Te Kura ā-Tuhi
The Correspondence School

science

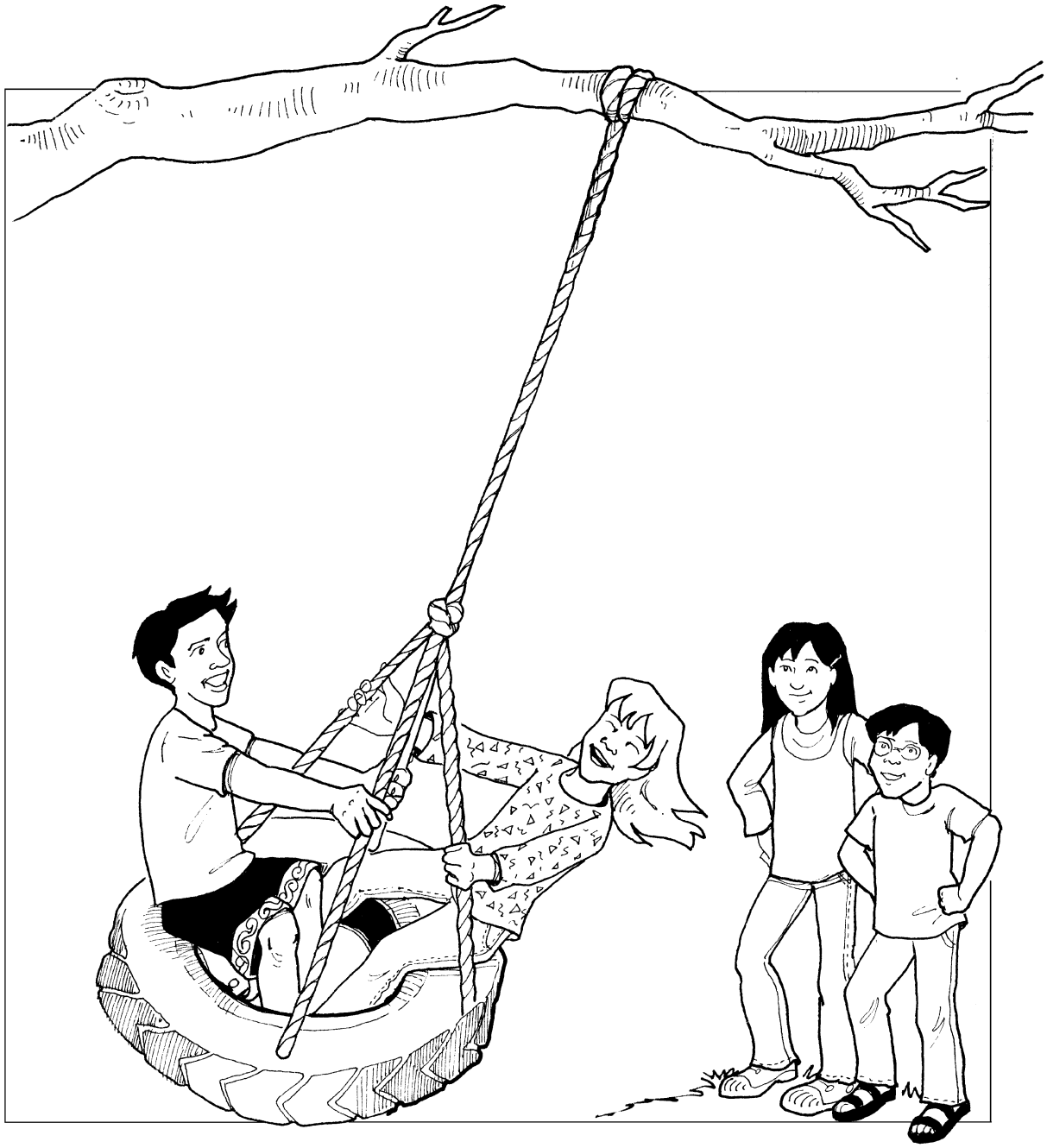
pūtaiao

Pendulums

Ngā tāwēwē

98/2

SCL311



Pendulums

Ngā tāwēwē

How to do the work Me pēhea te whakamahi

Do at least 4 hours work on this booklet.
You could do

- all the work in one day
- a 2 hour chunk each week
- an hour a day over four days
- 6 × 40 minute sessions over two weeks.

You will
investigate the properties of pendulums
record what you find with graphs
make and **interpret** the graphs.

You need Whakaarotia ēnei

- ball of light string or cotton thread
- rice
- sticky tape
- plastic shopping bags
- fizz bottle
- small plastic container or bottle
- stop watch or timer
- large sheets of blank paper
- old newspaper
- food colouring or thin paint.

Assessment Aro matawai

Your teacher will be looking to see how well you

- make a model of a pendulum
- identify patterns when you observe the way pendulums work.

Science in the New Zealand Curriculum: **Making sense of the physical world, level 3**

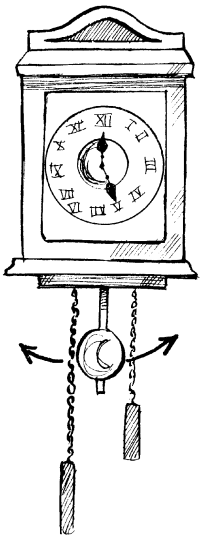
ngā rārangi kōrero
contents

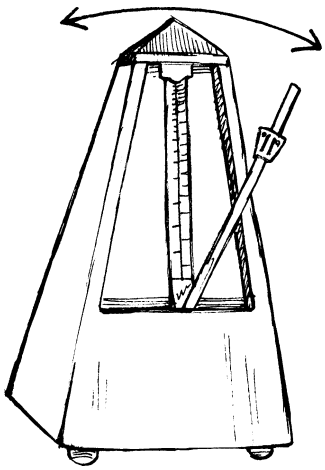
whārangi / page

1 What are pendulums?

He aha ngā tāwēwē?

