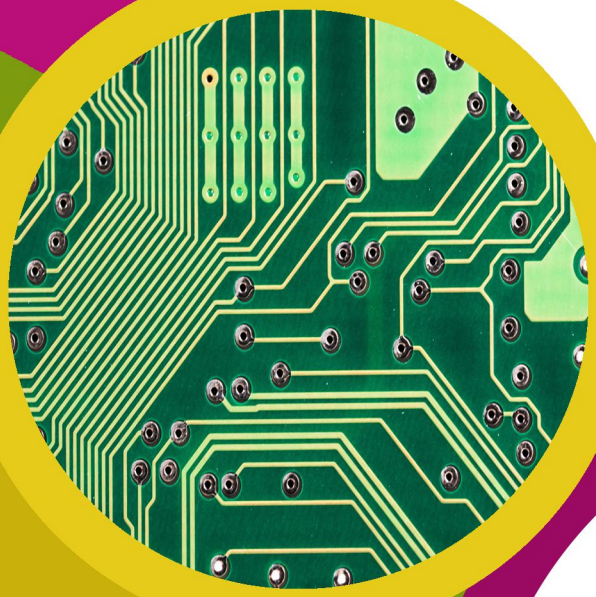
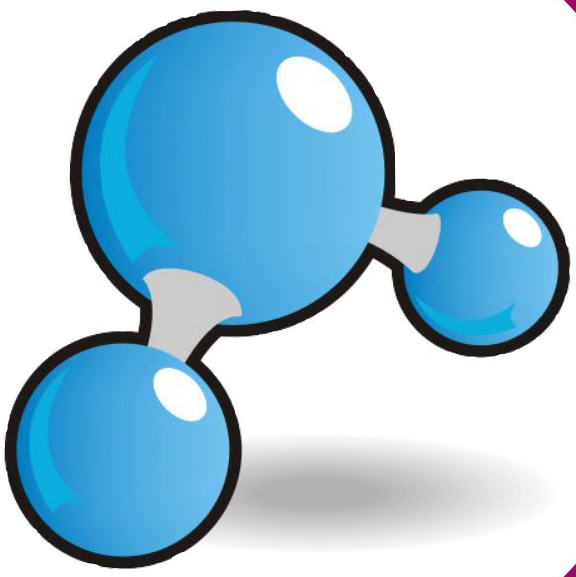
technocamps

Modelling Molecules Session Plan





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Workshop Schedule

Introduction - 10 minutes

Atoms and States of Matter - 30 minutes

Boiling and Melting Points, Movement - 30 minutes

How Do Atoms Move -20 minutes

Scratch - States of Matter— 1 hour 20 minutes

Atoms, Molecules and Compounds - 20 minutes

Displacement Reactions - 30 minutes

Scratch - Displacement Reactions - 1 hour

Conclusion - 10 minutes

Post-Day Questionnaires - 10 minutes

Note: These are estimated times, these will vary between classes, schools etc. so times will need to be adjusted accordingly.

Total: 5 hours

Preparation

1. Print out workbooks, one for each student.
2. Access to the scratch.mit.edu website will be necessary.

Learning Outcomes

1. Improved understanding of science concepts such as states of matter and chemical reactions.
2. Improved problem-solving abilities.
3. Improved programming skills in Scratch.

Attendee Prerequisites

1. Basic experience of programming in Scratch.

Session Plan Key

In this session plan we use the following colours to differentiate the types of activities:

- **Yellow - Explain.** Teachers should explain the slide/example to the class.
- **Green - Discuss.** Teachers should start an open discussion with the class to get them to feedback some answers/ideas.
- **Purple - Activity.** Students are expected to complete an activity whether it be in their workbooks or on the computer, followed by a discussion of their solutions.
- **Green - Introduction/Conclusion.** The introduction/conclusion is also colour coded green. Teachers should hand out materials in the introduction and conclude the day and collect materials at the end.

Introduction

Begin with introductions, and a brief explanation of the Technocamps programme, before handing out pre-day questionnaires to be filled out by the students and teacher.

Activity: What Is Modelling?

Ask students to write their own definition and description of modelling in the context of Computer Science in their workbooks.

Explain: Modelling

Ask students to provide their definitions before showing them the given definition on the slide.

Explain: What Is an Atom?

