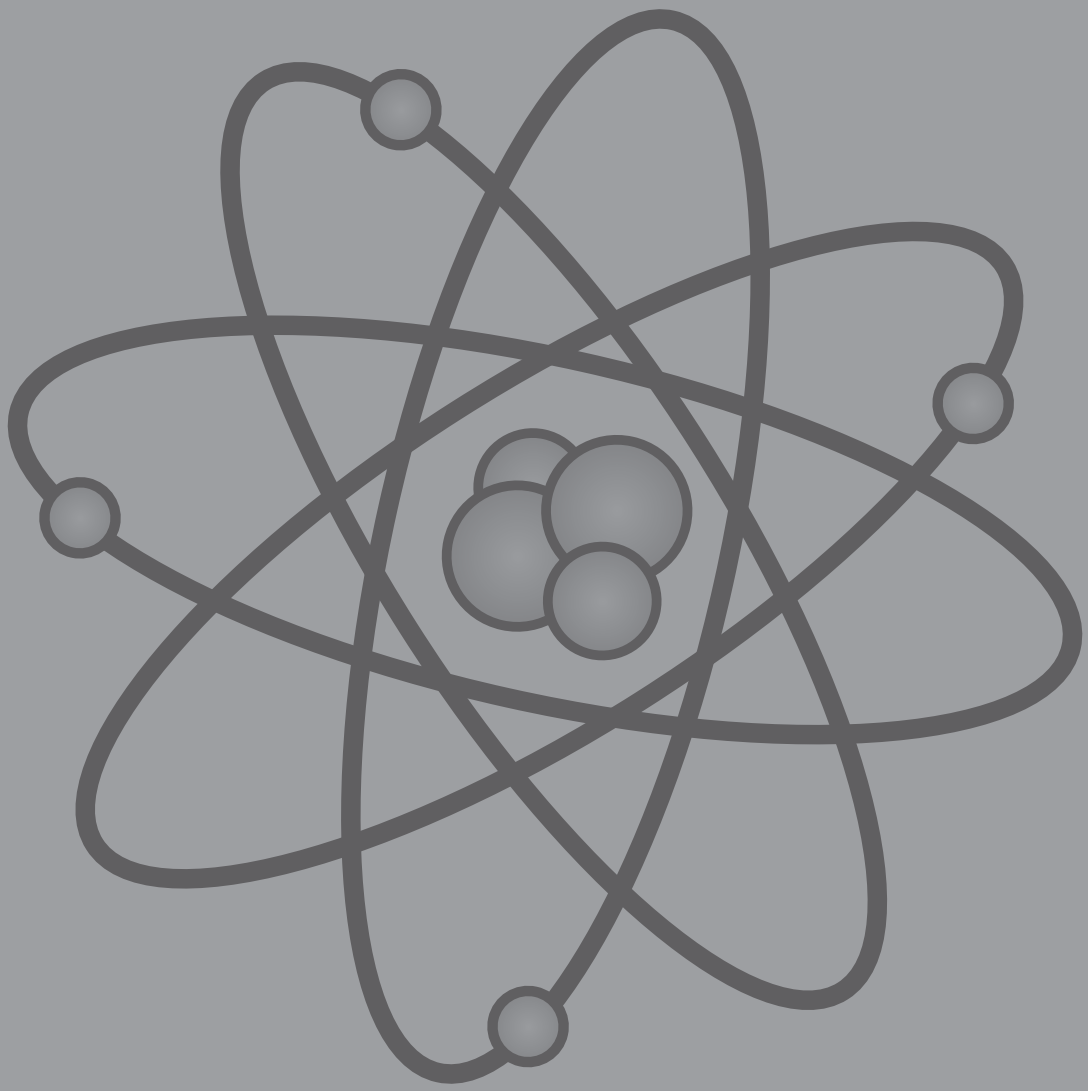

Mission Invisible

SUITABLE FOR STUDENTS IN YEARS FOUR TO SIX

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government

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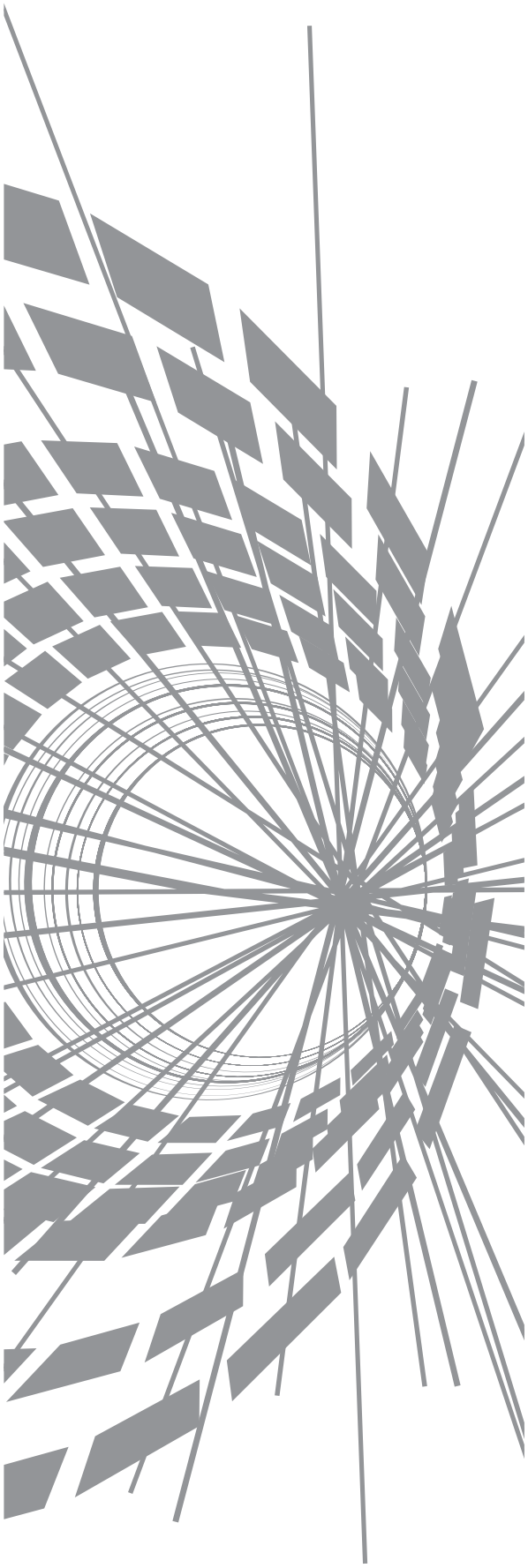


Detector Experiments: Large Hadron Collider

Your Mission

You are about to take a journey into the invisible world. You will discover what Scientists know about the smallest particles that make up all of matter and the universe. You will find out how they discover these mysteries and then practice some of their methods to make some discoveries of your own. You will learn how to describe objects that you cannot see when you accept the challenge of Mission Invisible! To succeed in this challenge you will need to use all your detection powers to discover the secrets of the mystery box.

To prepare for this challenge you have to first undergo pre-mission training so that you have all the skills you need to fulfil the mission.

Let's get started!

ENGAGE

Searching for the smallest (invisible) particle

In pairs or groups of 4, discuss answers to these questions:

1. What is the smallest particle that you know about?
2. How do Scientists search for the smallest particles that can't be seen?

Little things

1. What is the smallest object or living thing that you can see?
2. What is an object or living thing that is so small you can't see it?
3. If something is so small that it can't be seen then how do we know when it is there?
4. What can we use to help us see very small things?

How can you detect what you cannot see?

Write answers to these questions.

1. Can you see the wind?

2. How do you know when the wind is blowing?

3. How do you know if the wind is strong or weak?

4. What do you think the wind is made of? Why do you think this?

5. What can we use to detect the wind? Can you draw a picture of one?

EXPLORE AND EXPLAIN

Detecting unseen forces

Place a piece of paper flat on the desk. Your challenge is to move the paper off the desk in as many different ways that you can.

1. How many different ways can we move a piece of paper on the desk?

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

2. Which ways would be a push? Which ways would be a pull? Make two lists:

Push	Pull

3. Pushes and pulls are called forces. Some forces can be seen directly while for other forces we can only see the effects of the force.

For example:

Seen – We can see a push with the hand as it moves an object across the desk.

Unseen – We can't see the wind but we can see can see the effect of its push. How?

Make another two lists:

Forces that can be seen (Visible)	Forces that can't be seen (Invisible)

In pairs or groups of 4, discuss answers to these questions:

1. What are some other unseen forces?

5. How can we detect or see the effects of some of these unseen forces?

a. Wind -

b. Gravity -

c. Magnetism -

d. Electricity-

Key Question

If we can't see the force of electricity then how can we detect it?