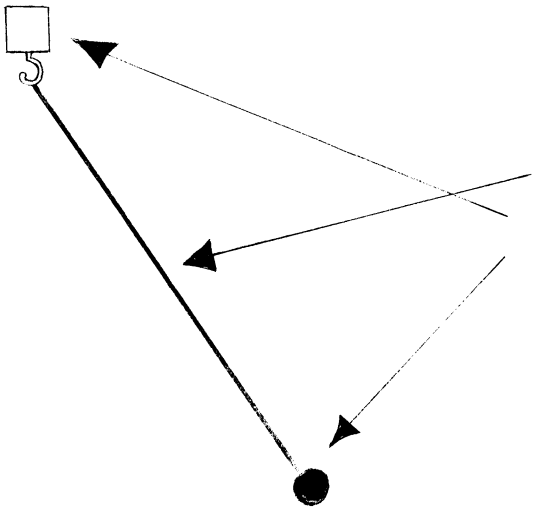
What do all these things have in common?





Write your ideas here.

◗ Check other ideas at the back.



A pendulum is made of

- a **string**
- **somewhere to hang** the string
- **a mass** on the bottom of the string.

It is **pulled back** to let it swing.

Write four things you could change on a pendulum.

_____

_____

_____

_____

◗ Check the ideas at the back.

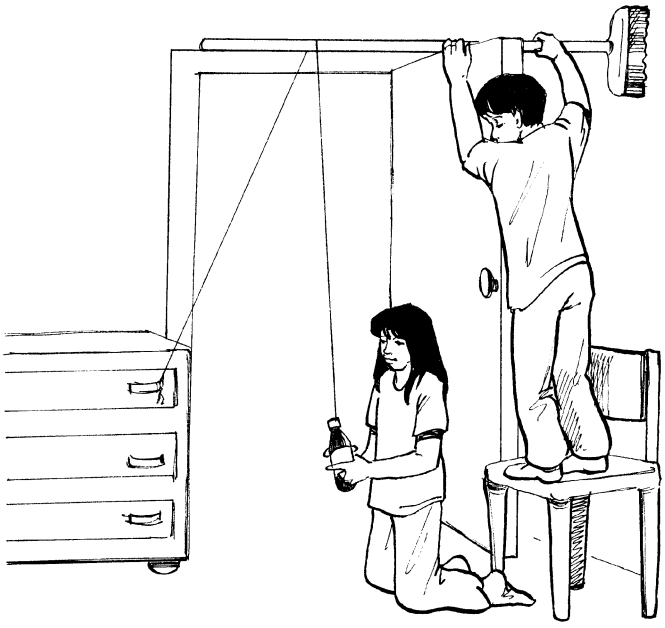
In the rest of this booklet you will be making and testing pendulums using these changes.

Pendulums with different masses

Ngā tāwēwē i te taha o ngā papatipu rere kē

You need

- a plastic fizz bottle
- light string
- water
- a stop watch.



Ask an adult to help you set this up.

Fill the bottle with water. **Screw** the top on. **Tie** the string onto it.

Find a place to hang your pendulum so it can swing. Somewhere outside would be fine if it's not windy.

You could hang it from rafters inside or from a piece of wood (a broom handle) over a door frame.

Try swinging your pendulum.

Make sure

- your pendulum swings close to the floor
- the length of the string stays the same (tie it in place)
- you pull the bottle (the mass) back the same distance each time
- the place it's swinging from is still (get someone to hold it for you, use nails).

Test your pendulum.
Write what you predict will happen when the mass (the fullness of the bottle) changes.

