From Particles to Properties: Chemistry Concepts with Water Models

Presenter:

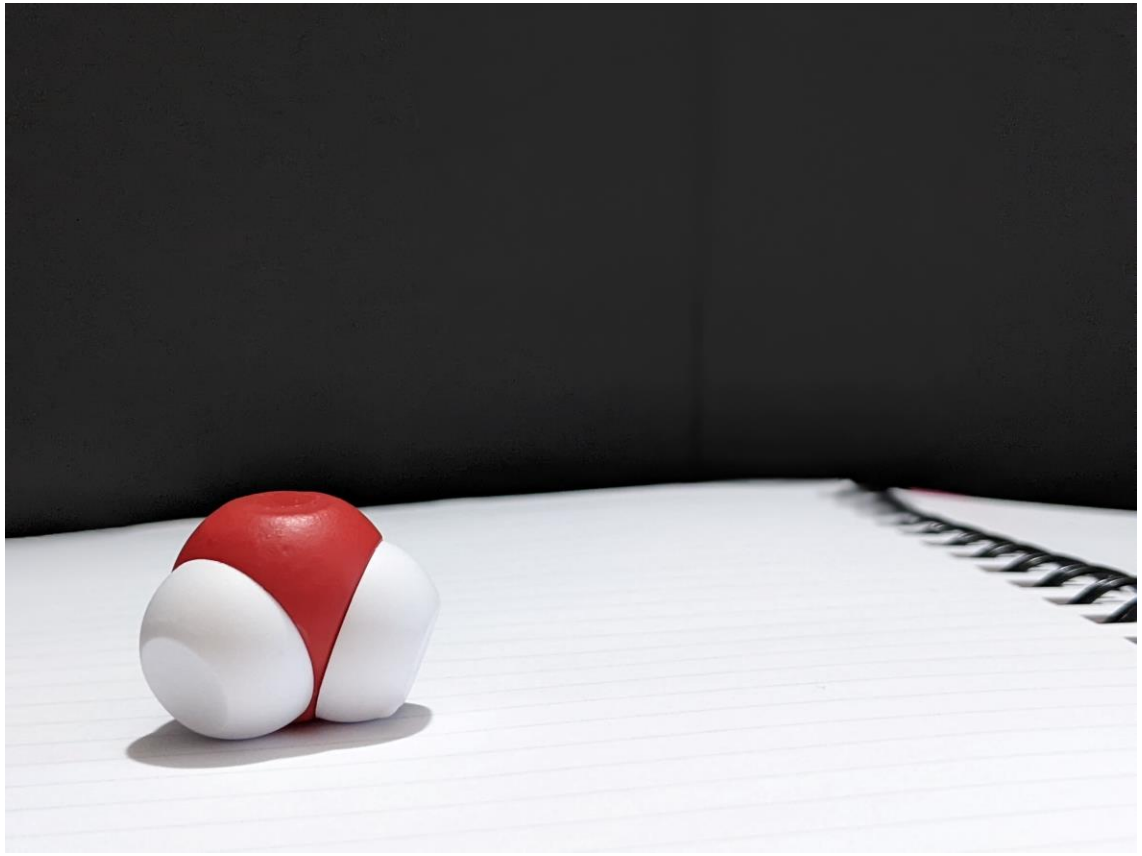
RUTH HUTSON,MSSE

3D Molecular Designs Science Educator

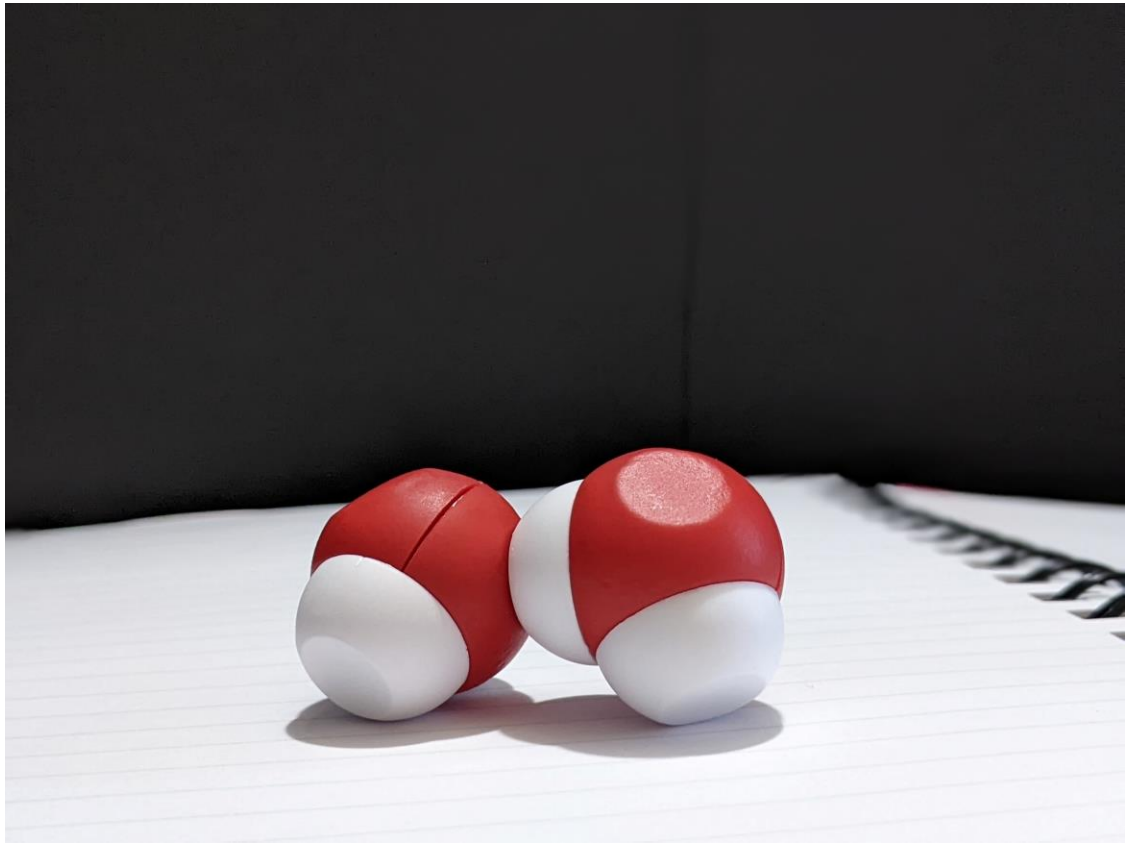
Workshop Learning Goals

- Learn strategies for using hands on models to explain structure-function relationships.
- Use models to compare the structure of water at the macroscopic level (the bulk scale) to infer the strength of electrical forces between particles (NGSS HS-PS1-3).
- Explore how models can be used to describe the atomic composition of simple molecules and extended structures (NGSS MS-PS1-1)
- Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction (NGSS HS-PS1-7).
- Have fun!