Explain that an atom is the building block of nature. Just like houses are (usually) built with bricks, and old ships were made with planks of wood.

Atoms are the tiny pieces that make up every material, every liquid, almost everything in the entire universe.

Explain: What Does an Atom Look Like?

An atom can be thought of as two main parts, the nucleus in the centre, and the electron shells around it.

However, this image is not to scale and doesn't give a good idea of the size of an atom. Electrons are much smaller and much further away than the image shows.

How Big Is an Atom?

Discuss: How Big Is an Atom?

A Hydrogen atom has a radius of around 25 picometers. This is incredibly small!

Ask the students how many centimetres and millimetres are in a metre.

In a metre there are 1,000,000,000,000 picometres.

A picometre is much smaller than our eyes can see, so we can never see atoms (unless using a very powerful and clever microscope.)

Explain: A Better Idea of The Size of Atoms

A single grain of sand contains around 50 quintillion atoms. i.e. 50,000,000,000,000,000,000 atoms.

There are between 5-10 times more stars in the universe than grains of sand on the Earth, but there are more atoms in a single grain of sand than stars in the entire universe.

Discuss: States of Matter

Now that we know that everything is made up of atoms, we can explain different states of matter by looking at how these atoms behave.

Ask the students what the 3 main states of matter are: (Solids, Liquids, Gases)
They may know that Plasma is the fourth fundamental state of matter where the temperature is so hot that the atoms break down and the electrons are free.

Explain: Phase Transitions

Explain that elements can be found in the 3 states of matter depending on the temperature (or pressure). Each element has its own melting point and boiling point.
Compounds such as water will have different melting and boiling points to the elements Oxygen and Hydrogen.

Discuss: Boiling and Melting Points

Discuss melting and boiling. Pupils will be familiar with ice melting and water boiling, ask them if they know at which temperatures these occur.

Explain that we could display these facts in a simple diagram to work out in which state a substance such as water is at any given temperature.

Activity: Boiling and Melting Points

Students are to draw and complete the diagram for water by writing the melting and boiling tempreatures on their respective points on the diagram and then answering which state it is in at the given temperatures. Pupils could label the temperatures on the diagram.

They will then need to do the same with oxygen and mercury. They will need to use the table provided to find their respective melting and boiling points.

Discuss: How Do Atoms Move?

Explain that atoms are always moving, but depending on the temperature, they can move in different ways. In each of the 3 states of matter, atoms will behave differently. Ask a pupil to look at the animations and to describe how the atoms are behaving as a solid, ask another for a liquid, and another for a gas.

Activity: How Do Atoms Move?

Ask pupils to write a short description of how atoms move in each state of matter. Ask them to think about their speeds, how much they move, and how much space is between the atoms.

Explain: Atom Behaviour Comparison

Explain the differences of how atoms move and flow, how much space there is between them, as well as if they are compressible. That is, solids and liquids are hard to squeeze and compress, you're able to compress gas much more like in air fresheners and deodorants.

Explain: What Is a Molecule?

A molecule is 2 or more atoms bonded together. They could be the same or different elements.

Explain: Adding a Molecule

It is very important when adding our circle that it is not too big and that it is placed in the centre of the screen, as shown on the slides. If the circle is too big or not centred it will cause issues when the molecules touch eachother later.

Discuss: Movement of Molecules in a Solid

Ask a pupil to come out to demonstrate the movement of a solid. Explain that an atom in a solid vibrates back and forth in random directions but stays in the same position. Instruct the pupil to:

1. Pick a random direction
2. Move forward a step
3. Move backwards a step
4. Repeat steps 1-3

Note: the wait blocks are optional

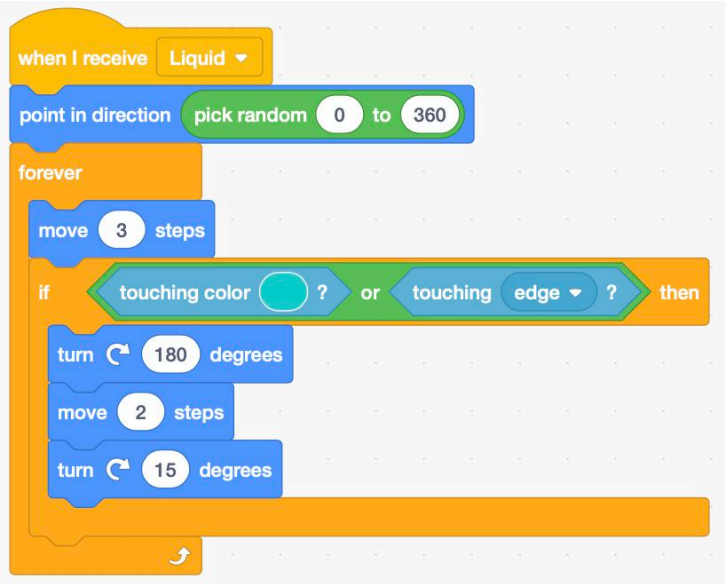
Discuss: Movement of Molecules in a Liquid

Explain that atoms in a liquid tend to move around relatively slowly in straight lines colliding with each other.

Demonstrate this by repeating 3 steps forward and asking what we want to do if we collide with a wall or another molecule.
The pupils may come up with the idea of turning 180 degrees and then moving a couple of steps away. This will ensure the molecules aren't still in contact when they begin moving again.

The turn 15 degrees makes the collisions look slightly more realistic.

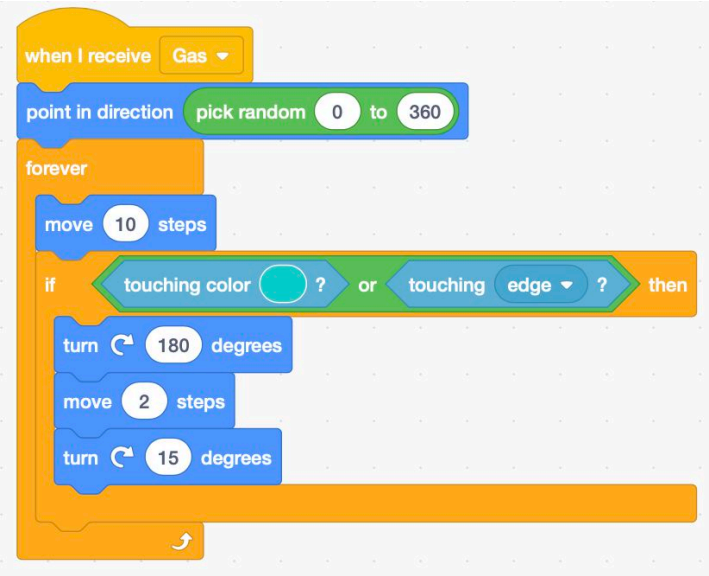
You may want to give a hint towards the use of if touching colour or touching edge.



Activity: Movement of Molecules in a Gas

Challenge the pupils to finish the code for the movement in a Gas.

The only thing that needs to be different from the code for Liquid is the move 3 steps now needs to be higher, i.e. move 10 steps.



Activity: Adjusting the Program for Mercury

The pupils would only need to adjust the values in the if statements for Solid, Liquid and Gas.
If they decide to change the colour of the molecules then they will need to adjust the if touching colour block to match the new colour.

Activity: Improving Our Model

Pupils can use the go to block for the solid using numbers near to 0 for the x and y coordinates so the molecules are all together in the centre.

Discuss: Element, Compound or Mixture

Explain each of the three elements, compounds and mixtures and then discuss each item on the following slides. If they are a single element like Gold or Iron, then they are an element. If they are a compound such as Salt (Sodium and Chloride bonded together) then they are a compound. If there are multiples of these together then they are a mixture, i.e. Salad, Sand, Food/ Drink are mixtures.

Activity: Atoms, Molecules and Compounds

Pupils are given time to work together in order to match the terms, definitions and images of atoms, molecules, compounds and mixtures. It isn't too important that they have prior knowledge of this, we just want them to try and work it out themselves. Solution is on the following slide.

Discuss: Chemical Reactions

Explain what a chemical reaction is and after using burning as an example ask the pupils if they know of any other kind of chemical reactions. Rusting is a good example. Even if you aren't sure, ask the pupils to explain or describe some of the reactions they know about.

Explain: Displacement Reactions

Explain Displacement Reactions using the displacement disco example as well as the Gareth Bale example. It's important to use the words reactive and attractive during the explanation in order to link with the reactivity series on the next slides.

