

## Tricky tracks: observation and inference in science

This resource accompanies the article **Show students how to grasp the scientific process** in *Education in Chemistry* where you will find more ideas and tips:

[rsc.li/3lpMQ3g](https://rsc.li/3lpMQ3g)

It was originally published in *Nature of Science* alongside two other activities to introduce the scientific process which can be found at: [rsc.li/3JyVKTQ](https://rsc.li/3JyVKTQ)

### Learning objectives

- 1 Distinguish between observation and inference.
- 2 Recognise that scientific theories develop over time when new evidence becomes available.

### Introduction

When drawing a conclusion, scientists need to take care that it is consistent with the evidence.

As part of this learners need to know the difference between an observation and an inference. This activity assumes the following definitions:

- An observation is what is actually seen.
- An inference is interpreting what is seen.

Sometimes new ideas or evidence come along which do not fit existing scientific theories. Then, more experiments have to be carried out to see if the new idea is correct.

### How to use the resource

This activity will fit into a scheme of work for learners aged 11–14 anywhere where experimental observations are made. It can be used before a class practical which requires careful observation, followed by interpretation. For example, the reaction of metals and acids [rsc.li/3JphFwI](https://rsc.li/3JphFwI), or reactions of carbon dioxide, see [rsc.li/3Fp7FTe](https://rsc.li/3Fp7FTe).

This activity could be carried out as a whole class exercise. Learners may record their answers working individually using the student worksheet or in groups of three to four. The subsequent discussion is key to learners developing the understanding.

### Timing

50–60 minutes. Approximately half the time should be used for learners to answer the questions and the rest of the time discussing the answers.

### Lesson plan

1. Introduce the activity in context (slide 5) and show Tricky tracks 1 to the class (slide 6). Give the class 5–10 minutes to answer question 1, individually or in small groups.
2. Show Tricky tracks 2 (slide 7) and Tricky tracks 3 (slide 8) and give learners ~10 minutes to answer the questions.
3. Feedback to the whole class some answers to question 1, by asking different learners to read out their accounts. Try and get as many different explanations as you can. It is important to accept all explanations equally.
4. Go through questions 2–4 using the answers below as a guide and pointing out the difference between observation and inference.
5. Return to Tricky tracks 1 and ask learners to answer question 5 (slide 10) focussing on observation only.
6. Finally, link this exercise to science in the real world, saying that scientists often make similar inferences as they try to interpret their observations. There may be several equally valid theories until new evidence comes along to change it. Follow up with questions 6 and 7 (slide 11).

### Differentiation

To provide additional support for learners you could come back together as a whole class group to answer the more demanding questions, such as 3 and 7.

### Answers

1. All answers to question 1 should be accepted. Possible answers to question 1 could include:
  - (a) Two animals or birds were out hunting in the forest. On meeting each other at the clearing, they had a fight.
  - (b) Two animals or birds had a fight in the forest and then went off home to different places.
  - (c) The tracks lead down to the place where birds meet before going for a swim. During the day many different birds will come and go, that is why you can see so many tracks. The big birds and little birds live in different places and that is why the big tracks go off in a different direction to the small tracks. Usually, the small birds and the large birds go to the ponds at different times because the little birds try to avoid the big birds, which often chase them.
  - (d) One day a large male dinosaur was out looking for food. As he was searching a small area he noticed a beautiful female dinosaur coming towards him. It was love at first sight. Being a little shy, he hid behind a rock and when she got closer he jumped out and introduced himself. At first she was afraid, she thought that he was going to attack her and she tried to escape. But when he spoke and told her not to be afraid, they sat down on the rock and had a good chat.
2. In Tricky tracks 2 we see two sets of marks. The marks on the track towards the top of the page are bigger than on the bottom of the page. Each big mark has three points coming out of a small black blob. The marks form a diagonal line.

Each mark is pointing in the same direction.

The marks on the right-hand side of the page have three points coming out of an elongated blob. There are two rows of marks going along the side of the page.

There are 14 big marks and 34 small marks.

Only accept answers that describe what is actually seen on the page.

**Do not accept any answers that try to interpret what the marks are.**

A typical learner answer might be:

'I can see two sets of bird tracks on the page. One bird is bigger than the other bird.'

**Challenge the learner:** How do you know they are bird tracks? Could the tracks belong to anything else?

**Explanation:** You should now explain that an observation is what you see on the page, not what you think you see on the page.

The typical learner answer given above, had been interpreted using some other knowledge. The learner reasoning could be as follows:

'From previous knowledge, I know that these marks resemble birds' tracks. I know that big birds have bigger feet than small birds, therefore I have used bird tracks in my answer.'

Remind the class of the question, 'what do you **observe** in Tricky tracks 2?'

3. This is really a trick question. We do not know that the tracks have been made by animals and we do not know that they are going in the same direction. It should be pointed out that this question has been built on two assumptions. Often in science, we have to be careful about the questions we ask.
4. These should be treated in the same manner as question 2. You may wish to give the class time to change the answer to their questions, in the light of the answer to question 2.
5. Refer to the answer to question 2 above.
6. Based on the current evidence, we can never know what has really happened. We can only imagine what has happened. Therefore, at each stage all the theories put forward in question 1 are equally valid.
7. To find out more about the situation we could try to identify the tracks using a key. Once the tracks were identified, more could be found out about the behaviour of the animals, which may offer support to some theories and not to others.