3-D Molecular Designs
Water Kit
3D Water Makes Learning Sensational



I notice	I wonder



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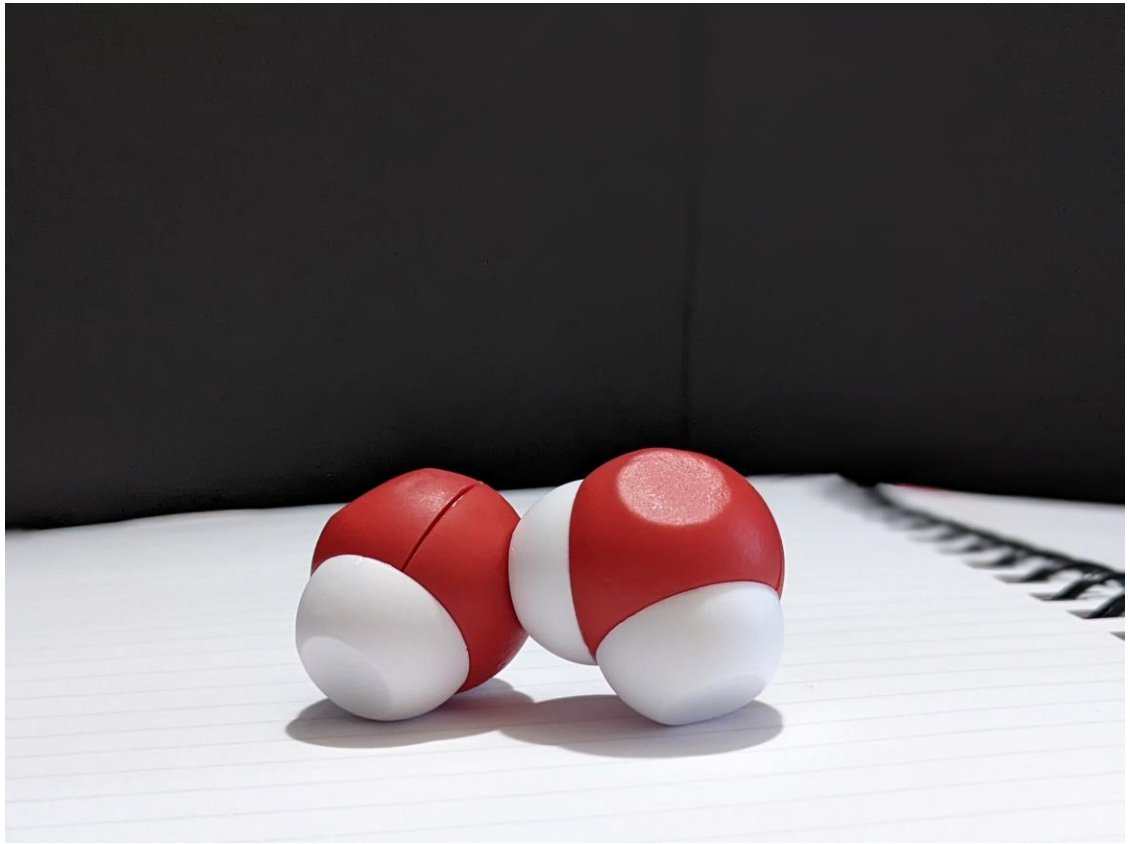

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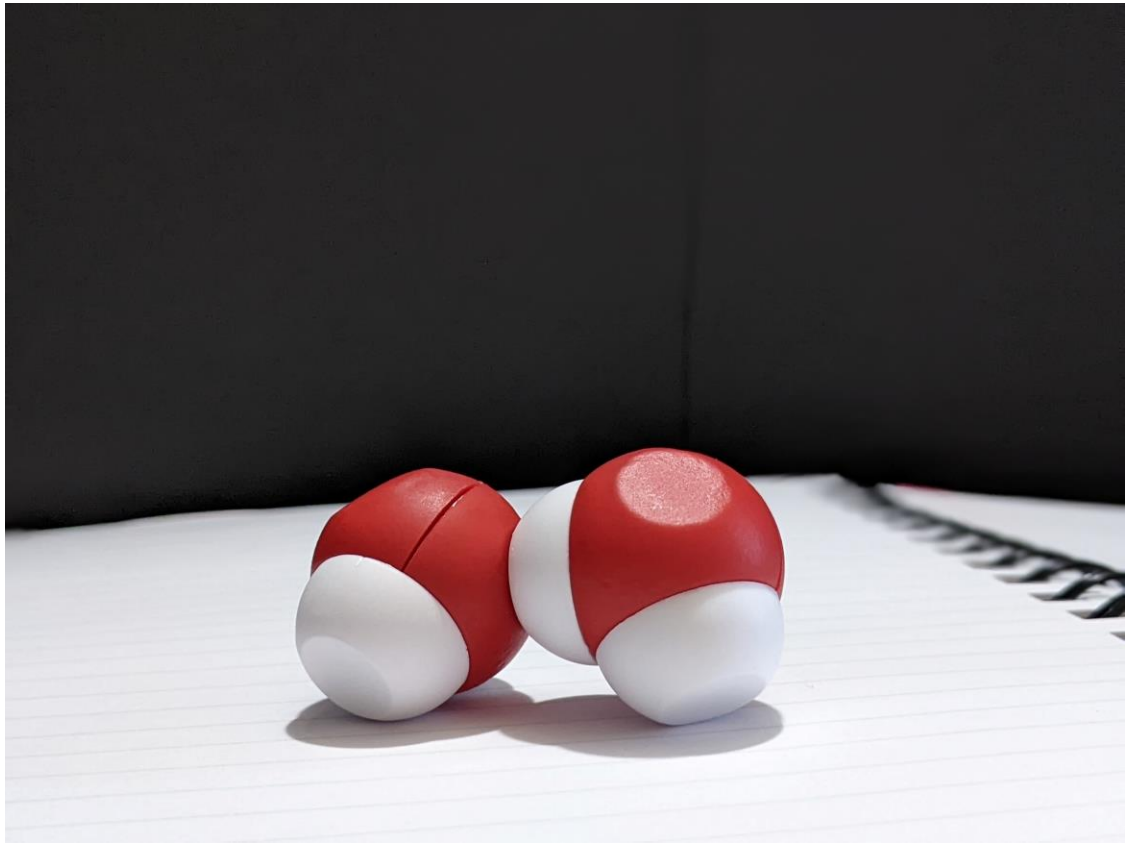
What questions do you have?



