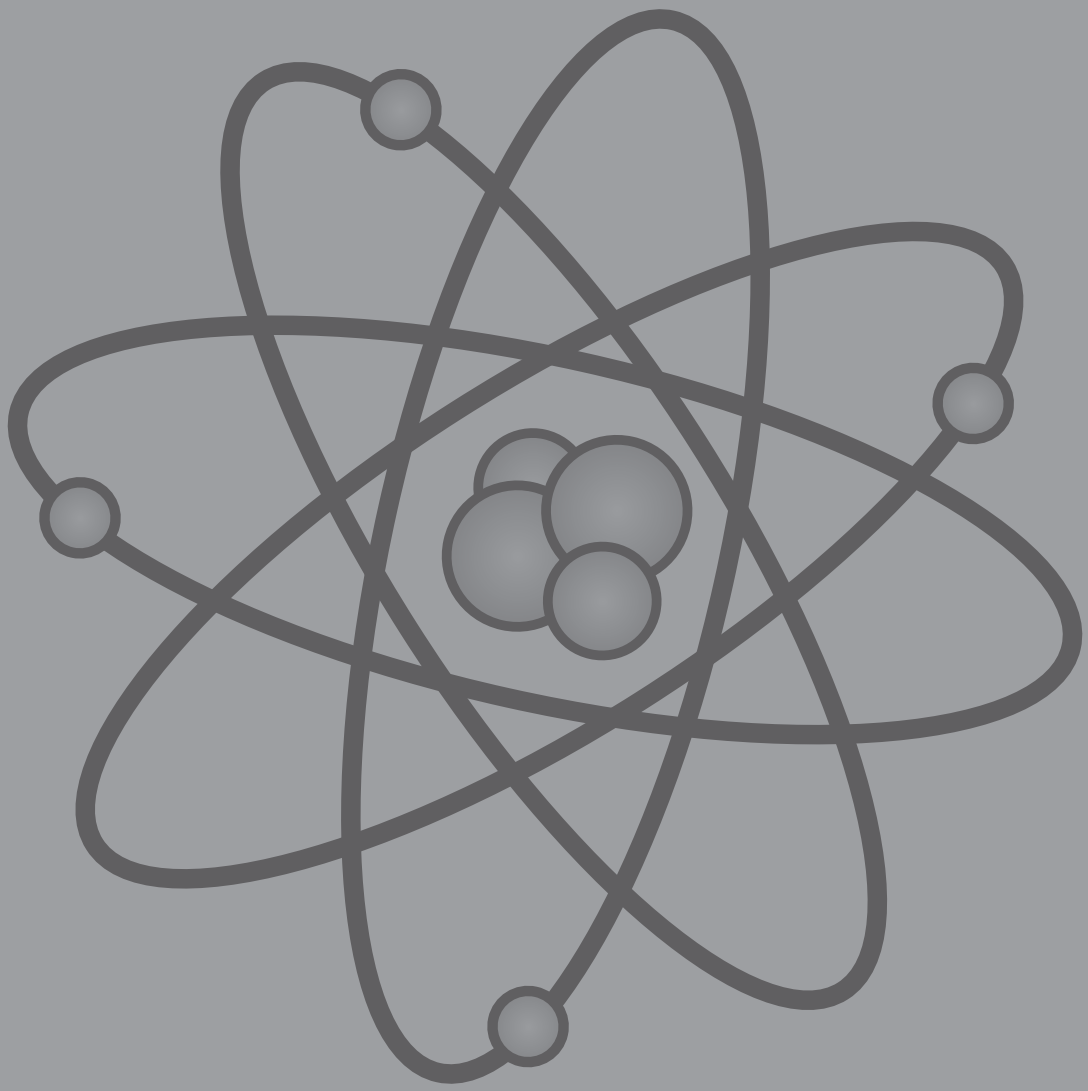

Mission Invisible

YEAR FOUR TO SIX TEACHER NOTES

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government

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Overview and Curriculum links: Years 4–6