This activity will help you answer this question.

Forces of electric charges: Balloon activity challenge

1. Inflate two balloons and tie a piece of string on each.
2. Work with a partner and each hold one of the balloons
3. Rub the balloon on some cloth or your school shirt or pullover
4. Each hold the balloon by the string and bring it close to your partner's balloon.

What happens?

Can you explain why or how this happens?

Need to know

- There are two types of electric charges.
- Two charges that are the same will repel each other.
- Two charges that are different (we say opposite) will attract each other.
- Rubbing separates the different charges between the balloon and the cloth material.
- There will be more of one type on the balloon and there will be more of the opposite type on the cloth.

Check point – Class or small group discussion

What do you know now about how electric forces can be detected?

What are other ways electric forces can be detected?
Find out more in the next activity.

Making an electric force detector

Your teacher or an adult will help you with making this detector.

Only adults should use the hot glue gun needed to make this device

Materials

Jar with plastic lid
(or make a plastic lid from a margarine container)

Large paper clip

Straw

Aluminium tart tray

Aluminium foil

Student's Tools

Scissors

Pliers (can use fingers to bend)

Teacher's Tools

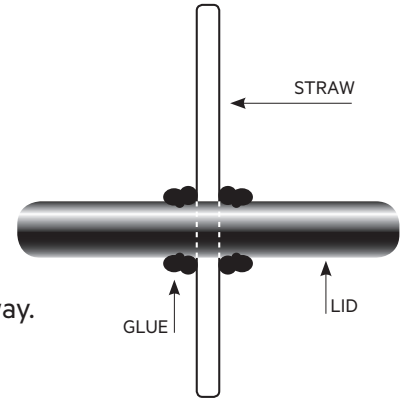
Hot glue gun

Drill bit, the size of a straw

Procedure

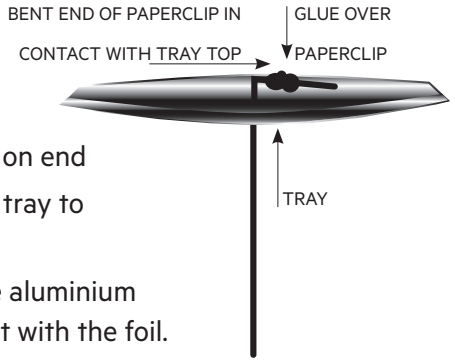
A. Lid

1. Drill hole large enough for the straw to pass through the lid centre (Adult to drill hole)
2. Cut straw in half
3. Place straw in hole and position evenly at about half way.
4. Ask your teacher to hot glue the straw into the lid. Keep straw at right angles.



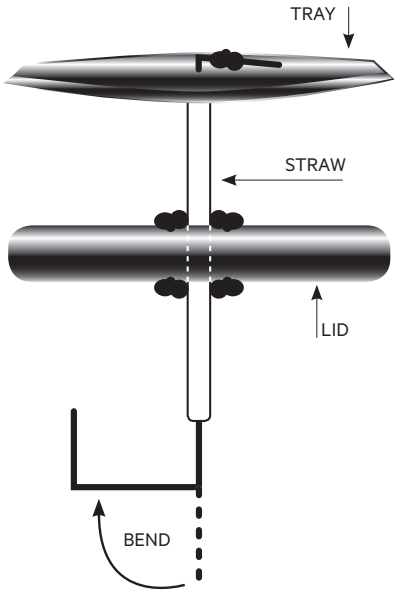
B. Paper clip assembly

1. Straighten paper clip except for right angle bend on end
2. Push paper clip through centre of aluminium tart tray to place bent end along the top of the tray.
3. Ask your teacher to hot glue the paper clip to the aluminium tart tray. Make sure the paper clip stays in contact with the foil.



4. Thread the paper clip through the centre of the straw from above until the underside of foil tray rests on top of straw.

