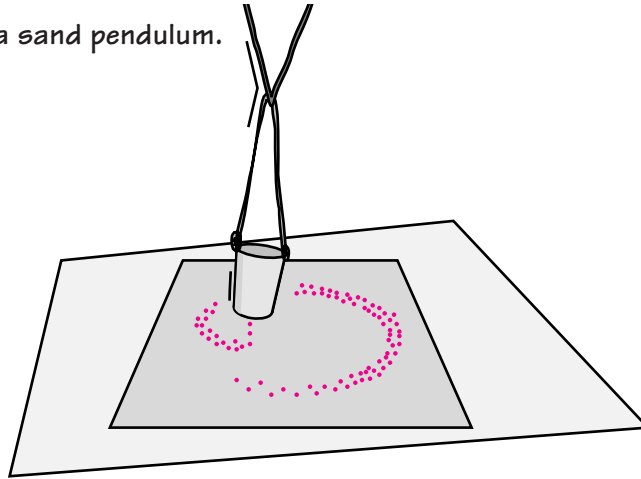


# Team games: Sand pendulums



60 mins

**S**tudents are introduced to the concept and skills of co-operative learning. They work in teams of three to construct a sand pendulum.



## At a glance

Student book pages 1–4

- Introduce and explain team skills and team jobs.
- Introduce the team investigation.
- Form teams and allocate jobs.
- Students carry out the team investigation.
- Discuss questions in the student book.



## Lesson outcome

**Students are aware of the skills that will help them to work in teams.**

They show their awareness by:

- moving into their teams quickly and quietly;
- speaking softly;
- staying with their teams;
- taking turns; and
- doing their jobs.



## Equipment and preparation

**For the class** team skills chart (BLM 7.1)  
team jobs chart (BLM 7.2)

### Team investigation

**For the class** dustpan and brush

**For each team** 1 paper cup  
1 sharp pencil (longer than the depth of the cup)  
2 lengths of string (1 metre each)  
1 container (eg, yogurt), half-filled with fine sand (or table salt)  
1 sheet of newspaper  
1 large sheet of coloured paper or card (eg, a coloured manilla folder opened out)  
glue (optional)  
job badges for director, manager and speaker

*Managers will find it easier to collect the equipment if you put the items for each team into a separate container.*

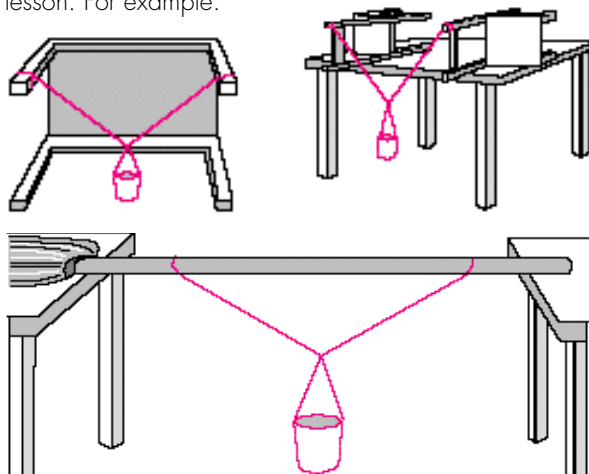
**Preparation**

**P**ractise making a sand pendulum and pattern before the lesson.

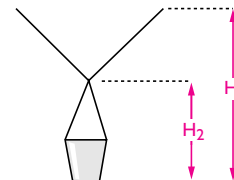
**I**f using sand, make sure it is completely dry and even. Do this by sieving it and then drying it in an oven. After drying, store it in sealed containers. Even sand that looks dry will probably contain some moisture and need drying.

**I**f using salt, make sure it is from a freshly opened packet.

**A**rrange your classroom furniture for this lesson. For example:



*Simple patterns are produced if the strings are adjusted so that the distances  $H_1$  and  $H_2$  are in the ratio of the squares of whole numbers (eg, 4:1, 9:1, 9:4). A ratio 9:4 (nearly 2:1) is probably best.*



**BLMs** Make one copy of 7.1 and 7.2.

**Teaching strategies**

- 1 Introduce and explain the team skills chart and team jobs chart.

*If students are using Primary Investigations for the first time, provide them with a full explanation of team skills and team jobs. Emphasise that each team member will contribute to the team investigations and that the team jobs will be rotated during the year.*

- 2 Show students the equipment table and discuss its use. Explain that this is where team managers will collect and return the equipment.
- 3 Outline the team investigation: *How do we make a pattern with a sand pendulum?*

*Make sure students understand that only the manager of each team collects or returns equipment from the equipment table.*

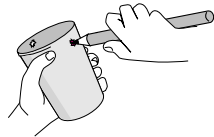
*Remind students to wear their job badges. This makes it easier for you to identify which job each student should be doing—and easier for the students to remember what they and their team members should be doing.*



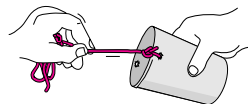
- Form teams and allocate jobs.
- Ask managers to collect team equipment.

- 4 Ask students to carry out steps 1 to 11 in the student book.