_____

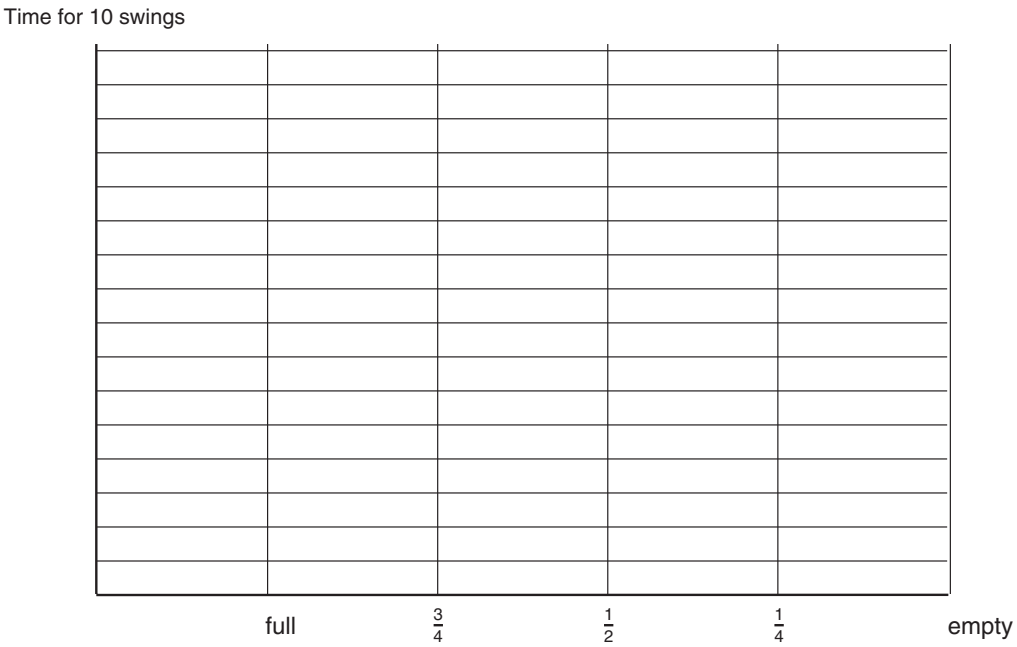
_____

Time how long it takes for 10 swings with a full bottle, a $\frac{3}{4}$ full bottle, a $\frac{1}{2}$ full bottle, a $\frac{1}{4}$ full bottle and an empty bottle.

Record your results on the table below.

Fullness of bottle (mass)	Time for 10 swings
full $\frac{4}{4}$	
$\frac{3}{4}$	
$\frac{1}{2}$	
$\frac{1}{4}$	
empty	

Graph the results below. Give the graph a title and number the time axis.
My graph showing _____



Write what this graph tells you about pendulums.

_____

Let the pendulum swing until it stops. **Time** how long it takes for an empty bottle and a full bottle to stop swinging.
What do these tests tell you about pendulums?

_____

◗ Check the answers at the back.

2 A rice ball pendulum

He tāwēwē rice ball

In session 1 you changed the mass on your pendulum.
This session you are going to have the same mass but change the length of the swing.

You need

- a plastic shopping bag
- sticky tape
- light string or cotton thread
- a cup of rice (or lentils or sand or dirt).

Make a pocket with a flat part of the shopping bag.

Pour the rice into it.

Tie string around the twist.
Sticky tape the string down.

Tightly twist the top to make a ball of rice.
Sticky tape the twist closed then cut off the rest of the plastic bag.

Set up the pendulum as you did for the ‘bottle’ pendulum.

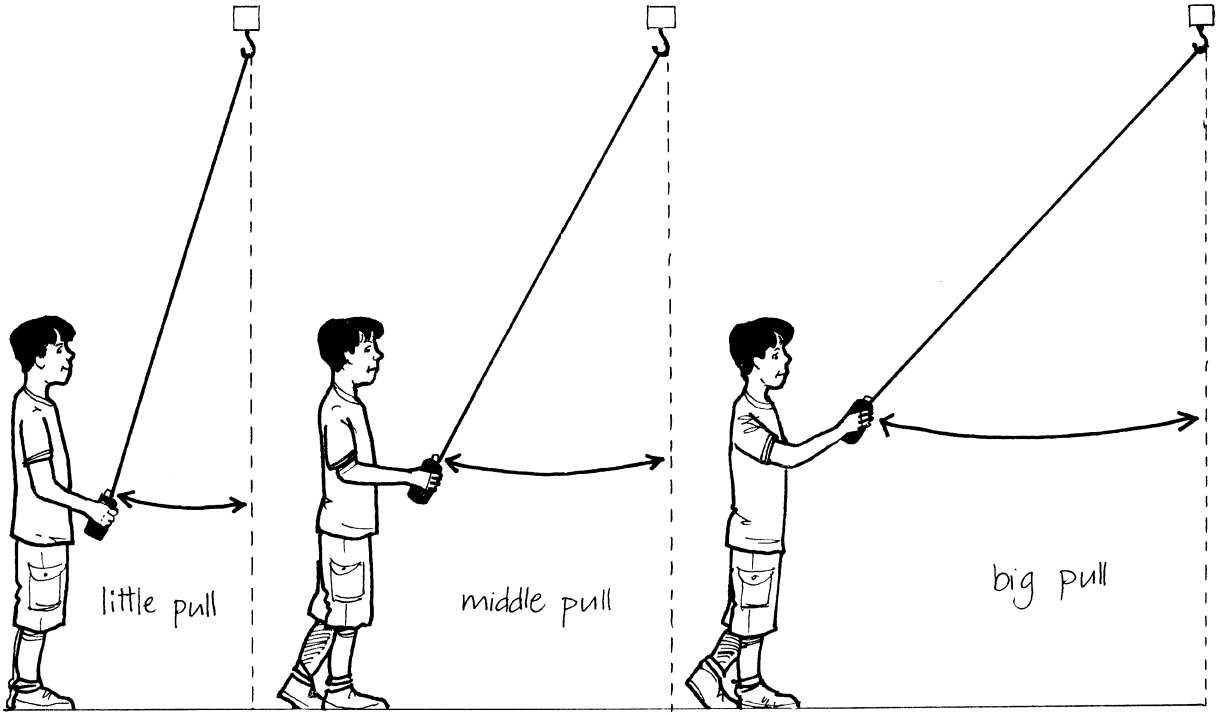
Changing the length of the swing

Use your rice ball pendulum to test what happens when you change the lengths of the swing.

Predict what you think will happen when you change the length of swing.

Make sure
- the length of string stays the **same**
- the mass stays the **same**
- the place it's swinging from stays **still**.

Time how long it takes to do 10 swings after letting it go from three different distances.



Record your results in the table below.

Length of pull from the centre	Time for 10 swings
little pull	
middle pull	
big pull	

Graph the results below.