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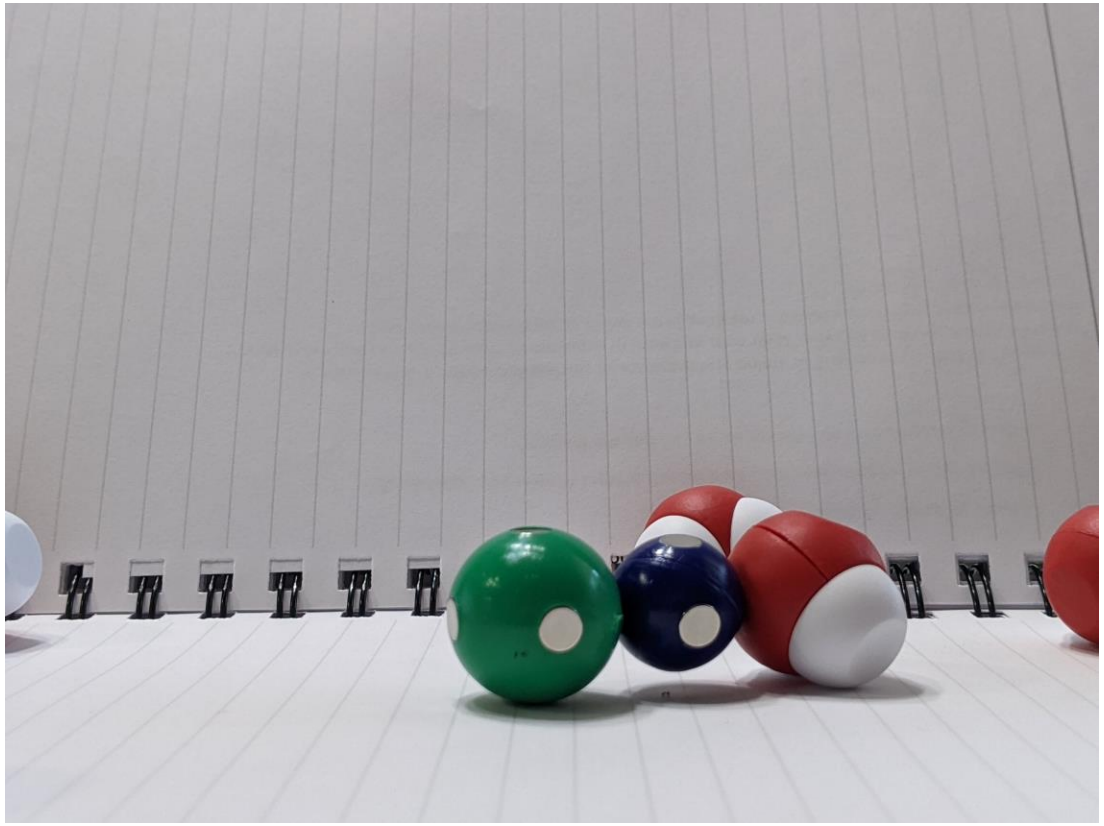
Notice	Wonder
2 white atoms 1 red atoms atoms are @ an angle white sticks to red red repels red white repels white	Why is the molecule bent?



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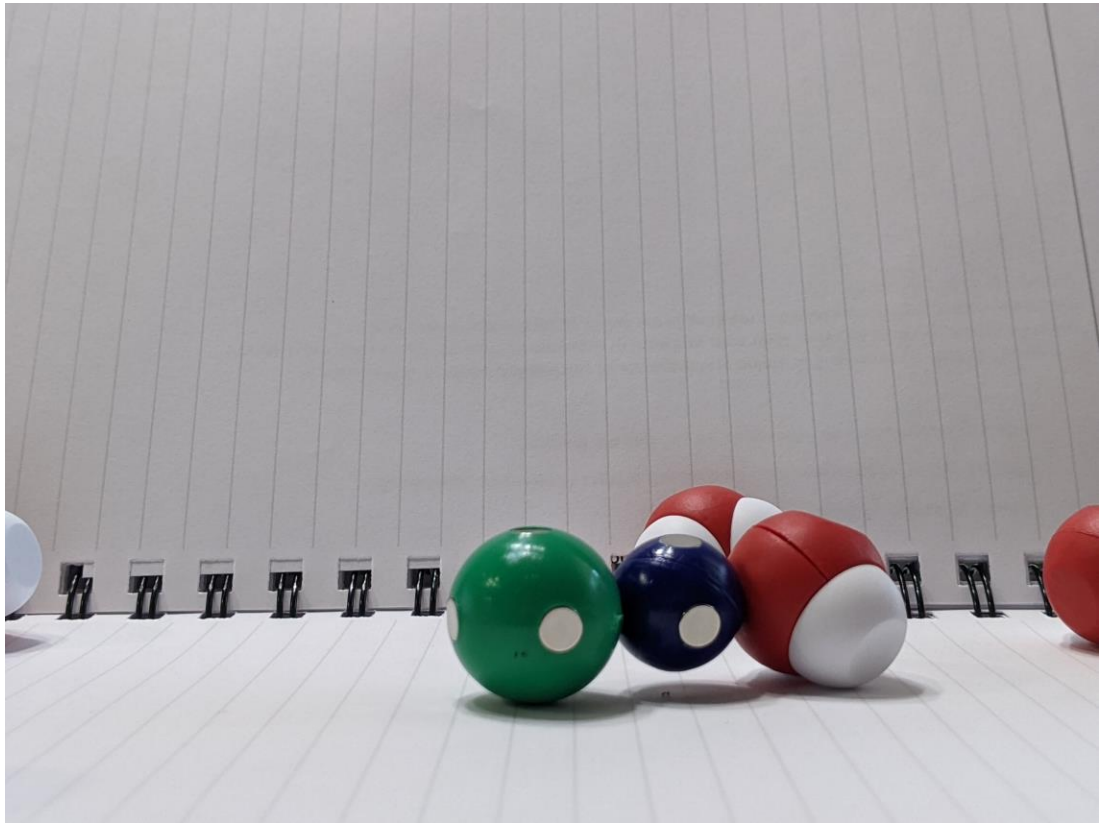