Year	Curriculum focus	Activity
4	**Science Understanding** **Physical Sciences** Forces can be exerted by one object on another through direct contact or from a distance (ACSSU076)	Detector Experiments: investigating unseen forces • Unseen forces • Electric force detection – balloons • Electric force detector – make
	Science as a Human Endeavour **Nature and Development of Science** Science involves making predictions and describing patterns and relationships (ACSHE061) **Use and influence of science** Science knowledge helps people to understand the effect of their actions (ACSHE062)	Detector Experiments: the Large Hadron Collider • LHC Exhibition • LHC Video
	Science Inquiry Skills **Questioning and predicting** With guidance, identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge (ACSIS064) **Planning and Conducting** Suggest ways to plan and conduct investigations to answers to questions. (ACSIS065) Safely use appropriate materials, tools or equipment to make and record observations, using formal measurements and digital technologies as appropriate (ACSIS066) **Processing and analysing data and information** Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends (ACSIS068) Compare results with predictions, suggesting possible reasons for findings (ACSIS216) **Evaluating** Reflect on the investigation; including whether a test was fair or not (ACSIS069) **Communicating** Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports (ACSIS071)	• Investigations with a force detector • Mission Invisible Challenge: What's in the box?

Year	Curriculum focus	Activity
5	**Science as a Human Endeavour** **Nature and development of science** Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081)	Detector Experiments: twhe Large Hadron Collider • LHC Exhibition • LHC Video
	Science Inquiry Skills **Questioning and predicting** With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS231) **Planning and conducting** Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS086) Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS087) **Processing and analysing data and information** Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS090) Compare data with predictions and use as evidence in developing explanations (ACSIS218) **Evaluating** Reflect on and suggest improvements to scientific investigations (ACSIS091) **Communicating** Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)	• Mission Invisible Challenge: What's in the box?
	Physical sciences Electrical energy can be transferred and transformed in electrical circuits and can be generated from a range of sources (ACSSU097)	Detector Experiments: investigating electric forces • Electric force detection – balloons • Electric force detector – make

Year	Curriculum focus	Activity
6	**Science as a Human Endeavour** **Nature and development of science** Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE098)	Detector Experiments: the Large Hadron Collider • LHC Exhibition • LHC Video
	Science Inquiry Skills **Questioning and predicting** With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS232) **Planning and conducting** Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS103) Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS104) **Processing and analysing data and information** Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS107) Compare data with predictions and use as evidence in developing explanations (ACSIS221) **Evaluating** Reflect on and suggest improvements to scientific investigations (ACSIS108) **Communicating** Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS110)	• Investigations with a force detector • Mission Invisible Challenge: What's in the box?
	Physical sciences Electrical energy can be transferred and transformed in electrical circuits and can be generated from a range of sources (ACSSU097)	

Teacher notes are positioned in call outs throughout the document

Introduce students to the idea that some things are so small that we cannot see them. We can use some tools to help us like hand lens and microscopes but there are other ways to detect what we cannot see.

Recently Scientists have been using a very large detector called the Large Hadron Collider to detect the smallest particles that make up the universe. View the video of the Large Hadron Collider Exhibition to make some understanding of what Scientists are trying to find and how they are doing it.

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

Make the link between what they know and what Scientists are trying to find out.

Scientists at the Larege Hadron Collider are looking for the basic (fundamental) particles that make up matter.

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?

To find the nature of the basic particles of matter Scientists use detectors that interact with the particles. The interactions are due to forces that give evidence of the nature of the particles. Detecting wind is a simple example of this.

Observing interactions is a way of determining the properties of the particles that cause the interactions.

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?

Alternative activity idea:

- Have a selection of objects e.g. elastic band, marble; feather; straw etc. Challenge the students on how they can make one item move without touching it- may start blowing, hitting it with another object (you could also have magnets available for moving specific items).
- Discuss as a class the criteria for Student challenge is to then devise a game (in groups of 3 or 4) using a certain number of objects (that would include using all the forces, perhaps electrical force may not work at this stage).
- Students then create a poster around the game (are there rules, do you score, are there winners? Incorporate literacy skills?) and have to present it to the rest of class.
- Students all get a chance at trying out every game and can vote at the end for the best dependent on certain success criteria

This should reinforce earlier work in Year 2 on identifying pushes and pulls as forces. The difference here is that students have to distinguish between forces that they can see as opposed to forces that they can only see effects.

