

# Lesson 4

Reasoning pattern: **Variables**

## The 'fair' test

### OVERVIEW

This investigation involves looking for relationships (and non-relationships) between three input variables and one outcome variable. Pupils are asked to find out what affects the note produced by a pipe, length, width or material? This is not a lesson about what affects pitch so do not be concerned if pupils do not draw the correct conclusion that only length affects the note. Look for their method of 'proof'. The multiple values of each variable provide pupils with a lot of choice. To be logical about selecting pipes to test, they must develop a systematic approach. Very little guidance is given to pupils so that they have to construct a 'control of variable' strategy for themselves. For the first time in the sequence of lessons pupils encounter cognitive conflict at a high level. A series of fair test problems is provided for follow-up or homework. The problems are at a lower cognitive demand level than the lesson so are suitable for constructing a better understanding and consolidating pupils' ideas.

New key words: **fair test**

### EQUIPMENT REQUIRED

#### For whole class

Lengths of copper and plastic piping, of different widths, made into long, medium and short pipes and jumbled together in trays so that pupils will have to choose from a variety.

Do not give them to pupils in 'sets' but make sure that the tray contains at least three pipes of each combination of length, width and material.

*Combinations of variables for pipes*

- Materials: plastic or copper.
- Length: 'long', or 'medium', or 'short'.
- Width: 'wide' (may only be in plastic), or 'medium', or 'narrow'.

You can improvise with any lengths and widths. Large DIY stores sell 3-metre lengths of plastic plumbing pipes and copper central heating pipes. You can get two matching widths in both copper

and plastic (22 mm, medium and 15 mm narrow) but usually only the plastic pipes come in wide (32 mm waste pipe). You can add any 'off cuts' to the trays just to make the choices that the pupils make more demanding.

It is essential that all 'long' plastic and copper pipe lengths are the same, all 'medium' the same length and all 'short' the same length. Pupils are very fussy about measuring them so all 'same length' pipes of each material and width must be level with each other when held together.

The lengths we use are: long, 20 cm; medium, 10 cm; short, 5 cm.

#### Per group

- Notesheet.
- 'More thinking about...' pages.

**Safety note:** All pipes must be filed or abraded to a smooth finish around both open ends. Plastic can be sand papered, copper needs very fine grade wire wool or milling. Wear gloves when smoothing both materials.

### LESSON PLAN

- 1 Demonstrate tapping a pipe lightly on the palm of the hand to get notes. The investigation is to find out which variables affect the note produced. Give each group three or four pipes taken randomly from the tray, and allow them to experiment for a few minutes. (5 minutes)
- 2 Elicit variables and values involved: material (copper/plastic); length (long/medium/short); and width (wide/medium/narrow). There are three input variables and one outcome variable (note). This is the concrete preparation phase of the activity, establishing the parameters of the problem. The task is to find out which, if any, of these input variables affects the note. Give out the Notesheets and emphasise that they should try the pipes in pairs, comparing the note produced by each. Ask them to listen for big differences in the notes. They will hear differences due to tone, rather than pitch and

will find this a distraction. Suggest that they reach a consensus, if everyone does not agree that the notes are different in a group, record the notes as sounding the same. Make a rule that groups cannot have any more than two pipes to test at any one time, but they can keep returning and reselecting the pipes from the trays. Tell them they will have 10 minutes only to do the investigation. (5 minutes)

- 3 Before they begin, ask them to predict which variables they think will affect the note, give them 1 minute to talk about it in their groups. Take votes for length, width and material and write the numbers of pupils voting for each on the board. (5 minutes)
- 4 Go around the groups as they work, asking what conclusions can be drawn and whether a particular pair of pipes is useful to reach a conclusion. This is where you provide cognitive conflict: if a group shows you a pair of pipes of different length and diameter and claims that length makes a difference to the note, press them: 'is there anything else different apart from length? ... then how do you know it is length and not width that makes the difference? ... find me a pair that will really show the effect of length'. This can be a slow and challenging process for many pupils. Much of the construction work in this activity is done in small group discussions and explorations. (10 minutes)
- 5 After most groups have done three or four pairs, get the attention of the whole class and ask for some conclusions so far, pressing more able pupils for full justifications and leading less able pupils to see that pairs they have chosen don't really tell them much. (5 minutes)
- 6 Now they can go back and try a few more 'really good pairs' and complete their Notesheets. You circulate and prompt again. Able pupils can be asked to eliminate the effects of width and material with a series of 'good pairs', and less able to find any good pair that shows the effect of length. If they do this quickly, give them the 'More thinking about' page to work on. (5 minutes)
- 7 In a final whole-class discussion get pupils to reflect on what they have been doing (metacognition) and to try to put into words what counts as a good or fair test. For now, any formulation about keeping all variables the same except the one you are investigating will do nicely. (10 minutes)

- 8 If time, give out the 'More thinking about...' pages, and while pupils work on them individually, go around and discuss difficulties as they arise. If your pupils do homework, they could take these pages home.