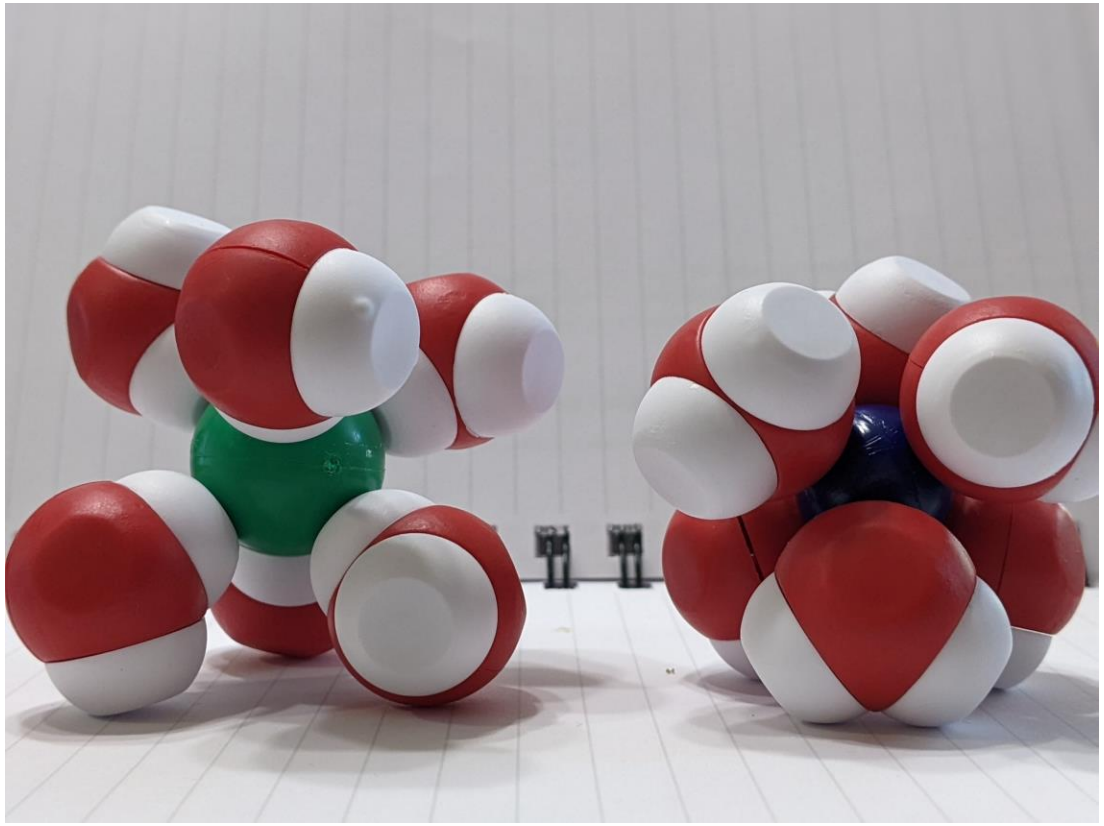
One green atom
One blue atom

Blue interacts with red at 6 places, but not white.

Green interacts with white at 6 places, but not red.

The blue & green are attracted to each other.

Why do the different parts of the water molecule interact differently with the blue & green.



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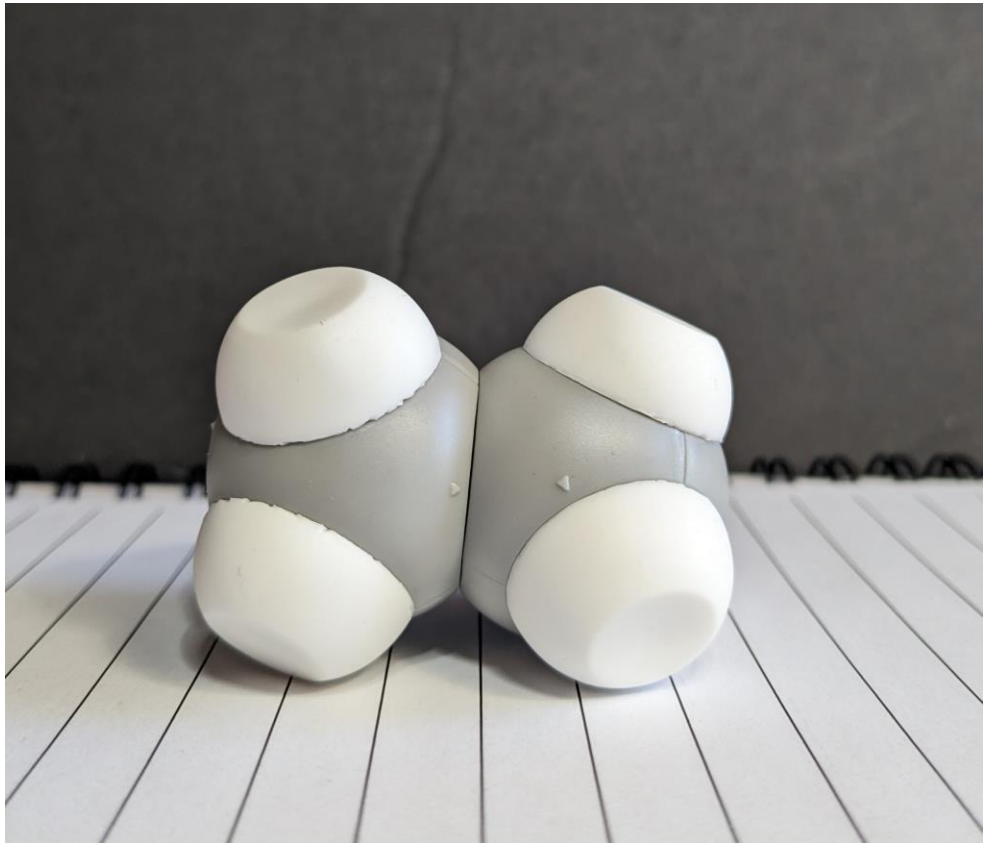

