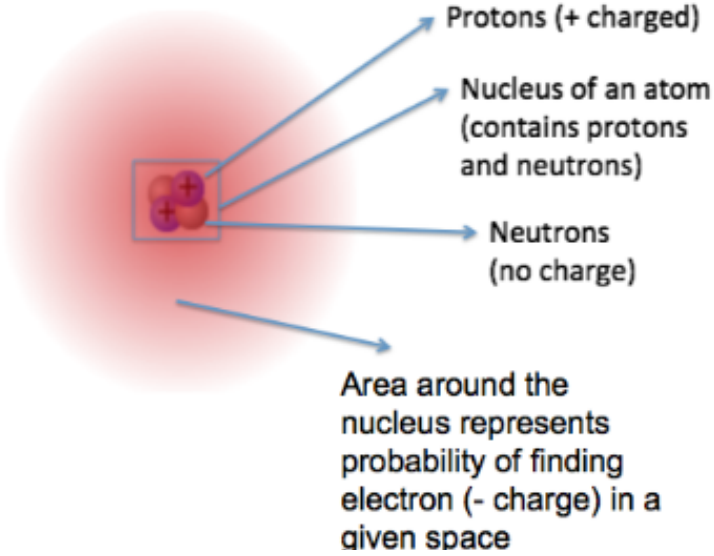
Activity 3.2: What holds the atoms of a molecule together?

In the previous investigations, you explored the idea that matter is made up of positive and negative particles that can attract or repel each other depending on whether their charges are alike or opposite. Could this electric nature of matter help to explain what connects the atoms of a molecule?

Review Atomic Model



Recall the model of an atom you saw in Unit 1. You concluded that an atom has both positive and negative charges arranged as shown in the model depicted in Figure 1 below. Depending on the identity of the atoms, their nuclei can have different number of protons and neutrons. For example, the model below shows a helium atom that has two protons and two neutrons.

Figure 1. Probabilistic model of an atom.

Review the model and answer the following questions.

Question #1

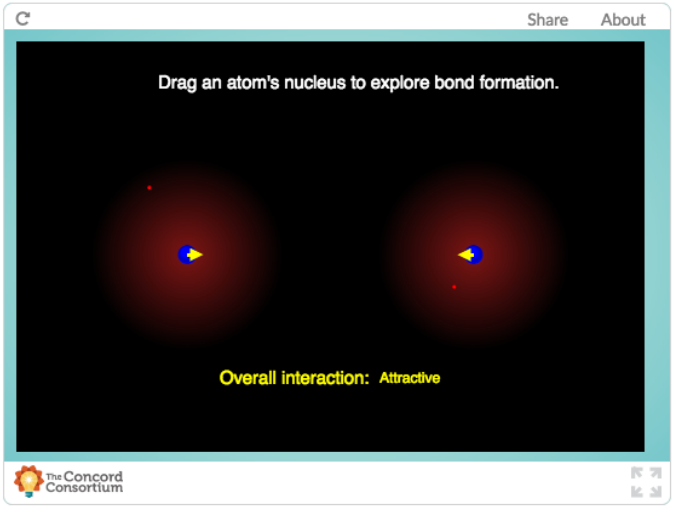
Using the model of an atom shown in Figure 1, describe the types of forces involved in holding the atom together.

Question #2

Predict how two atoms will interact as they come close to each other. Support your prediction based on the model of the atom in figure one.

What holds oxygen atoms together when they form an oxygen molecule?

You saw that electrons can be represented by a **probability map**, which shows where electrons are likely to be found. Based on the model of the interaction between the rod and balloons that your teacher just demonstrated, you made some predictions about how electrons and atoms might interact with each other. You will continue to explore what happens to electrons when two atoms approach each other.



https://lab.concord.org/embeddable-dev.html#interactives/interactions/forming- molecule.json

Explore the simulation by dragging the atoms closer to each other or farther apart. Notice how the distance between the two atoms influences the force between the atoms and the electron probability map of each atom.

Question #3

Starting with the simulation in it's initial state, move the atoms closer together, and draw a snapshot of what it looks like when interactions are balanced.

Question #4

What causes the electron density to change as the two atoms get closer together?

Question #5

Move the atoms closer together than the point where the interactions are balanced.

How do the interactions between the two atoms change when the atoms get closer than the balanced point?

Question #6

What causes the interactions between the atoms to change when they move closer together than the balanced position?

Question #7

Draw a model to compare the interactions between two atoms when the overall force between the two atoms are: attractive, balanced, and repulsive.

Question #8

Using the simulation, explain how attractive and repulsive interactions between atoms contribute to holding the two atoms together and ensure that the two atoms stay together and not drift apart.

Question #9

Using the simulation, explain how the electron density shift resulting from changing relative position of the atoms contributes to holding the two atoms together.

Question #10

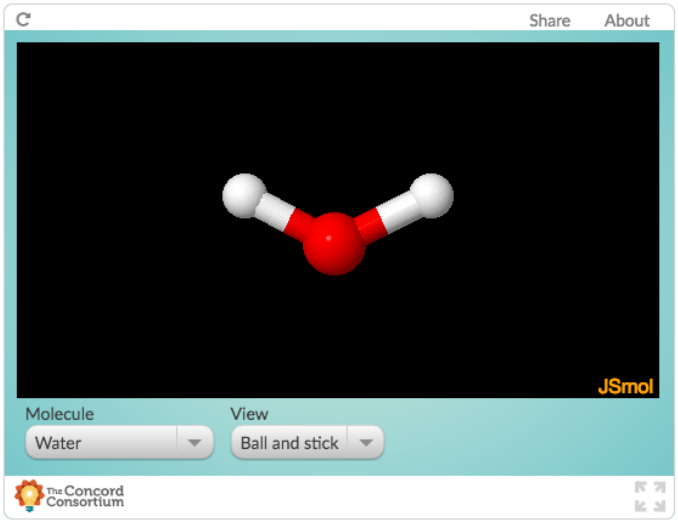
Now you will apply what you've learned from the simulation to develop a model that explains how oxygen atoms form an oxygen molecule.

Using your understanding of atomic structure and forces, explain what is happening when an oxygen molecule is formed from two separate oxygen atoms. Make sure to explain the following:

- the cause of the forces between the atoms
- the effect of the distance on the forces between the atoms
- what holds the molecule together

How do scientists represent atoms that are bonded together?

Think back to the discussion from the beginning of this activity about different ways that molecules can be represented. In the next simulation, you will explore two different types of models that scientists use to represent how the atoms are connected to each other in molecules.



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https://lab.concord.org/embeddable.html#interactives/jsmol/exploring-views.json

Question #11

How are the two types of representations (ball-and- stick and space-filling) similar? **Tip**: *Click and drag on the molecule to view it in 3D.*

Question #12

How are the two types of representations (ball-and- stick and space-filling) different?

Homework: Reading for Activity 3.2 Same Molecules but Different Representations