

Molecules workshop: “building matter”

Secondary: (ages 11 – 14)

Science (physics and chemistry)

Through the building of models of molecules, this activity develops students’ abstraction capacity, spatial vision, and knowledge of the formation of molecules from elements. Once molecules have been studied and drawn in class, students undertake this workshop that aims to foster their creative and critical thought. The aim is to imagine and build molecular structures of compounds in 3D. Students work with toothpicks and modelling clay, although balloons, cork balls and other materials may also be used. This activity provides insight into chemical reactions because the molecules (reagents) can be broken down and re-combined to form new molecules (products).

Time allocation 4 lesson periods

Subject content Identify molecules of compounds used in everyday life
Understand how atoms bond to form more complex structures
Simple molecular geometries (trigonal, angular, tetrahedral)

Creativity and critical thinking This unit has a **creativity** and **critical thinking** focus:

- Produce a meaningful model that is personally novel
- Appraise models of molecules and reflect on steps taken

Other skills Collaboration, Communication, Persistence/Perseverance

Key words molecules; models; elements; atoms; compounds; bonds; trigonal, angular, tetrahedral; structures

Products and processes to assess

Students come up ways to build, present, and display a number of different molecules. At the highest levels of achievement, they are actively engaged in discussions/team-work, demonstrate evidence of considering several ways of approaching the task, are open to the ideas and feedback of others, come up with unusual and/or personally novel solutions to problems encountered, and thoughtfully appraise the models of molecules made by themselves/others

Teaching and Learning plan

This plan suggests potential steps for implementing the activity. Teachers can introduce as many modifications as they see fit to adapt the activity to their teaching context.

Step	Duration	Teacher and student roles	Subject content	Creativity and critical thinking
1	First session	Teams of 4 or 5 students are formed. Whenever possible, students are allowed to form their own teams, although the aim is to avoid the groups being overly heterogeneous and to ensure a good mix of levels within teams.	Planning how to build molecules and distributing the work across the team	
		Each team is asked to bring modelling clay (e.g. plasticine) and toothpicks to the workshop, along with newspaper to cover the tables. The teacher hands out images of various models of molecules that have been explained in class beforehand and drawn in the notebook. Teacher then explains students need to build models of molecules using modelling clay and toothpicks.	Using existing knowledge of molecules to plan and build a model	Coming up with personally novel ideas and solutions to plan models and address complications that arise in the process
		The teacher encourages the students to foster a healthy competitive atmosphere between the teams to nurture the production of different, creative ideas among the groups.		
		The teacher explains that once they have built their structure, each team will need to name each molecule and specify the symbols of the elements that comprise it. To do so, they may use skewers made from toothpicks, signs made from card or paper and fasten them using pins, or come up with any other creative proposals in their teams. Each team should perform research and decide what model they will use in their construction, and whether they will leave toothpicks in view or cover them with modelling clay.	Naming and labelling molecules	Proposing how to create labels for their molecule/s
		The students begin to work on the molecules. If necessary, they can engage in an independent search for any additional information they need in order to develop their knowledge of the structure of particular molecules. They decide what colours of modelling clay to use and what shape the signs need to be. Students are now ready to begin working on their 3D molecular structures in the next session.	Developing knowledge of the structures of molecules	Analysing and addressing gaps in physics or chemistry knowledge Envisioning and producing a scientifically meaningful output
2	Second session	The students build 3 or 4 more molecules.	Developing knowledge of structures of different molecules	Imagining and creating model molecules
		Once they have finished, each team puts forward ideas in order to label the molecules with their names and affix the signs. They subsequently discuss the way they wish to present their work to the class. If they need additional materials, they are responsible for bringing them to the next session.	Deciding on how to present their molecules to class	Justifying their opinions on how

					best to present their molecules
3	Third session	<p>The students bring the materials needed in order to set up the completed structures with their names.</p> <p>Each team proceeds to set up the molecules for the presentation.</p> <p>All the teams finalise their work. The teacher enters into a discussion with the students about where and how to present their structures (classroom, school corridor, laboratory, etc.) and may decide to challenge them to find a really unusual, interesting, and eye-catching way of presenting their models.</p>	Planning molecules	presentations of	<p>Reflecting on how and where to present their structures</p> <p>Coming up with personally novel ideas about how to make an eye-catching and different display</p>
4	Fourth session	<p>Each team's work is brought together. The students show their finished products to the remaining classmates and the teacher facilitates a comparative discussion of the models and what they allow us to see about molecules.</p> <p>One possible way of closing the activity is that the teacher could facilitate a discussion or ask for written work on the strengths and weaknesses of the models, the materials used, and the labelling systems and what students learned in the process of creating their molecules.</p>	Presenting molecules to the rest of the class	and explaining their	<p>Considering different perspectives on a problem</p> <p>Appraising products based on scientific and other criteria.</p> <p>Reflecting on the steps taken to solve the problem of representing molecules in 3D.</p>

Resources and examples for inspiration

Web and print

- Images of molecules
- <https://descubrirquimica.wordpress.com> (Spanish language site)
- <http://www.cienciaonline.com>

Other

- Modelling clay (e.g. plasticine), toothpicks, newspaper, straws (optional), paper or cardboard, additional materials (to be chosen by the team).

**Creativity and
critical thinking rubric**

- Mapping of the different steps of the lesson plan against the OECD rubric to identify the creative and/or critical thinking skills the different parts of the lesson aim to develop

	CREATIVITY Coming up with new ideas and solutions	Steps	CRITICAL THINKING Questioning and evaluating ideas and solutions	Steps
INQUIRING	Make connections to other scientific concepts or conceptual ideas in other disciplines	1	Identify and question assumptions and generally accepted ideas of a scientific explanation or approach to a problem	
IMAGINING	Generate and play with unusual and radical ideas when approaching or solving a scientific problem	1,2,3	Consider several perspectives on a scientific problem	4
DOING	Pose and propose how to solve a scientific problem in a personally novel way	1,2	Explain both strengths and limitations of a scientific solution based on logical and possibly other criteria (practical, ethical, etc.)	1,2,4
REFLECTING	Reflect on steps taken to pose and solve a scientific problem	3,4	Reflect on the chosen scientific approach or solution relative to possible alternatives	4