Write titles for the graph and its axes.
Put numbers on the vertical axis.

My graph's title _____

Write what this graph tells you about pendulums.

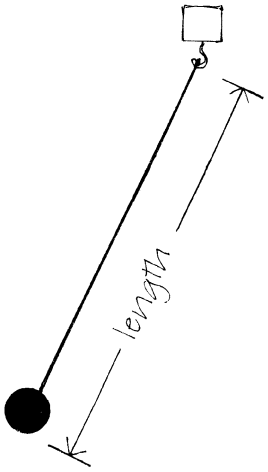
_____

◗ Check the answers at the back.

Put your rice pendulum in a safe place. You'll need it again.

3 Change the length of the string

Whakarere kēngia te roa o te tuaina



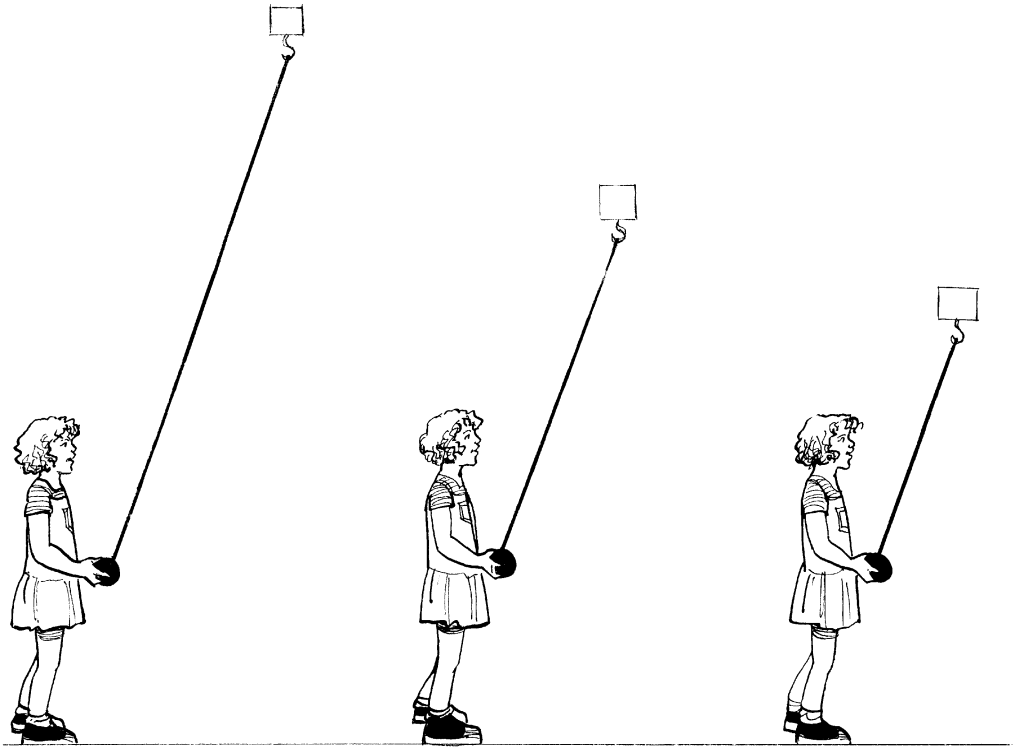
You measure the length of the pendulum from where it swings to the bottom of the mass.

Use the rice ball pendulum to test what happens when you change the length of the string.

Write what you predict will happen here.

I predict that if the string is very long the pendulum will take a

If the string is shorter

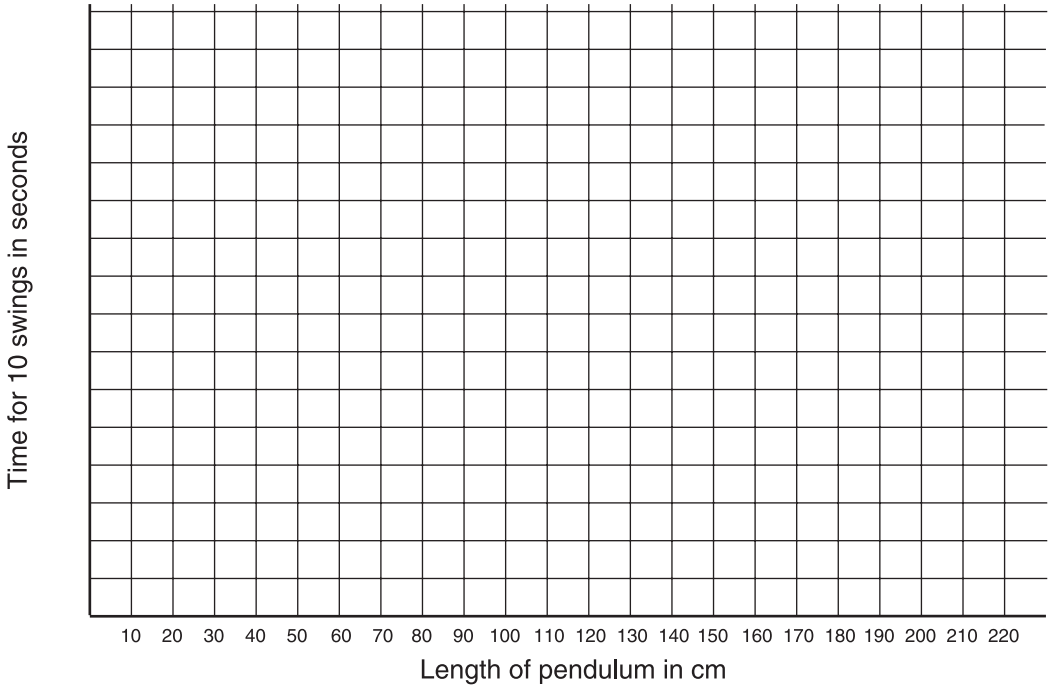


Record the results on the table and graph below.