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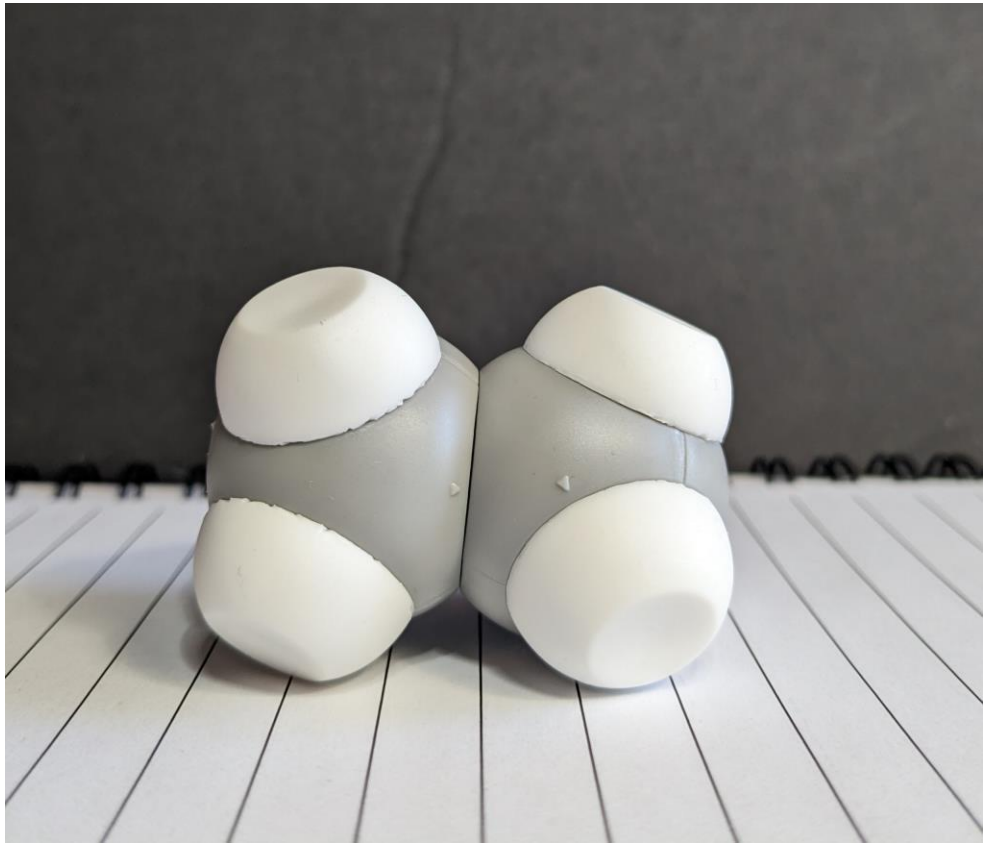

There are two grey atoms & Six white atoms.

Nothing sticks to this molecule.

Why don't water and NaCl stick to the molecule?

Comparing Types of Forces	COVALENT BONDING	IONIC BONDING	HYDROGEN BONDING
What is it?	Formed when two atoms share a bond within one molecule, can be partially charged or without charge.	Complete transfer of electrons between two atoms resulting in one that is positively charged, and one negatively charged.	A weak attraction of a hydrogen atom that is covalently bound to a more electronegative “donor” atom or group.
How is it represented by the model?	The plastic post connecting the oxygen and the hydrogen in water	The magnet in the sodium atom connecting to the magnet of chlorine atom	The hydrogen of one water molecule attracted to the oxygen of another water molecule
Type of force	Intramolecular Force	Intramolecular Force	Intermolecular Force

Alcohol	Observations in Lab	Modeling
Methanol		
Ethanol		
Butanol		
Octanol		

What is going on in this beaker at the molecular scale?

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Methanol		
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Unknown Solution	Observations in Lab	Modeling
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Butanol		
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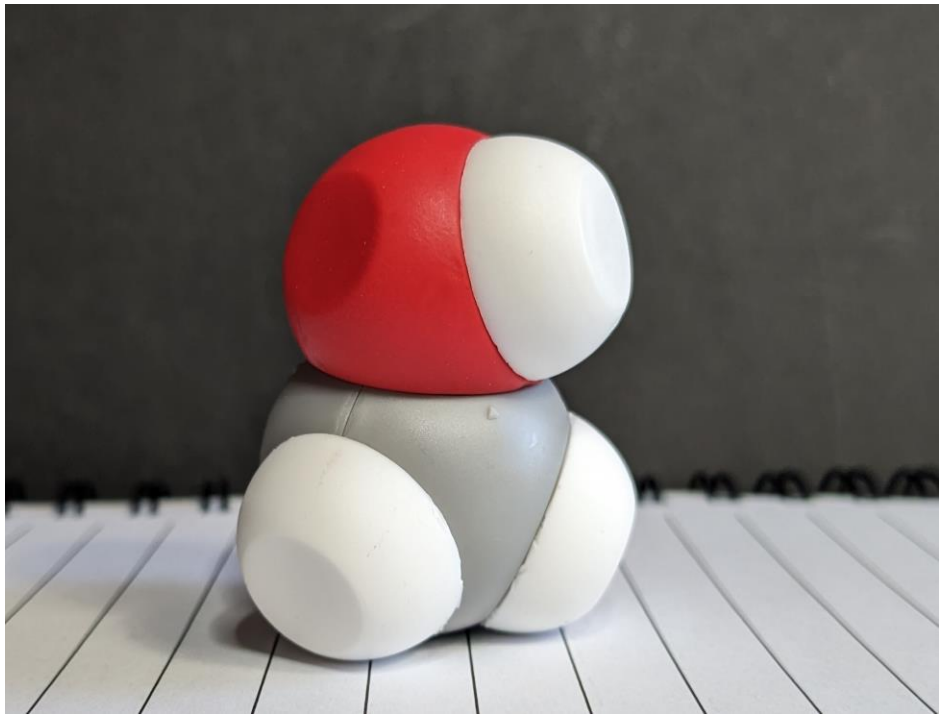

Unknown Solution	Observations in Lab	Modeling
Methanol		
Ethanol		
Butanol		
Octanol		

What is going on in this beaker at the molecular scale?