Seen" forces can generally be seen as a contact or collision whereas for "unseen" forces no point of contact between objects can be seen. Wind is moving air that can be detected by its effect on fan blades but the point of contact cannot be seen so the wind is an unseen force.

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. _____

Possible responses:

- Hand
- Other parts of body
- Blow (wind)
- Tilt the desk (gravity)
- Another object

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)

- Magnetic
- Electrical
- Gravity
- Nuclear (not expected response)

Some responses to expect:

- Wind – wind vane, windmill turns etc
- Gravity – objects fall down to Earth
- Magnetism –attract or repel metal, compass needle points NS
- Electricity- Wires get hot, Light from globes

Electrical forces are chosen for more exploration as an unseen force.

This fits well for Year 4 Forces- seen and unseen. Electrical forces not normally covered in Year 4. A magnetism activity could be substituted if teacher prefers this approach and resources are already available.

This exploration can be used as introduction to Electricity in Year 6 but emphasis at that level is on electrical circuits and energy rather than forces.

Materials for each group:

2 x inflated balloons with string attached. This activity works best on a dry day.

(4) Expected response:

The balloons should either come closer together (attract) or move away (repel) from each other.

'What Happens'
Expected response:

The balloon should either attract or repel. It should do the opposite of what happened when the two balloons were close together.

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?

This introduces the idea that the effects electric forces that we see are due to the interaction of two or more charges (particles). We can't see the force or the particles but we know that they are there by the effects we observe. Attraction and repulsion is evidence that there are two types of charges. This is analogous to the North and South Poles of a magnet.

This is the same process that Scientists use when detecting the fundamental particles of matter. Interactions determine the nature of the particles and the forces.

Summary of what we learned from the balloon activity:

- Rubbing two balloons together caused charges to separate.
- The charges can either attract or repel showing the electric force between them.

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.

Leads to the next activity making an electric force detector.

Safety Alert:
A hot glue gun is needed to make this device so should be done by teacher or a responsible adult. Schools need to make their own risk assessments based on their circumstances.

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

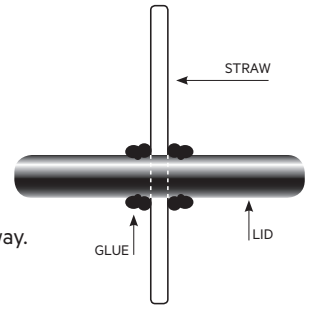
Drill bit, the size of a straw

This one is a coffee jar with the plastic insert removed from the glass lid. The glass lid was not required.

Procedure

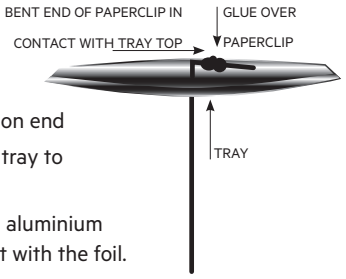
A. Lid

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

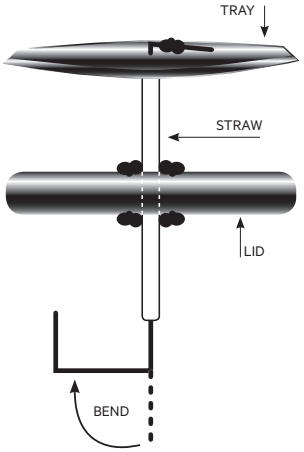
1. Straighten paper clip except for right angle bend on end
2. Push paper clip through centre of aluminium tart tray to place bent end along the top of the tray.
3. Ask your teacher to hot glue the paper clip to the aluminium tart tray. Make sure the paper clip stays in contact with the foil.



If students are making their own detectors. then an adult should perform this step.