Write a title for the graph and number the vertical axis.

Length of pendulum	Time for 10 swings

My graph's title _____



Write what this experiment tells you about pendulums.

_____

◗ Check the answers at the back.

4 Swinging from a swing

Te piu, mai i tētahi piunga

Set up your rice ball pendulum like this.

Swing it from different positions.

Predict what will happen before you try each swing.

Straight on swing _____

Swing at an angle _____

Write what you see happening. Say how it is different to a pendulum swinging from a fixed point.

_____

_____

_____

Leave this set up for session 5.

Now that you have tested the four changes you can make to a pendulum, what can you say about them?

1 If you change the length of the swing _____

_____

_____

2 If the swing hangs from a fixed point _____

_____

_____

3 If the string hangs from a moving point _____

_____

_____

4 If the length of the string changes _____

_____

_____

5 If the size of the mass changes _____

_____

_____

What else did you find out?

_____

_____

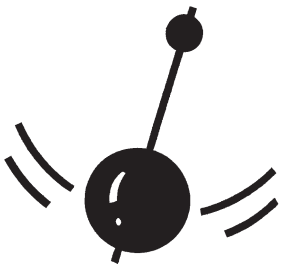
◗ Your teacher will check this.

5-6 Things to do with pendulums

Ngā mahi e pā ana ki ngā tāwēwē

Choose one or more of these to do.

Two pendulums on a swing



Make another rice ball pendulum the same as in session 2.

Hang the two rice ball pendulums from the string between the chairs (about 50 cm apart). Leave one to hang still and carefully give the other a swing.

Predict what you think will happen.

Draw and label a diagram of how you set it up.

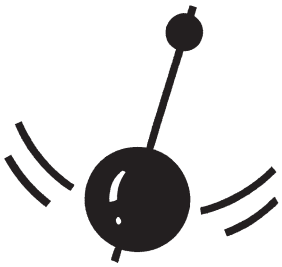
Write about what you found out.

◗ Check the answers at the back.

Paint with a pendulum

Te peita mā tētahi tāwēwē

Attach your pendulum painting here



You need

- old paper
- the swinging pendulum system from the last session
- a small plastic container to use for the mass of the pendulum and hold the paint
- food colouring and/or paint.

Kia tūpato
(Take care)
Ask an adult to help you.
Use plenty of old newspaper to absorb any spills.
Don't do this over the carpet!

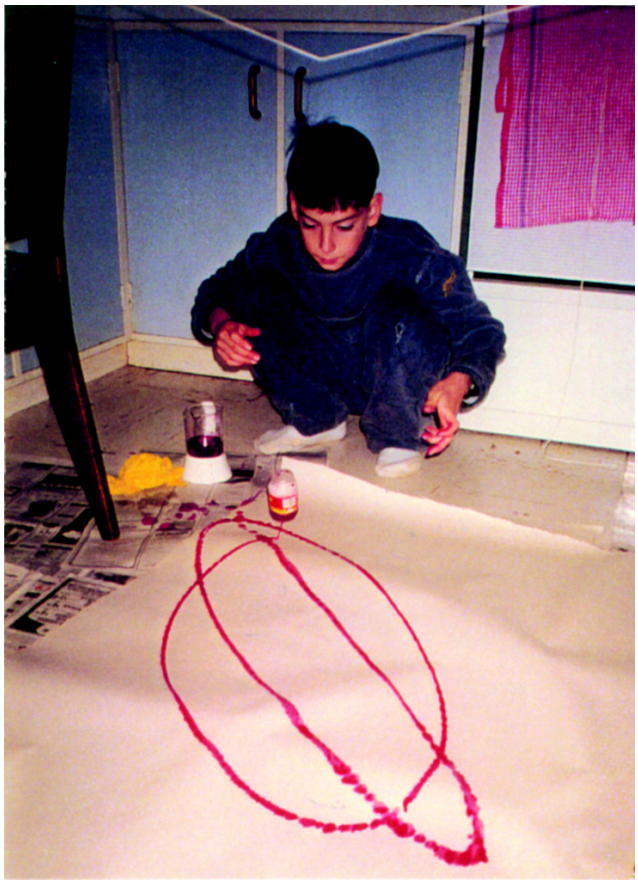
Make a small hole in a small plastic container (a hot 40 mm nail is good). Then tie it onto the string to make the mass of the pendulum.
Put water coloured with food colouring or runny paint into the container.
Swing it over a sheet of paper.
Stop the drips when you're satisfied with your pattern.

You could try

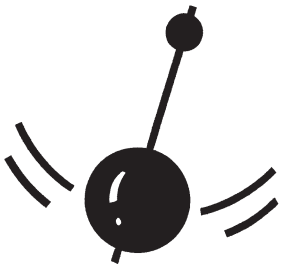
- pendulums with different coloured paint/dye
- different thicknesses of paint/dye
- varying the line of swing
- varying the size of the hole
- changing the position of the pendulum.

Can you predict or control the pattern?