Unknown Solution	Observations in Lab	Modeling
Methanol (CH_3OH)		
Ethanol		
Butanol		
Octanol		

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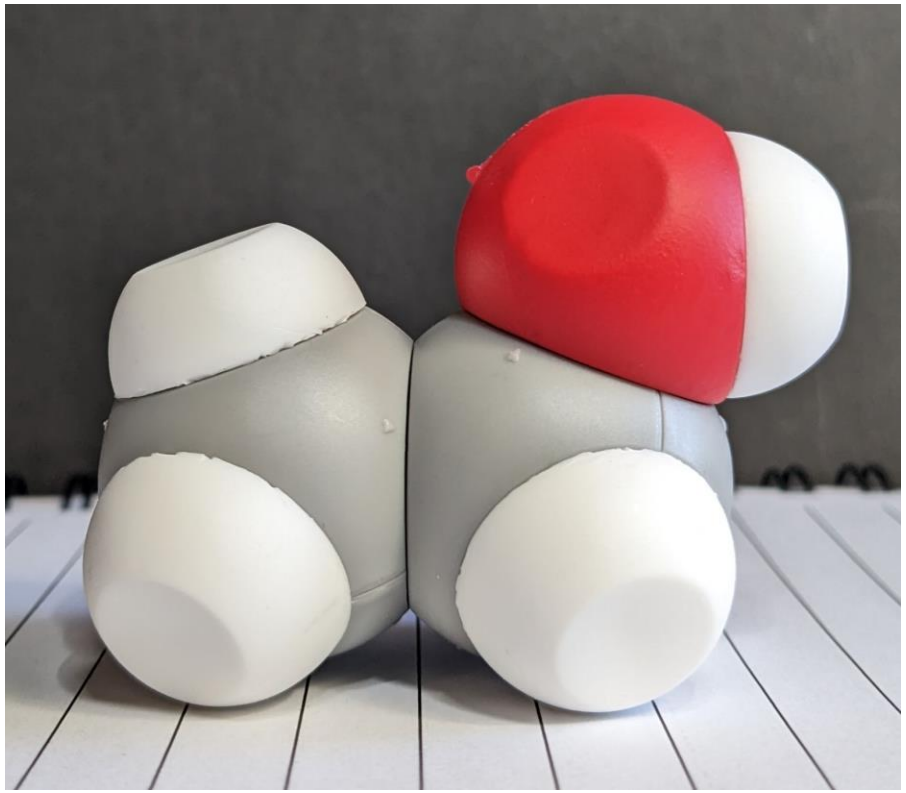

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Methanol (CH_3OH)		
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What is going on in this beaker at the molecular scale?

Unknown Solution	Observations in Lab	Modeling
Methanol (CH_3OH)		
Ethanol (C_2H_5OH)		
Butanol		
Octanol		

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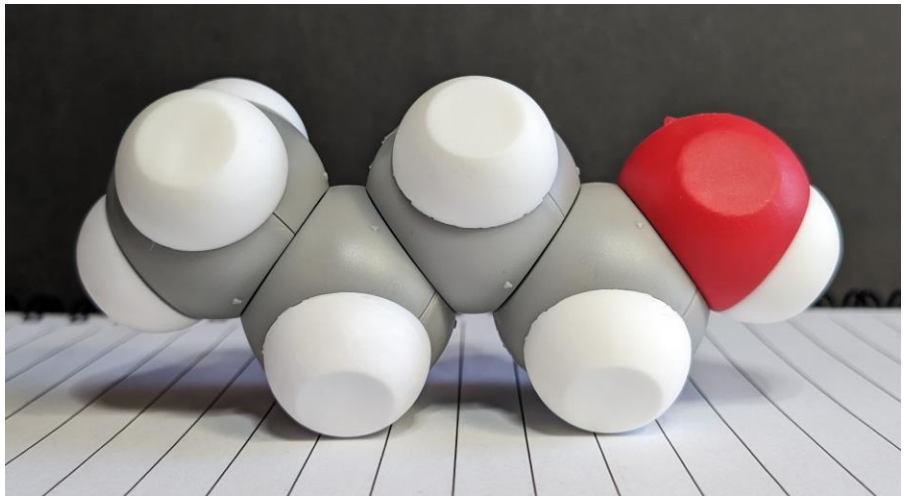

