

# Reaction mechanisms

## Target level

This probe is intended for students on post-16 courses.

## Topic

Reaction mechanisms

## Rationale

The comprehension of, and use of, reaction mechanisms requires students to not only appreciate the electrical changes which are conjectured to accompany chemical reactions, but also to learn a new formalism where the movement of electrons or electron pairs is represented by full or half arrows ('curly arrows' and 'fish-hooks') which may start and end on either atoms or bonds.

These ideas are discussed in Chapter 9 of the Teachers' notes.

During piloting, it was found that the probe was 'very worthwhile', 'useful for revision' and a 'good way to check understanding of principles'. It was reported that the probe discriminated well between students with a good understanding and weaker candidates. Students generally found it easier to select the correct response than to explain why it was correct (this was considered to demonstrate rote learning without deep understanding). The range of alternative answers was considered to be useful, as it allows valuable discussion of why each wrong answer was not correct.

## Instructions

Some teachers may wish to use only one of the question sheets depending upon the examination specification being followed.

It may be worth emphasising to the students that the first step is shown in the centre, and they must select one answer from the surrounding options.

## Resources

- Student worksheets
- Reaction mechanisms – instruction sheet for students
- Reaction mechanism 1 – question based on an ionic mechanism
- Reaction mechanism 2 – question based on a free radical mechanism
- Reaction mechanisms revealed – answers sheet

## Feedback for students

An answer sheet, **Reaction mechanisms revealed**, that teachers may wish to issue to students during, or following, discussion of the answers, is provided.

A web site containing tutorials to support the ideas introduced here can be found at <http://www.abdn.ac.uk/curly-arrows/> (accessed October 2001).

## Reaction mechanisms

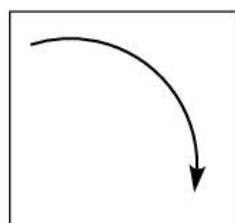
Chemists use reaction mechanisms to show what they think might be happening as molecules interact during chemical reactions.

When drawing reaction mechanisms the chemist usually assumes:

1. that the reaction occurs in several distinct steps;
2. that each step can be represented as the movement of electrons; and
3. that sometimes electrons move as pairs, and sometimes they move individually.

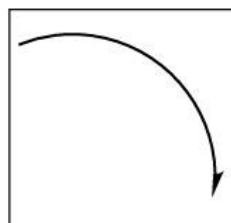
Diagrams showing the steps in reaction mechanisms usually show the molecules and/or ions (shown by + and -) and/or radicals (shown by •) involved, as well as arrows showing the movement of electrons.

Two types of arrows are used:



**curly arrow**

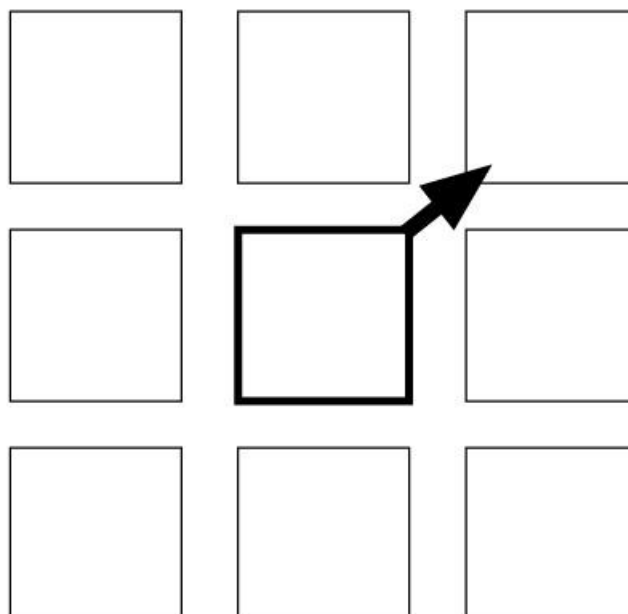
an arrow with a full head (a 'curly arrow') represents a pair of electrons moving