Discuss: Reactivity Series

The reactivity series lists metals according to their reactivity. i.e. how reactive they are and how likely they are to react with other substances. You can show them the video linked on the slide in order to give them more of an idea of what reactivity means. A reaction will only occur if the metal on it's own is more reactive than the one in in the the compound. So for Sodium Chloride and Potassium, since Potassium is more reactive than Sodium then it will displace the Sodium and form Potassium Chloride. Ask for pupils to answer the slides on whether a reaction would occur or not.

Activity: Complete The Equations

Pupils are to finish the equations in their workbooks, writing either the products of the reaction, or "No reaction" if one will not occur.

1	Sodium Chloride + Aluminium	→	No Reaction
2	Aluminium Nitrate + Potassium	→	Potassium Nitrate + Aluminium
3	Copper Sulphate + Aluminium	→	Aluminium Sulphate + Copper
4	Iron Sulphate + Copper	→	No Reaction

Activity: Designing Our Compound

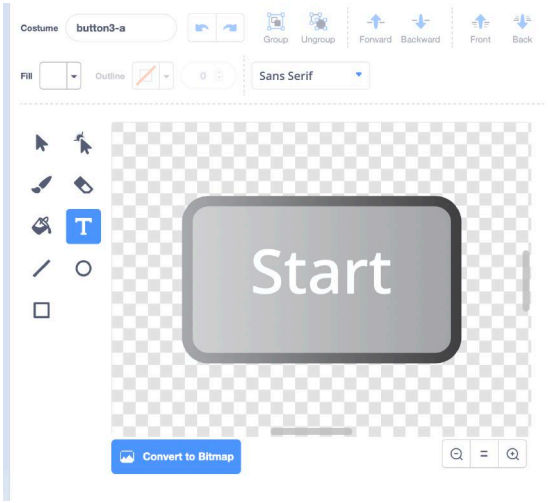
When Desigining the Compound we need to have two circles touching, one purple and one yellow. **It's important that they are centred on the screen and not too large!** Then we need to create a new costume (not a new sprite), this time with purple and green circles.

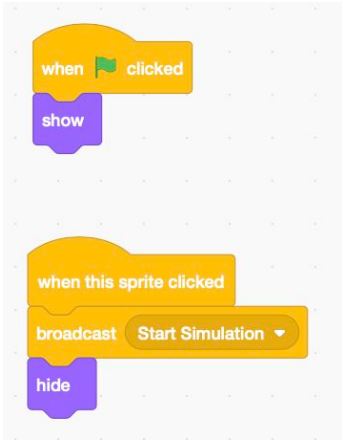
Activity: Designing Our Metal Ion

Design a couple of costumes for the metal ion, one a green one and another a yellow circle.. Again remember to centre the molecule and they are not too big, but not too small.

Activity: Designing Our Start Button

Design a button to use as a start button and have it broadcast a message to let the sprites know when to start moving.





Discuss: Sprite Costumes

Ask 3 pupils to come out to demonstrate the changing of the sprite costumes using cards. Give pupil 1 the purple card and pupils 2 and 3 a yellow and a green card each. Get pupil 1 to hold up the purple card and to stand with pupil 2, who will hold up the yellow card. Get pupil 3 to stand separately holding the green card.

Explain to the class that pupils 1 and 2 are the compound sprite with costume 1 and pupil 3 is the ion sprite with costume 1.

Then get pupil 3 to walk towards and 'collide' with pupils 1 and 2. Explain to the class that this is the random collision of the compound and ion. When this happens, instead of getting the sprites to change, we can simply change their costumes to make it look like they have change.

To do this, get pupil 2 to swap their yellow card for their green card and get pupil 3 to swap their green card for their yellow card. Pupils 2 and 3 should not swap cards with one another.This is now costume 2m of the compound and the ion. Explain to the class that the pupils do not swap cards with each other, they simply change their own costume.

Activity: Finish the Game and Extension

The rest of the steps are described in the slides, for movements act out the movements that molecules would do in order to help visualise the block needed. If they have finished they could extend by creating a scratch program simulating a bunsen burner heating water. They are allowed to be creative so there are no guidelines for how they implement it, though having a flame which changes size as temperature changes and particles movement shown in a small box on the side of the screen. Potentially a freezer which freezes the water when clicked.

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