### **ANSWERS to 'More thinking about...' pages**

- 1 For example: one pipe fat, long, glass and the other narrow, long, glass (length and material the same, width different). There would be no difference in the notes.
- 2 A short one. Width and material are irrelevant.
- 3 Any design that includes closed end/open end as the only difference in a comparison between pipes of the same length (same material and width may be specified also).
- 4 The short ones give the highest notes.  
No, because width does not make a difference to the note (although it might make a difference to the loudness that can be achieved).
- 5 No, because the boy and girl did not start at the same place.
- 6 Yes is an acceptable answer, because other variables are not mentioned and implicitly are controlled.
- 7 Yes, this is a good test; other variables such as type of shoe leather are controlled by cleaning left and right shoes from the same pair with different polish.
- 8 No, because he should have used the same heat underneath each.
- 9 No, all should drop on the same surface.
- 10 Yes, as far as we can tell from the picture, variables such as density of application and equivalence of plots are controlled.
- 11 Fair enough, provided he walks on the same surfaces at the same speed, but what a silly way to test for bag strength! (You might ask pupils to design a better test.)

# Notesheet Lesson 4

## Variables

Names .....

### The 'fair' test

- ✓ Look at the selection of pipes.

What are the variables you can see?

What are the values for each of these variables?

- ✓ Gently tap a pipe on your hand, tap another that looks different.

Do they sound the same?

Which are the input variables and which is the outcome variable?

### Investigation into what affects the note

- ✓ Compare the notes you get when you test two pipes at a time. You choose the **input** variables and record the **outcome**.
- ✓ Listen for **big** differences in the notes, not small ones.
- ✓ Record your results in this table:

Pipes	Materials Copper, plastic	Length Short, medium, long	Width Narrow, medium, wide	Outcome Which pipe makes the highest note or are they both the same?
1st pair A B				
2nd pair A B				
3rd pair A B				
4th pair A B				

- ✓ Think about each input variable in turn and decide how it affects the note.

Is there a pair of pipes that tells you how length affects the note? Which pair?

Is there a pair of pipes that tells you how width affects the note? Which pair?

Is there a pair of pipes that tells you how material affects the note? Which pair?

So what do you think affects the note a pipe gives?

- ✓ If you are not sure, try some more pairs of pipes and record them in a table like the one you have already used.

More thinking about... **Lesson 4****Variables****The 'fair' test****High notes, low notes**

You have just done some experiments to find out which variables affect the note you get when you tap a pipe on your hand. Now answer these questions.

- 1 Janice says that fat pipes make lower notes than thin pipes. Describe (material, length, and width) just two pipes that you would choose to demonstrate to Janice that she was wrong (or right).

What result would you expect?

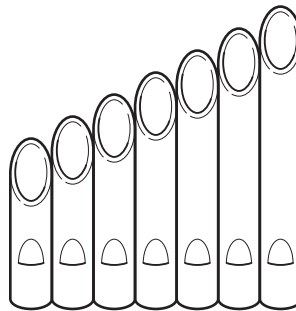
- 2 If you wanted a pipe that would give a very high note, what sort of pipe would you choose?
- 3 Describe a test or tests you would carry out to investigate the effect of closing one end of the pipe.

- 4 Here are some of the pipes of an organ in a concert hall.

Which pipes give the high notes?

Do all the pipes have to be the same width?

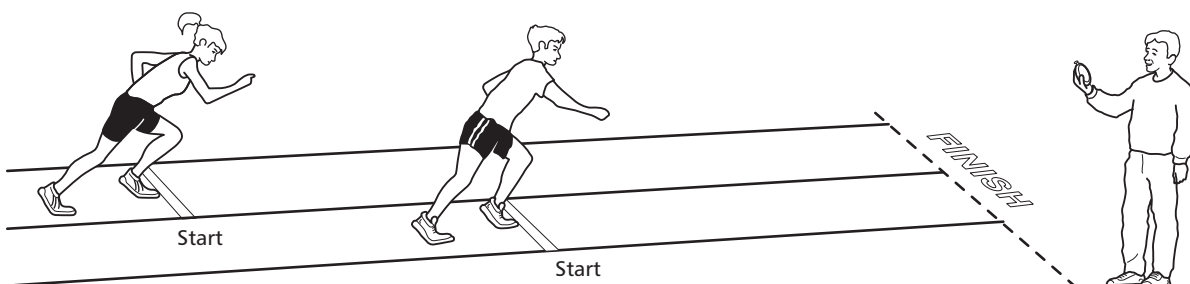
Give a reason for your answer.

**Some 'fair' tests?**

- 5 During a school sports afternoon it was decided to see if boys ran faster than girls. John and Jane were timed during this race; they both started to run at the same time.

Was this a fair race?

If not, why not?