5. Put a hook bend in the lower end of the paper clip.

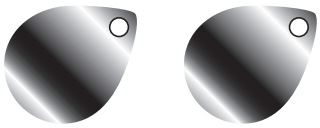


C. Foil assembly

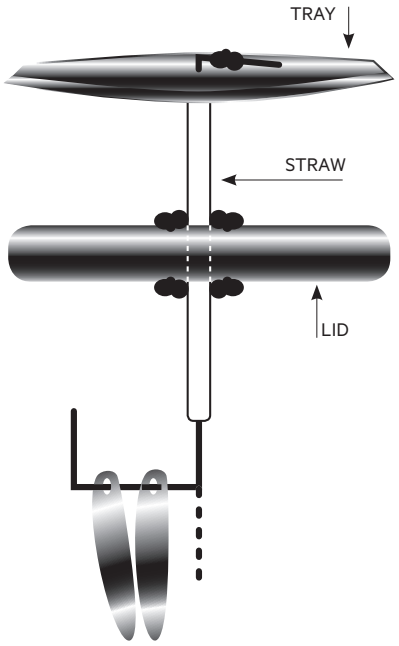
1. Cut two pieces of aluminium foil shaped like tear drops with 1 cm diameter.

   Try to have a nice round shape.

2. Put a small hole at the top of the tear drop in both pieces of foil.

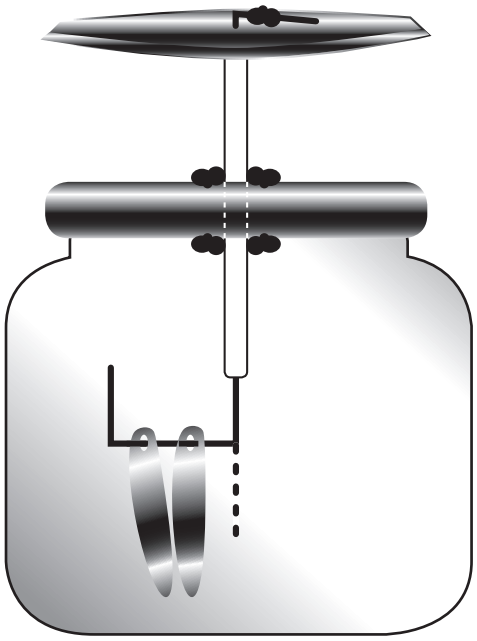


3. Thread both pieces of foil over the hook bend on the paper clip and straighten them so they hang verically and touching each other.



D. Final assembly

Place lid assembly on jar and you're done!



Using your electric force detector

Materials

- Plastic ruler or PVC pipe (Your teacher wll give you this)
- Micro fibre cloth or similar material
- Dry day – leave out in the Sun for 15 minutes to warm and dry the detector

Procedure

A. Rub plastic ruler (or PVC pipe) on micro fibre cloth vigorously for 30 seconds

B. Carefully bring the plastic ruler near (but not touching) the aluminum tart tray on top of your force detector.

What happens?

C. Move the ruler away from the tray.

What happens? iIf nothing happened in either test then have a look at the troubleshooting tips over the page.

D. Explore some other tests you can try.

Troubleshooting tips

A. Moisture

Moist air will remove the charge so it cannot be detected.
The detector will not work very well on wet or humid days.

1. Dry the detector, the plastic ruler or PVC in the Sun before use.
2. Make sure hands are dry and not sweaty or wet.
3. Use a dry material cloth for rubbing
4. Move to an air conditioned room

B. Sharp edges

Sharp edges are a place where charge will leak into the air. Remove sharp edges to improve the performance.

1. Apply sticky tape around the edge of the foil tray to remove any sharp points.
2. Use rounded plastic or PVC object for rubbing. Rulers have sharp edges but pipes are rounded. Pipes work better than rulers.

C. Conduction

Conduction of charge needs to happen from the foil tray to the alfoil leaves via the paper clip.

1. Make sure there is a connection between the paper clip and the foil tray.
   Check that the glue has not slipped underneath and prevented the connection.
2. Make sure the paper clip is not touching any other metal parts other than the foil tray and the foil leaves. Other metal that will take the charge away.
   Only use a plastic lid.

Need to know

- There are two types of electric charges.
- Two charges that are the same will repel each other.
- Two charges that are different (we say opposite) will attract each other.
- Rubbing separates the different charges between the balloon and the cloth material.
- There will be more of one type on the balloon and there will be more of the opposite type on the cloth.

EXPLAIN

Investigations with your electric force detector

Key questions

What materials can separate charges when rubbed together?

In this investigation you will test a range of different objects and materials to find out what combinations separate charges when rubbed together.

- What are the variables (things that can change) in this investigation?
- What variable will you change?
- What variables will you keep the same?