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

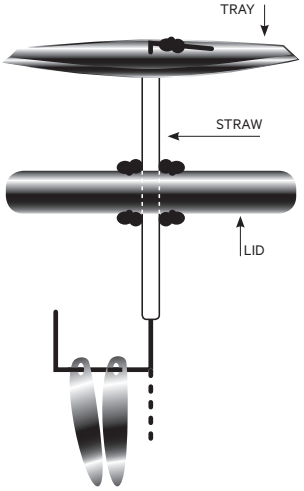
5. Put a hook bend in the lower end of the paper clip.



C. Foil assembly

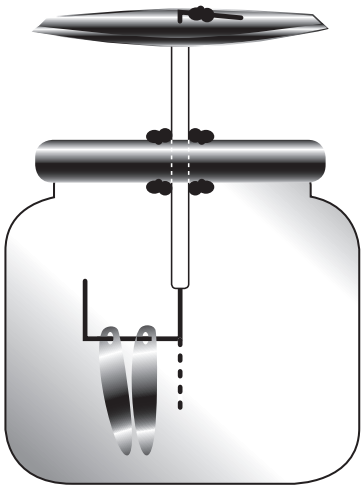
1. Cut two pieces of aluminium foil shaped like tear drops with 1 cm diameter.
   Try to have a nice round shape.
2. Put a small hole at the top of the tear drop in both pieces of foil.

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!



Size is not critical.

Try to round the top edge of the tear drop.

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?

Expected response:
The aluminium foils should move apart to form an inverted "V".

C. Move the ruler away from the tray.

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

Expected response:
The foils should return to the vertical position.

D. Explore some other tests you can try.

Other tests:

- Touch the tray with the ruler or pvc pipe.
- Bring the rubbed material close to the detector
- Touch the tray with your other hand while holding the rubbed ruler or PVC close.

Moisture is the single most important factor if the detector is not working very well as expected.

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.

These are critical points of understanding before proceeding with the next set of investigations.

- Two types of charges
- Opposite types attract
- Same types repel
- Rubbing can separate the charges

These ideas can be used to explain all of the outcomes of the tests performed so far and also the investigations that follow.

Students will now investigate whether different types of material affect the separation of the charges.

Variables:

- Object material

  Object size and shape

  Rubbing material

  Rubbing material size and shape

  Length of time rubbing

  Humidity in room
- There will be series of tests for different object materials.
- For each test series the same range of materials will be used.
- Rubbing time is 10 seconds
- Shape may be difficult to control

This first test would be best done with controlled materials.

- First try a plastic ruler with a range of rubbing materials.
- Then try a different rubbing object (PVC tube works well) on the same range of materials.
- This way students are changing one variable at time.

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

This is an important part of the process as students are applying what they have learned to new situations.

Students are making predictions for what they expect to happen for new combinations of materials.

In a similar way Scientists at the LHC make predictions about what they expect to find based on the what they believe to be the nature of the particles they are looking for. The detection of the Higgs Boson is a good example of this.

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				

This might seem out of context but actually opens a whole new line of enquiry so take care.

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.

Teachers may want more background on how Scientists have historically detected the invisible.

A lot of the videos are too complex for Year 4 These videos are best used as background for the teacher. Segments could be shown to class if relevant.

Röentgen– X-rays
https://youtu.be/I6Fu0GcLhVE

Becquerel – Curie Radiation
https://youtu.be/azwesgfZ1b8

JJ Thomson – Cathode rays
LHC Exhibition object- link to video

Rutherford – Atomic nucleus
https://youtu.be/XBqHkraf8iE

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.

These five questions will focus the students on important ideas to explore during a visit to the Large Hadron Collider Exhibition. Alternatively the Large Hadron Collider Exhibition video could be used to explore answers to these key questions.

Additional teacher resource:
Particle accelerators

Using electrostatics to accelerate small (invisible) particles: https://home.cern/about/how-accelerator-works

Additional teacher resource:
Particle beam

http://home.cern/about/engineering/pulling-together-superconducting-electromagnets. Using magnets to focus the beam of moving particles.

Look for answers at the LHC Exhibition or from the LHC video. Essentially the small particles break down into more fundamental (smaller) particles that can be detected.

Additional teacher resource:
Particle detectors

https://home.cern/about/how-detector-works

Looking at detectors. There are number of types depending on what is being detected.