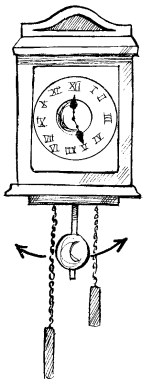
Send your best pattern to your teacher.

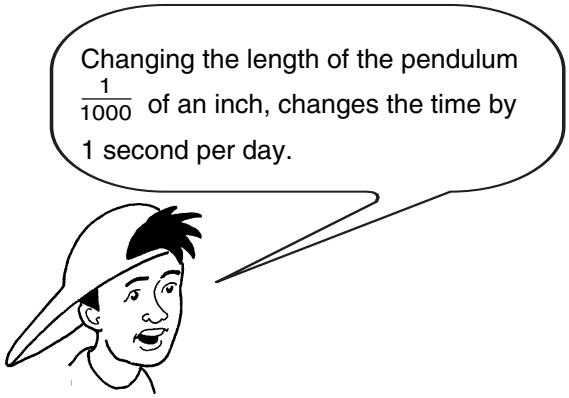


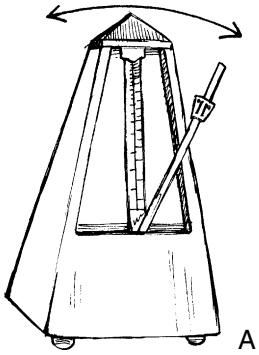
Make a pendulum that takes one second per swing



When Galileo discovered pendulums there were no accurate clocks. Pendulums were soon used for measuring time accurately.
Old fashioned clocks used pendulums to measure each second.







A metronome

Metronomes are upside-down pendulums.
You can vary the speed of clicks on a metronome by moving the weight up and down the rod. This changes the *length* of the pendulum.

Ask an adult to help you.

Calculate how long the string needs to be from your graphs.
Test to get the string just right.
Measure the length of the pendulum from the bottom of the mass to where it swings from.

Ten swings should take 10 seconds.
There should be sixty swings in a minute.
How long is the pendulum that has a one second swing?

◗ Your teacher will check this.

Foucault's pendulum

Te tāwēwē a Foucault

You probably noticed that the pendulum with the greater mass swung for longer.

In 1851 Foucault (born 1819, died 1868) made a massive pendulum which swung for hours. He found that even though he set it swinging straight it seemed to move in a circle. This was the first 'scientific' evidence that the Earth was moving.

The pendulum was swinging straight back and forth but the earth moved underneath it!
At the North and South Poles it would move exactly one circle per day.

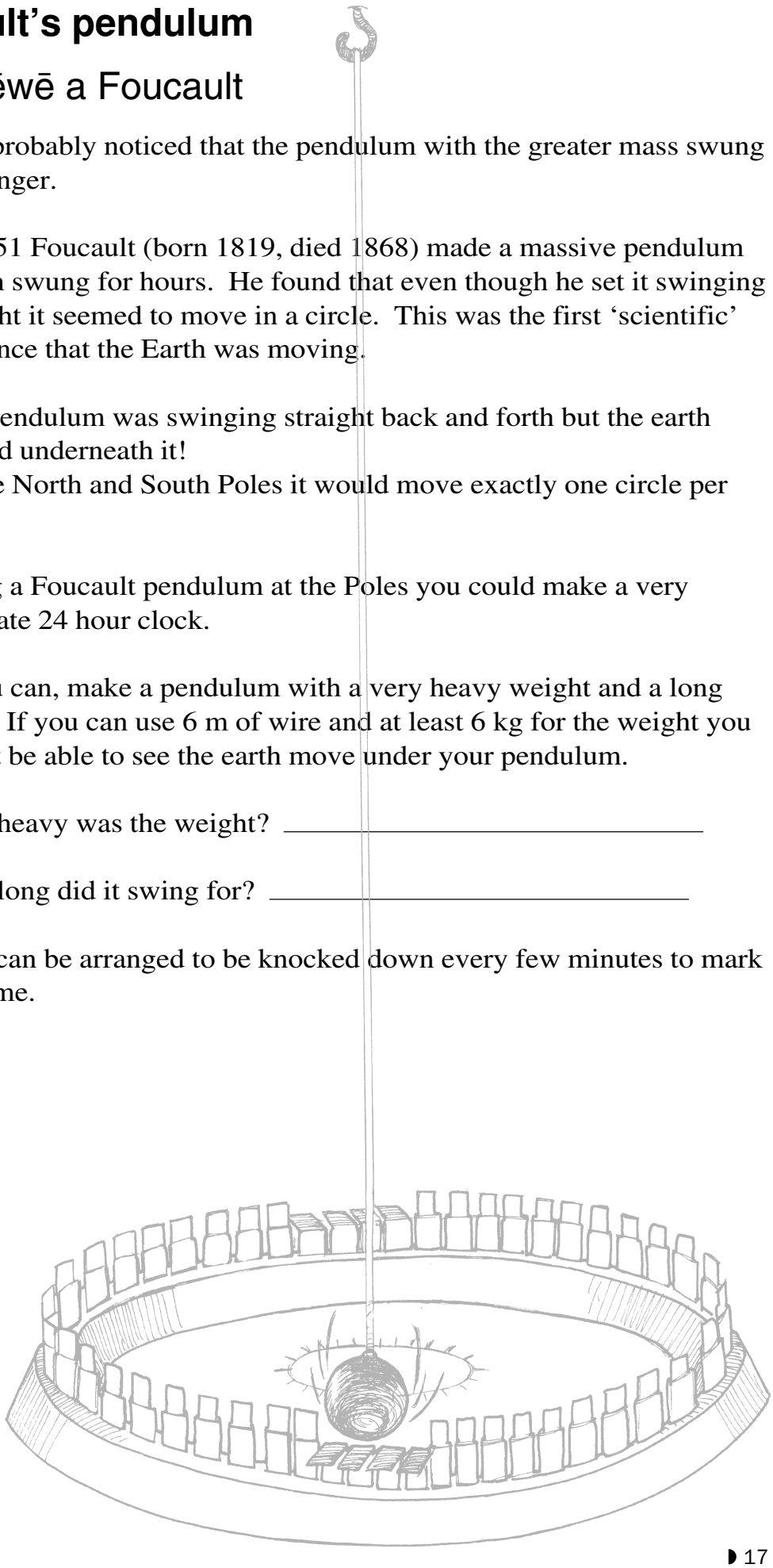
Using a Foucault pendulum at the Poles you could make a very accurate 24 hour clock.