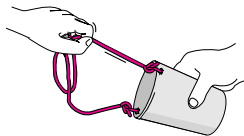
**Step 1** Use the sharp pencil to make two holes in opposite sides of the paper cup.



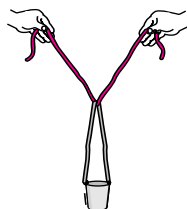
**Step 2** Thread one end of a piece of string through one of the holes and tie it so that most of the string is hanging free.



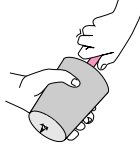
**Step 3** Thread the other end of the string through the other hole and tie it.



**Step 4** Take the second piece of string and thread it through the first piece.

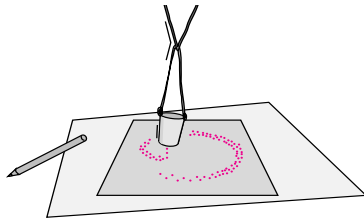


- Step 5** Your teacher will explain to you how to tie the string to a chair or table. Make sure the cup is just above the floor.
- Step 6** Put sand in the hanging cup. (Don't make a hole in the bottom of the cup yet.) Put the newspaper and coloured paper under the cup. Adjust the height of the cup so it is about one centimetre above the coloured paper.
- Step 7** Pull the cup gently to one side (to just above the corner of the coloured paper). Release the cup and see if it swings freely. If it doesn't, raise the cup by shortening the string.
- Step 8** Tip the sand out of the cup (into the container) and make a small hole in the bottom of the cup by pushing down through the cup with the point of a pencil.



- Step 9** Put a little sand back into the cup and see if the sand flows freely through the hole. If it doesn't, make the hole larger.
- Step 10** Block the hole with the pencil and put all the sand back into the cup.

Let the cup hang free. Remove any sand that may be on the coloured paper. Now you are ready to make your pattern. Pull the cup to one side as you did before and remove the pencil. The cup should swing gently and make a sand pattern on the coloured paper.



- Step 11** When you have made one pattern, lift the coloured card carefully and roll it to make a funnel. The sand can then be poured back into the spare cup ready for your next pattern. Adjust the string to different heights to make different patterns.

5 Suggest that teams make a permanent record of one sand pattern by spreading glue over the coloured paper before setting the pendulum in motion.

6 Discuss the questions in the student book:

- 1 Did your team work well together?
- 2 How could you improve your team skills and job skills?

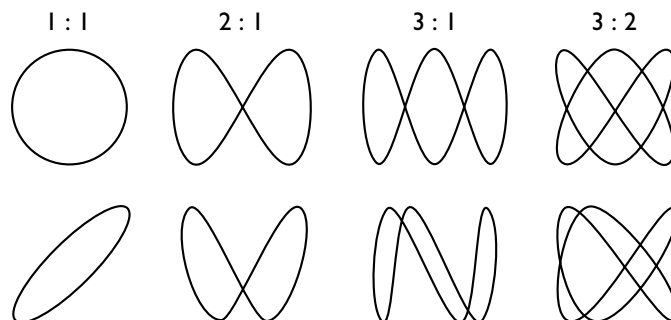


## Background information

The time taken for a pendulum to make a complete swing backwards and forwards is called its period. This period depends on the length of the string—a longer pendulum swings more slowly than a short one.

The sand pendulum can swing independently in two directions at right angles, because of the movements of the vertical string and the oblique strings, and the two movements will have different periods. If these periods are in a simple ratio such as 2:1 or 3:2, a simple pattern is formed. To achieve these simple ratios, the lengths of the strings need to be equal to the squares of the ratios (ie,  $H_1$  to  $H_2$  is 4:1 or 9:4, respectively).

The ABC's logo is produced when the period in one direction is three times that of the period in the other direction, so the ratio is



3:1. This means that there are three swings in one direction for every one swing in the other direction. This shows up in the pattern, which has three bumps along one side and only one on the other.

These simple patterns are called Lissajous figures after the French scientist, Jules Lissajous (1822-80), who first studied them.



## Extensions

**M**ake a very large sand pendulum, using a plastic bucket full of sand suspended by as long a wire as possible (such as from the ceiling of the school hall). Set the pendulum swinging in a straight line.

Observe the pattern after 2 or 3 hours. The decrease in size of the pattern is due to the loss of energy and consequent shortening of the length of swing, while the rotation is due to the interaction between the rotation of the earth and the swing of the pendulum. Such a pendulum is called a Foucault pendulum, after the French scientist Jean Foucault who demonstrated the effect in 1851.

The plane in which the pendulum swings rotates slowly because of the rotation of the earth. If the pendulum were at the North or South Pole, its true plane of swing would remain constant while the earth rotated beneath it, giving an apparent rotation of the plane of swing once each day. At the equator, the true plane of swing rotates with the earth so that the apparent rotation rate of the swing is zero. In southern Australia the plane will take between  $1\frac{1}{2}$  and 2 days to rotate through a full circle, while in northern Australia a rotation will take 2 to 4 days.

**S**tudents use library resources to investigate the work and life of Galileo, who first studied the pendulum scientifically. 🌀