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Octanol		

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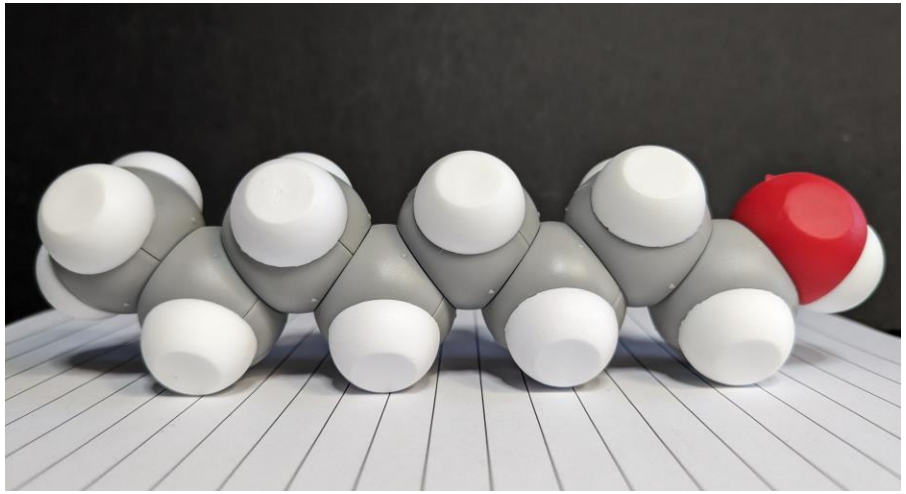
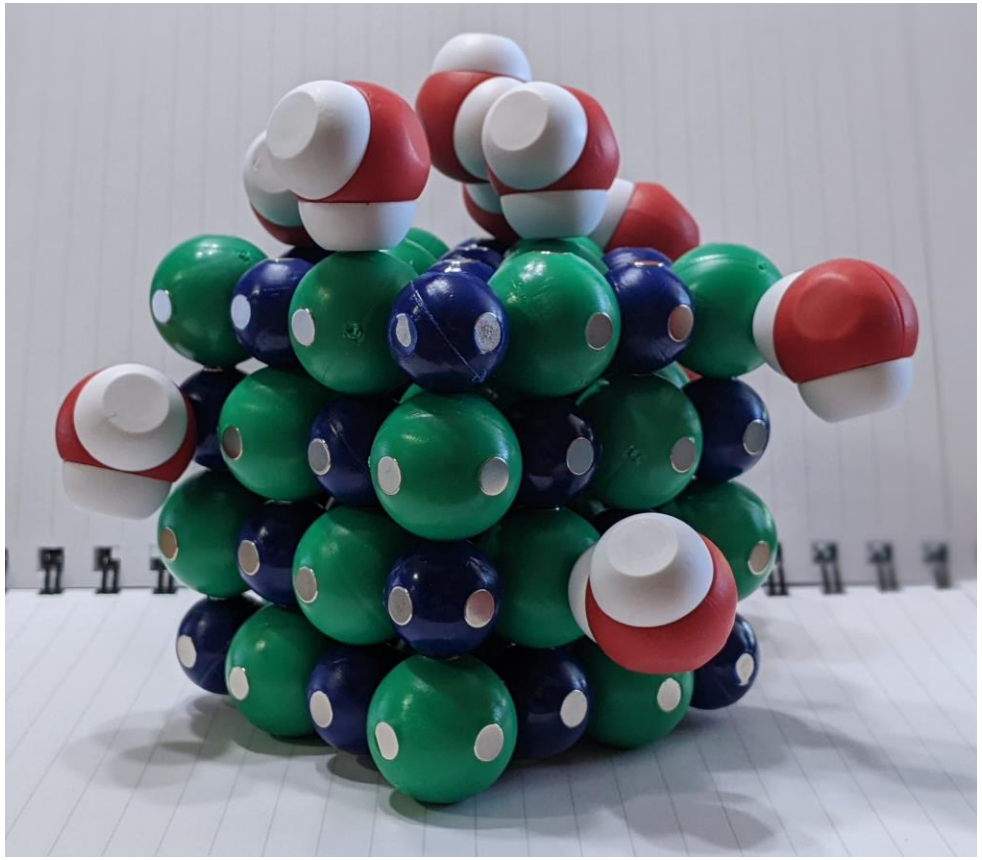


Unknown Solution	Observations in Lab	Modeling
Methanol (CH_3OH)		
Ethanol (C_2H_5OH)		
Butanol ($C_4H_{10}O$)		
Octanol ($C_8H_{18}O$)		

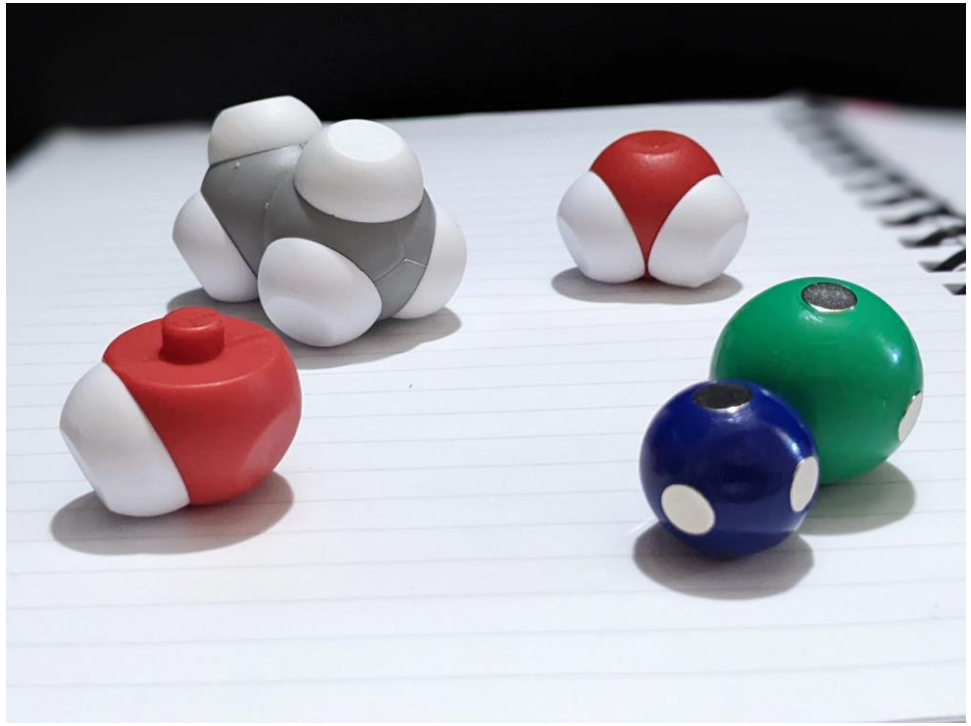
Assessment Time

Salt dissolves readily in water, but not as well in alcohol. Create a model that explains why using either ethanol or methanol. Contrast that model with the model we did in class of salt dissolving in water. Make a sketch in the space provided and write a short narrative for the sketch. Be sure to label all parts of the sketch.



Additional Assessment Ideas suggested by NGSS

Create an experiment to compare:
Melting points
Boiling points
Vapor pressures
Surface Tension
Evaporation Rates



Then model what is occurring at the molecular level.

Describe atomic composition of simple molecules and extended structures.

I notice	I wonder

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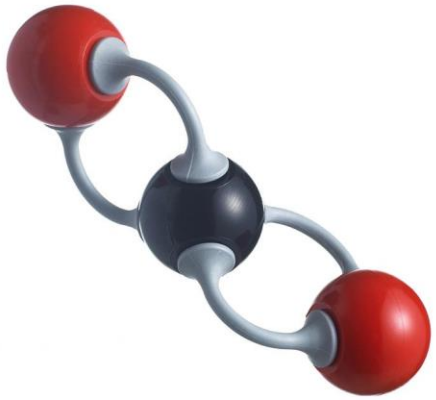

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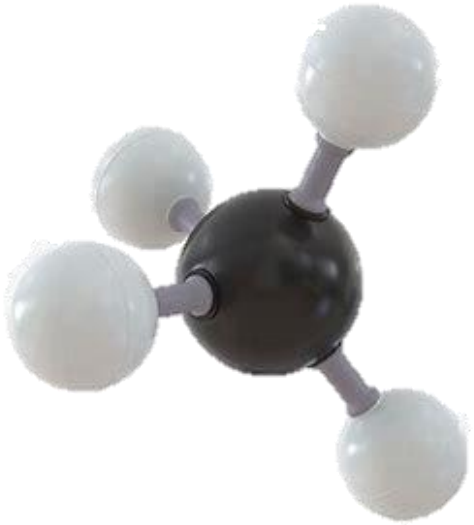