If you can, make a pendulum with a very heavy weight and a long rope. If you can use 6 m of wire and at least 6 kg for the weight you might be able to see the earth move under your pendulum.

How heavy was the weight? _____

How long did it swing for? _____

Pegs can be arranged to be knocked down every few minutes to mark the time.



Possible answers
He whakautu pea

whārangi

2 What are pendulums?

The clock, the swing and the metronome all have a part which swings from a fixed point. These special swings are called pendulums.

3 Pendulum variables

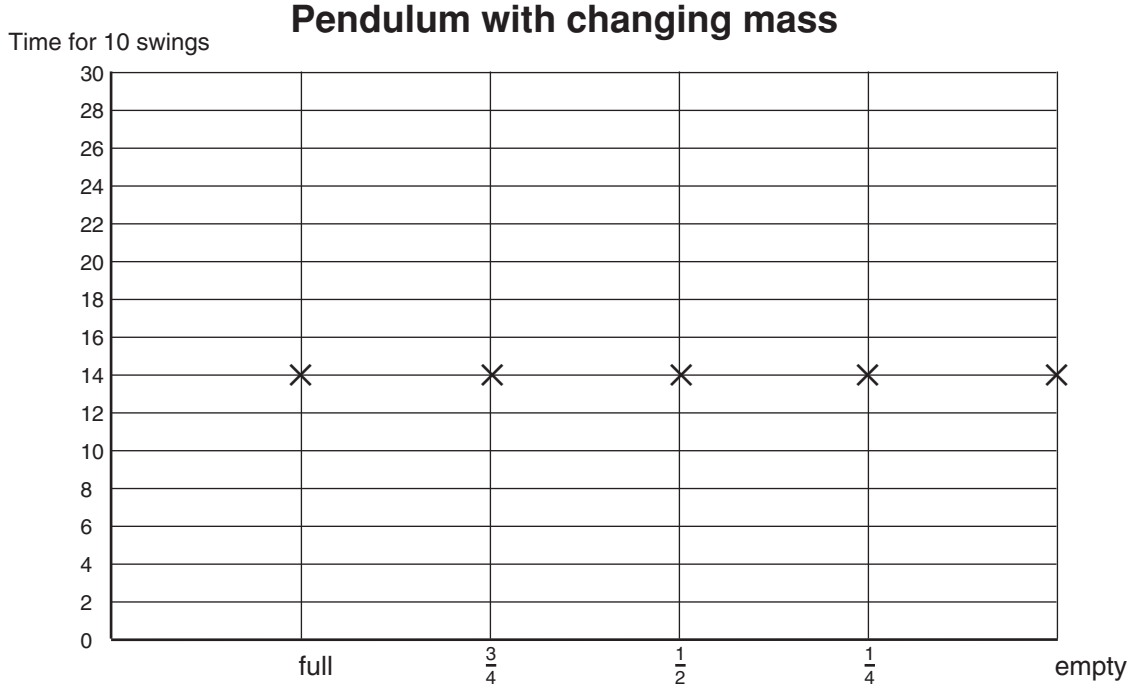
The changes you could make to a pendulum are

- length of swing
- size of mass
- where you swing it from
- length of string.

One of the first scientists (Galileo born 1564, died 1642) studied pendulums and discovered their properties when he was 19 years old. He used his heartbeat to time the swings. There were no clocks that could do the job then.