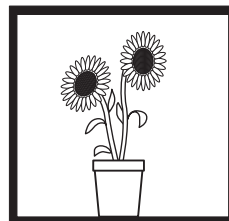


## More thinking about... 2 • Lesson 4

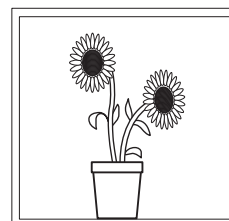
- 6 Sohail wanted to see if sunflowers grew better in the dark or the light. He started to grow two lots of flowers, one in a dark box and one in a light box.

Was this a fair test?

If not, why not?

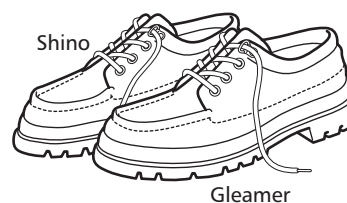
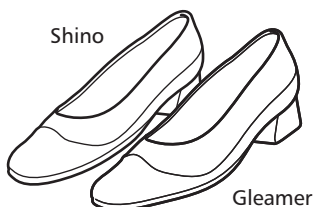


black box



glass box

- 7 Mrs Scott wanted to see if Shino was a better polish than Gleamer so she cleaned everyone's shoes in class like this.



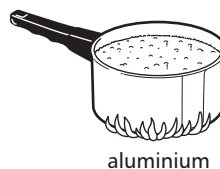
Was this a fair test?

If not, why not?

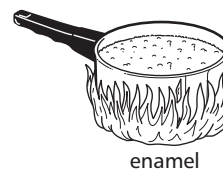
- 8 When Jack wanted to see if aluminium pans cooked food faster than enamel pans he did this.

Was this a fair test?

If not, why not?

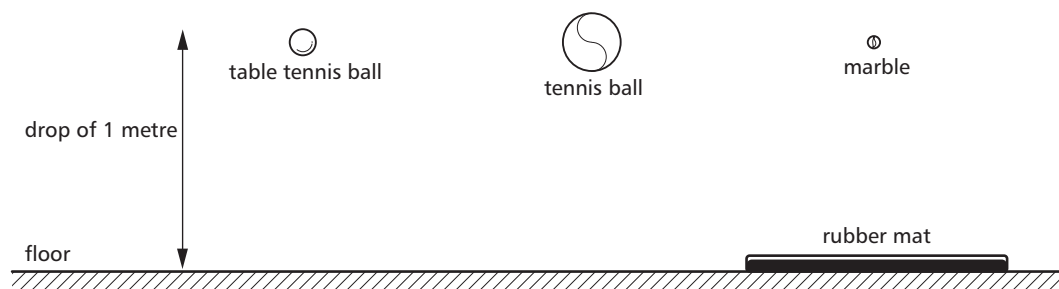


aluminium



enamel

- 9 Sarah wanted to see which object bounced highest so she set up an experiment like this.

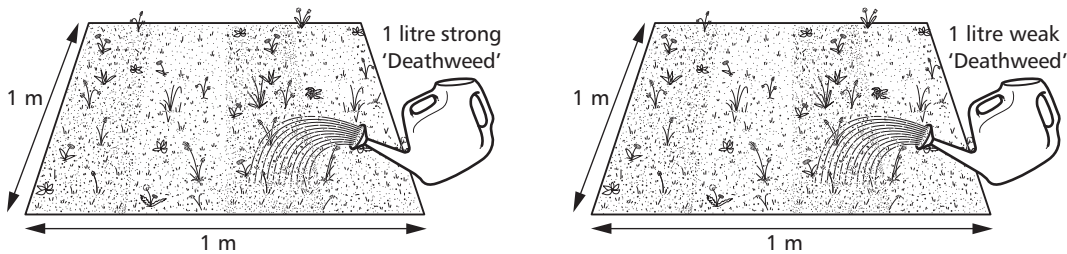


Was this a fair test?

If not, why not?

## More thinking about... 3 • Lesson 4

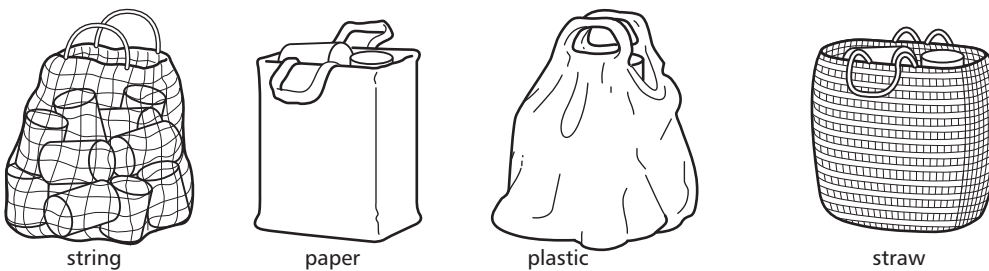
- 10 Miss O'Brien watered two patches of lawn with a weedkiller 'Deathweed', to compare its weedkilling powers at two different strengths.



Has she made a fair test?

If not, why not?

- 11 Tariq wanted to see which type of material makes the strongest shopping bag so he carried around ten tins of dog food in each of these bags and timed how long it took for each one to break.



Was this a fair test?

If not, why not?