Procedure

This activity can be done alone or in pairs.

- Your teacher will provide a selection of test objects and rubbing materials
- Select a rubbing material and a test object
- Rub the test object on the rubbing material for at least 10 seconds
- Now hold the test object close to your detector. Is there any separation of charges? How will you know?
- Record your data in the table below
- Test more objects and materials by repeating the procedure

Data

Record your results like this:

Test	Test object	Test object material	Rubbing material	What happened?
1	*Ruler*	*Plastic*	*Micro fibre*	*Charge detected!*
2	*Ruler*	*Plastic*	*Polyester shirt*	*??*
3				
4				
5				
6				
7				
8				
9				

What did you find out?

- Look for any patterns in the type of material that could separate charge when rubbed.
- Make a list of object and rubbing material pairs that worked.

Object	Rubbing Material

ELABORATE

Further investigations

Use your list and think about other objects that you think should work or not work.

Make a list of objects that you can test.
Write beside each item in your list if you think it will work or not.

Try this table:

Test	Test object	Test object material	Rubbing material	What will happen?
1				
2				
3				
4				

EVALUATE

Conclusions

- Did the tests match what you thought would happen?
- Can you explain this?
- Can small pieces of paper be used as a charge detector? Try this.

ELABORATE

Key Questions

What kinds of detectors do Scientists use?

What do they discover with these detectors?

Now is the time to find out more about some Scientists who are working on the detection of very small particles at the Large Hadron Collider. Finding out how Scientists work will help you on your Mission Invisible Challenge.

1. **How do Scientists detect the invisible?**
   You teacher may show you some video clips about the Large Hadron Collider in Switzerland, and the Large Hadron Collider Exhibition at the Queensland Museum.
2. **Large Hadron Collider Exhibition**
   Here are some questions to think about while visiting the Large Hadron Collider Exhibition or watching the videos.

In pairs or groups of four, discuss these questions and record your answers

1. How can particles be made to go very fast?

2. How can the movement of particles be made to go in a big circle?

3. What happens when very fast moving small particles collide with each other?

4. How do scientists find out what happens after fast moving particles collide with each other?

5. What is one important particle that scientists found from colliding fast moving particles with each other?

6. Why is it important?

ENGAGE

Mission Invisible Challenge: What is in the box?

Your mission

You have now completed your training. Congratulations!

Your challenge, if you choose to accept, is to find out what is inside the box as it contains particles that 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 so you must rely on all your other powers of detection.

Your teacher will give you a sealed box for your group but leave it on the desk until directed to look at it closely.

- Can you guess what is inside?
- Pick up the box and use your detectors to make another guess.
- Be prepared to share your ideas with your group.
- What detectors did you use?
  Think about what senses can be used to detect what is in the box.

What powers of detection do you have already? (Hint: We call them your senses)

To complete the mission you will need to identify what you think is in the box and describe:

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

A.

B.

C.

D.

EXPLORE

In your group discuss answers to the following questions:

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

Using the Test Box

- Your teachre will provided you with an open box similar to the sealed box that will allow you to perform some tests on some objects.
- Your group needs to decide what tests you can do on the objects in the test box to help you make a better guess about what is inside the sealed box.

Test procedure

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

For example:

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.*

Data Table

Now it is your turn:

Test particle	What did you do?	Describe what happened?

EXPLAIN

Prediction

Think about your test box data and how it helps you make better guesses about the particles in the box.

Record your predictionss about the types of particles in the sealed box;

- How many particles are there?

- What are their shapes?

- Do they have different masses?

- Do they have different hardness?

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.

- Investigate one property at a time. For example, shape.
- 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?

For example:

What did you do?	Describe what happened?	Shape?
Tilted box so objects started at one end. Tilted box slightly then listened	*There was a single soft rolling noise that lasted for more than 3 seconds before we heard a soft clunk.*	*Ball or sphere*

Data Table

Now it is your turn.

What did you do?	Describe what happened?	Shape?

Create a new table for each property:

- Number?
- Mass?
- Hardness?

What did you find out?

Use the evidence from your data tables to make your next best guess about the particles in the sealed box.

How many particles are there?

What are their shapes?

Do they have different mass?

Do they have different hardness?

Did this match your prediction? Can you explain this?

EVALUATE

Mission Accomplished?

- 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.

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%**

Think and write answers to these 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?