

## 40 What molecules are found in outer space? Could there be life out there?

14-16

G S P Q F T

In this activity, photographic images, discussion and a team exercise introduce students to the concept of molecules in space, leading to discussion of the possibility of life existing elsewhere in the Universe.

### Learning objectives

Students will be able to explain that:

- new substances are formed when atoms combine
- substances with covalent bonds may form simple molecular structures
- the rates of many reactions depend on the frequency and energy of collisions between particles.

### Sequence of activities

- Use images of the Orion nebula to introduce the learning objectives.  
*This is most dramatic in a darkened room, using an overhead projector or interactive whiteboard.*  
Ask students what they think the coloured parts of the pictures represent.
- Give each student the worksheet *Seeing space*.  
Have available copies of the related reference sheet.  
Ask the students to complete the observation table while looking at the pictures.
- Organise students into pairs and ask them to:
  - agree answers with their partner
  - complete the questions.*Allow about 10 minutes to complete the questions.*
- In a plenary, review answers to the questions.  
Introduce the next task, to find out more about the 'black dust', or the Interstellar Medium (ISM).
- Show the series of pictures of the Milky Way.  
*They can be shown either to the whole class using an OHP or IWB or by giving copies to each pair. The pictures show the ISM and the presence of atomic hydrogen, molecular hydrogen and complex molecules in the dust.*  
In their pairs ask the students to:
  - agree answers with their partner
  - complete the questions about each picture.*Allow about 10 minutes to complete the questions.*
- In a plenary:
  - invite students to share their answers to the questions
  - draw out the fact that the areas illuminated in pictures 2, 3 and 4 are in the black dust – this shows there is something there!
  - discuss the presence of hydrogen molecules and how these form, revising covalent bond formation.



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- Introduce the next task, to analyse the complex molecules in the ISM and to produce a presentation that answers the question, *Molecules in the ISM: Are these clues to life in space?*  
Give each student a copy of *Molecules in the ISM: Are these clues to life in space?*  
Circulate and support as:
  - pairs join into groups of four
  - each group member takes one of four roles as an astrochemist
    - *Element analysis*
    - *Molecular modelling*
    - *Practical techniques*
    - *Making conclusions*
  - students read the requirements for their role
  - groups work as a team to answer the question
  - they collect material and discuss their findings with each other
  - groups prepare a presentation.

Provide additional resources and reference material.

Allow at least 60 minutes for students to collate material and work on their presentations.

*This may involve work outside the lesson time.*

*The group work could be arranged as a 'jigsaw'. The group members go into "Expert" groups (for each of the four roles), for a short while, to develop their specialism. They then return to their original group to agree the presentation.*
- In a plenary:
  - ask students to devise criteria for peer assessment of presentations
  - invite each team of astrochemists to present their findings
  - encourage other teams to ask questions to clarify ideas or raise issues
  - use the devised criteria to assess contributions.
- Collect individual students' work. Provide written feedback based on the quality of the work, looking for the extent to which students have understood the learning objectives.

### Assessment for learning commentary

The notion of life existing elsewhere in the Universe is an attractive setting in which to draw out students' understanding of covalent bond formation.

By working in pairs, in the initial stages of the activity, students build their confidence in sharing (and evaluating) ideas. During the process of devising their presentation, students have to justify ideas, a process that is a strong stimulus for learning. Knowing that the presentations will be assessed openly by their peers is another potent stimulus for students to be clear and factually accurate in answering the questions.

Written feedback is a means to give credence to the class assessments and to support individuals.

For each group

- Access to the Internet and other resources for research
- Molecular model kit, eg *Molymod*®, with long grey links for triple bonds
- Presentation materials, eg OHTs, pens, display paper, access to IWB.



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