5 Different masses

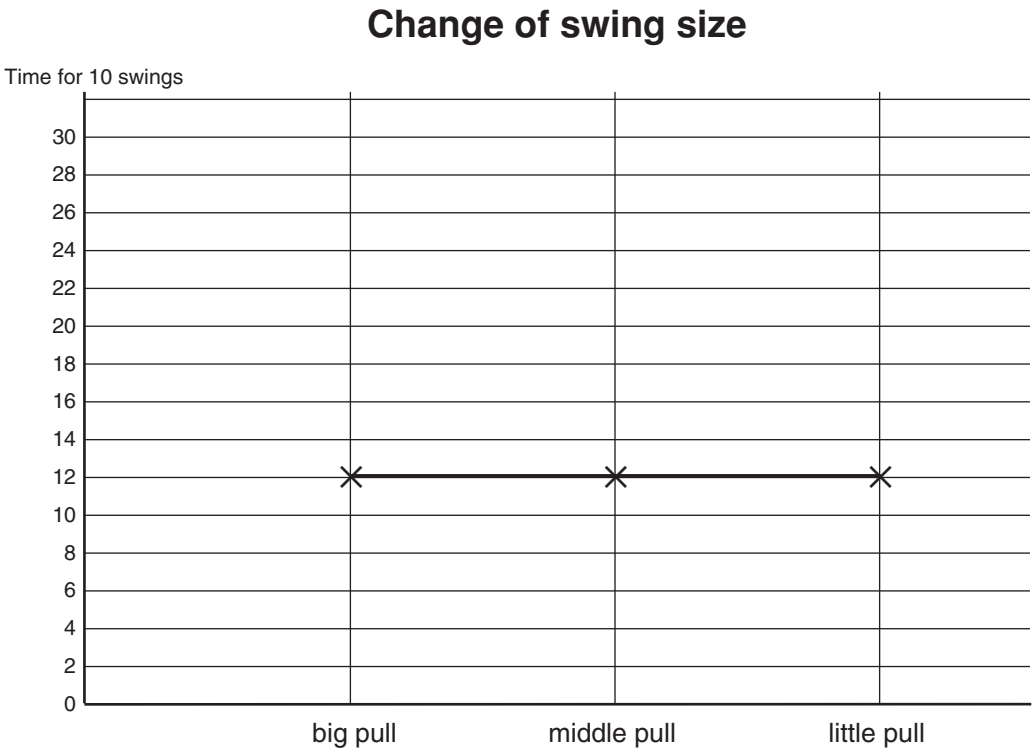
You probably noticed that the time for 10 swings stayed about the same. You could have said "the mass of the pendulum does not change the time it takes to make a full swing".



Your numbers might be different and the crosses might not be in a perfectly straight line, but the numbers shouldn't have changed very much.

9 Changing the length of the swing

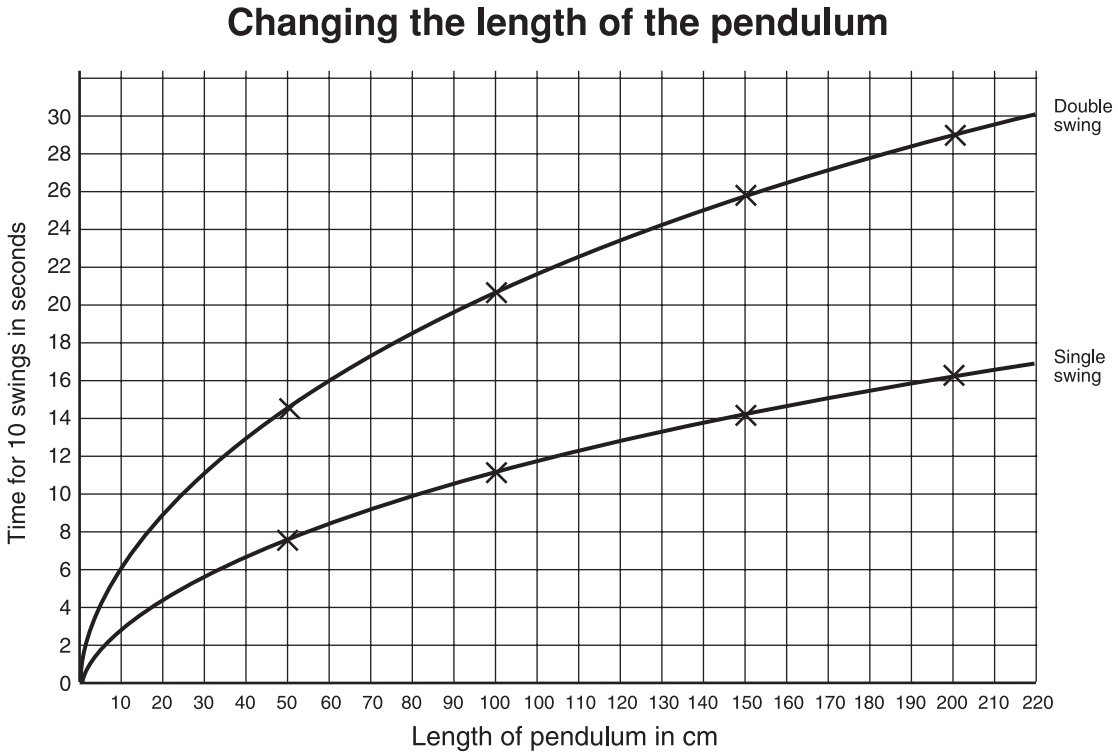
You probably noticed that the time for the 10 swings stayed the same. Your graph probably showed that the time of swing for the different lengths of swing stayed about the same. You could have said, "the time a pendulum swings doesn't change when the size of the swing changes."



Your numbers might be different and the crosses might not be in a perfectly straight line, but the number shouldn't have changed very much.

11 Changing the length of the string

You probably found that the time for the 10 swings changed this time. You could have said, "If you change the length of the pendulum you change how long it takes to make each swing."



Your graph may look a bit different. The thing to notice is the time for 10 swings gets longer as the string gets longer.

12 Swinging from a swing

When it swings 'straight on' it just goes back and forth. When it's swung at an angle the mass swings around in a way that would trace out circles, loops and ellipses.

14 Two pendulums on a swing

After giving one pendulum a swing the other, still pendulum, would have started swinging on its own. It would have started and stopped swinging whilst the first pendulum changed the size of its swings.

SCL311 Checkpoint

Taupeka matawai

My work				Teacher's comment
I tested pendulums and recorded the data accurately on graphs.				
I used my findings to describe what happens when you change a pendulum.				

Supervisor and student comments