The most significant discovery so far at the LHC has been the Higgs Boson. This is one of the fundamental building blocks of matter and the universe.

Additional teacher resource:
Higgs Boson

http://home.cern/topics/higgs-bosondditional

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.*

Hardness can be described in terms of hard or soft. The evidence is simply the sound as it either rolls, slides or collides with other particles or the sides of the box. Students may be able to feel the difference of impact on the side of the box between hard and soft.

Data Table

Now it is your turn:

Test particle	What did you do?	Describe what happened?

Having performed the range of tests in the test box and had an initial "play" with the sealed box the students should now be in a position to make a better guess or prediction about what they think is in the sealed box.

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?

Hardness can just be described in relative descriptors such as hard and soft. This property would be entirely optional.

- 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?

This is their next best guess based on new evidence.

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?

Reminder:

Do not open the box for students to see if they are "right". This is not about right or wrong as the students must realise that the Scientists cannot just open a box to find the answer.

Students should emulate the Scientist's process of expressing their confidence in their findings.

It is important that students reflect on the confidence they have in their results. This will need to be adjusted for Year level but it would be reasonable for Years 4 – 6 to consider this issue.

Prep – Year 3 may just a response about how "sure" they are about what they think is the shape of what is inside the box

- Scientists also judge their confidence level by assigning a percentage based on their degree of confidence. This has been particularly evident during the Climate Change debate.
- Confidence is the degree to which there is agreement with others performing the same tests as well as the robustness of the evidence.
- Students with very high confidence will need to feel that others can reach the same conclusions if they use the same tests or they will need to justify their conclusions against other points of view based on their evidence.
- The important point is that students realise that there is no right answer and they can only have a level of confidence in their results.

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?

Teacher introduction

Mission Invisible as Prep-6.

With a brief explanation of how you could differ it from each year group/individual capability

Elaborate more (Prep – Year 6)

Mission Invisible: What's in the box?

This activity can be adapted for any year level by adjusting the demands of the task and hence differentiating learning. To adjust task demands the box contents can vary in type and number. A simple box might have a single object such as a small ball or a cube toy block.

Students detect what's inside by tipping or gently shaking the box. The next level might have two objects in the box such as a ball and a cube.

The detection methods can increase in level too by adding an open "control" or test box and a range of objects that can be placed inside. Manipulation of the control box will provide clues about the nature of what is inside the closed box.

At higher levels objects can have other detectable properties such as magnetic, hardness, mass and shape.

All data can be qualitative so descriptions of hardness, mass, size and shape will generally be comparative. There may be opportunities to introduce more quantitative data through length measurements with probes, mass measurements with scales and perhaps even ways of measuring magnetic field strength. This would be mostly for higher levels of complexity and precision.

The important point is that students can only make claims on the nature of the particles they believe to be inside the box based on the evidence they can collect. As this leaves areas of grey then this is the limitation that they should understand has been the same limitation for Scientists through history as they have explored the nature of matter and the universe.

The sealed box must never be opened to find out if the students were "right". Doing so would destroy the whole point of the activity: What is your best guess of what is inside based on the evidence you have collected?

One way of pursuing this idea is to give students basic detectors then have them design and build their own detectors.

Materials

Suitable box

- Sealed shoe box
- Post pack box

Objects

- Spherical - golf balls, table tennis balls, squash balls, foam balls
- Prisms – toy blocks of triangular base, rectangular, cubes
- Other objects can be used

Test box

- Identical to sealed box except open
- Samples of each type of ball in box

Combinations of types will depend on resources available and the level of differentiation required. For lower Primary School two different shapes should be enough. Students might only be asked to determine what are the shapes the objects.

Year 4 may handle 3 objects and the level of description may need adjustment. Number and shape might be enough but you could add if they are hard of soft quite easily.

Set up for each group

- Sealed box with a combination of particle types provided by teacher.
- Test Kit
  - Sample of each particle type that might be in the box
  - Open box

Teacher direction

Engage

Mission Invisible Challenge: What is in the box?

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.

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

To complete the mission you will need to say what you think is in 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

- 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.

Explore (Students)

- 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

- You have been provided 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 you 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.