**fish-hook arrow**

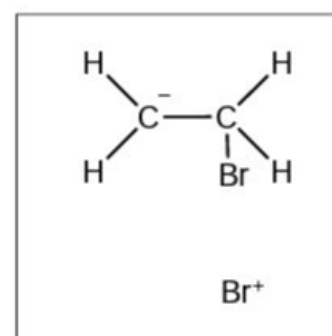
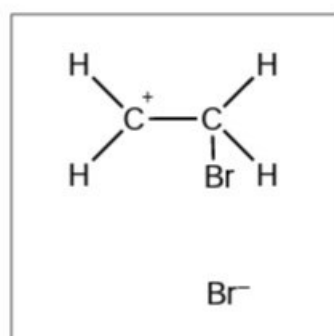
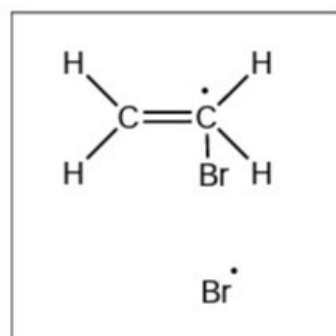
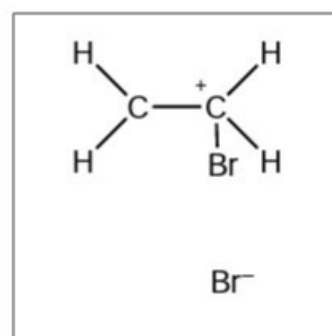
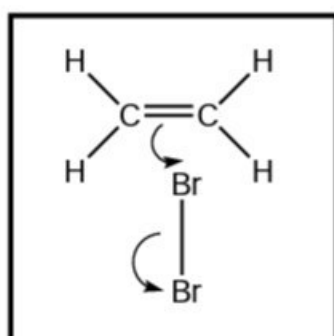
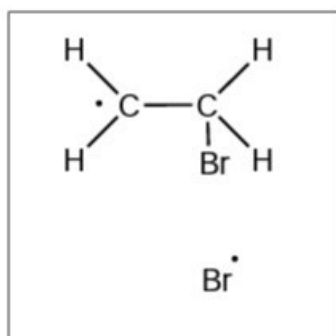
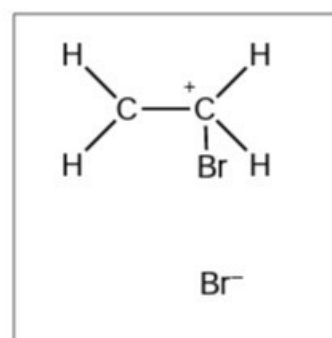
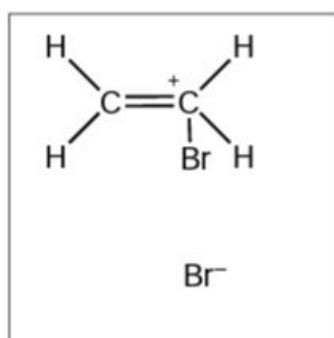
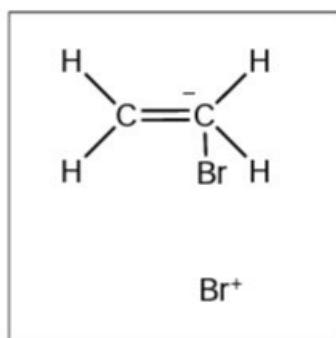
an arrow with a half arrow-head (a 'fish-hook') represents the movement of a single electron

There are two questions in this exercise. The questions each consist of a central diagram showing the initial stage in a reaction mechanism, surrounded by a selection of suggestions for the result of that step. Your task in each case is to identify which of the diagrams gives the correct outcome of that reaction step. Draw a large arrow showing which diagram is correct, as in the example below.



Try and explain your reason(s) for selecting the diagram you chose.

## Reaction mechanism 1



I selected this diagram because:

---

---

---

---

---

---

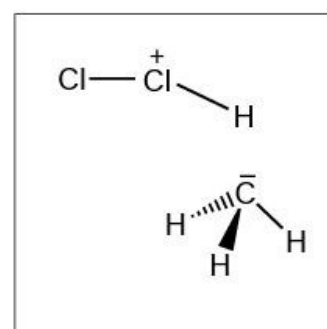
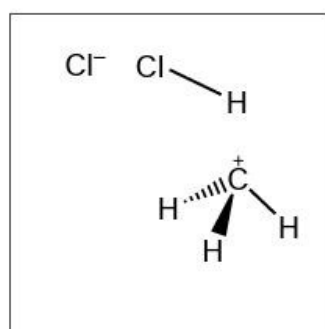
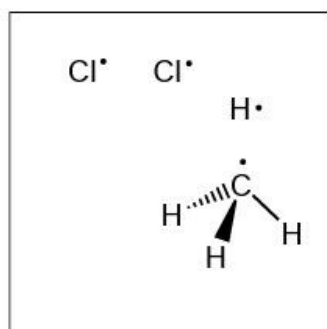
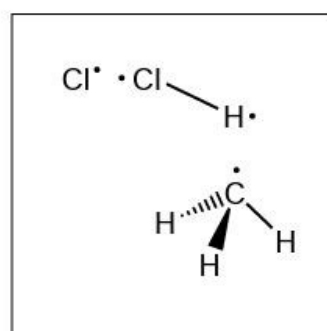
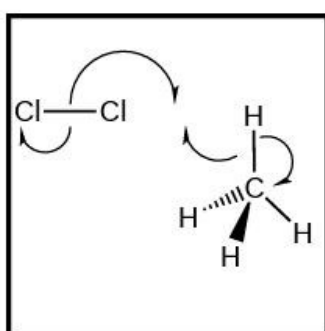
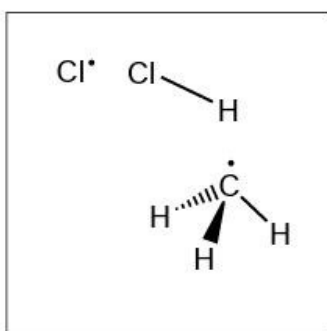
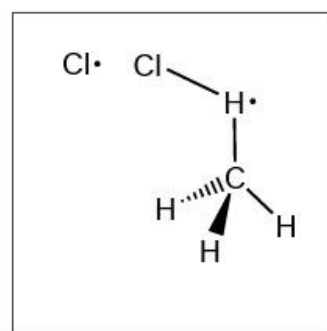
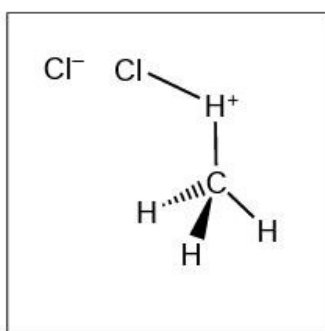
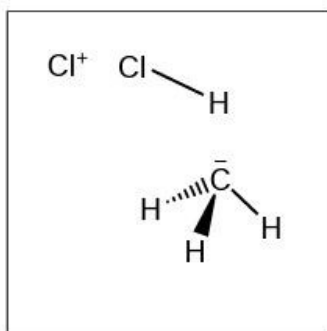
---

---

---

---

## Reaction mechanism 2



I selected this diagram because:

---

---

---

---

---

---

---

---

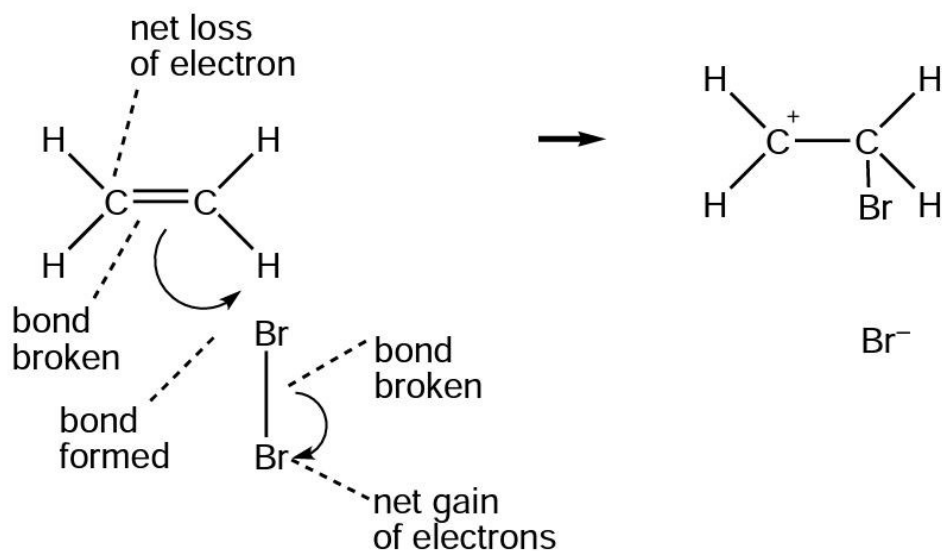
---

---

## Reaction mechanisms revealed

### Reaction mechanism 1

The diagrams below show and explain the correct answer to the question about the ionic reaction mechanism.



### Reaction mechanism 2

The diagrams below show and explain the correct answer to the question about the free radical mechanism.