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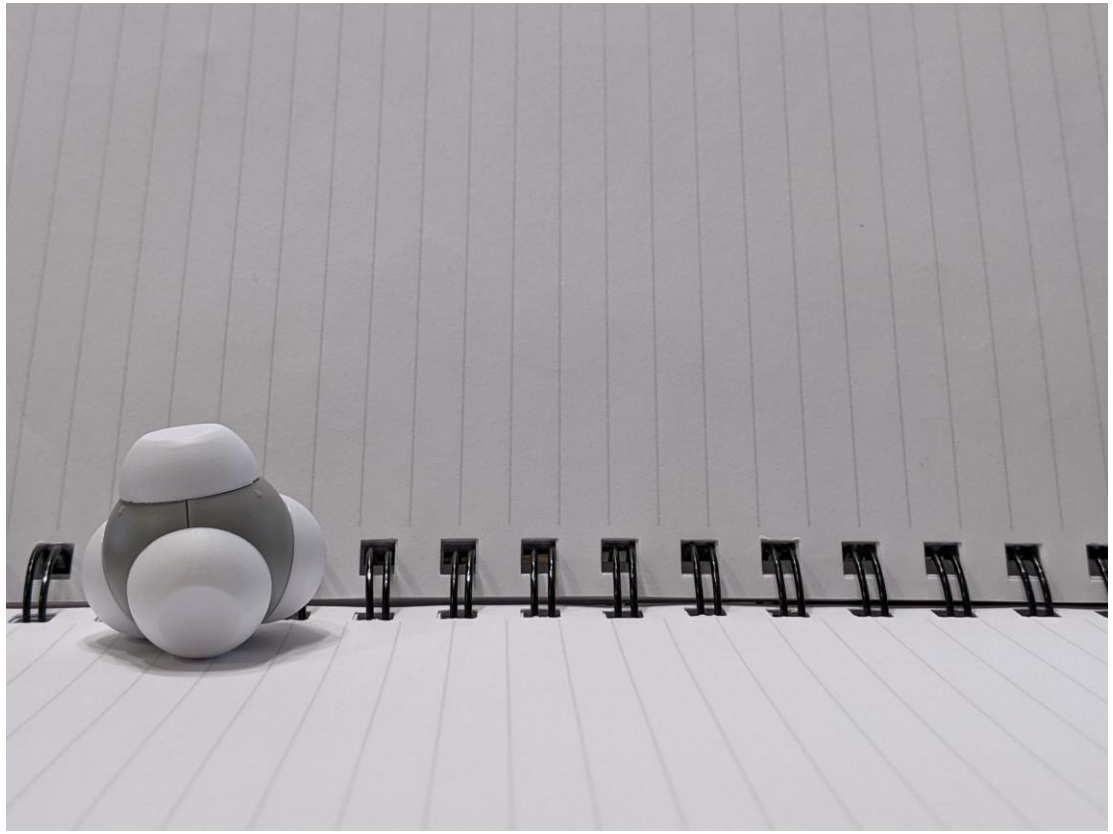

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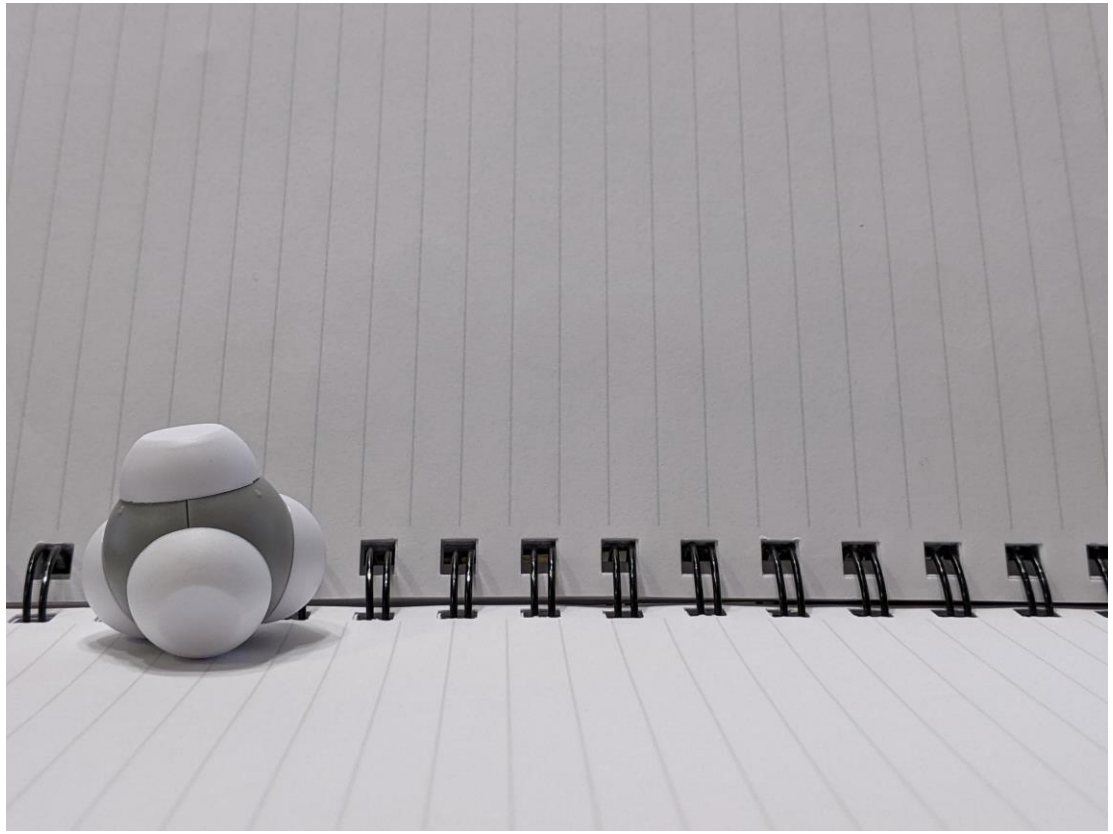
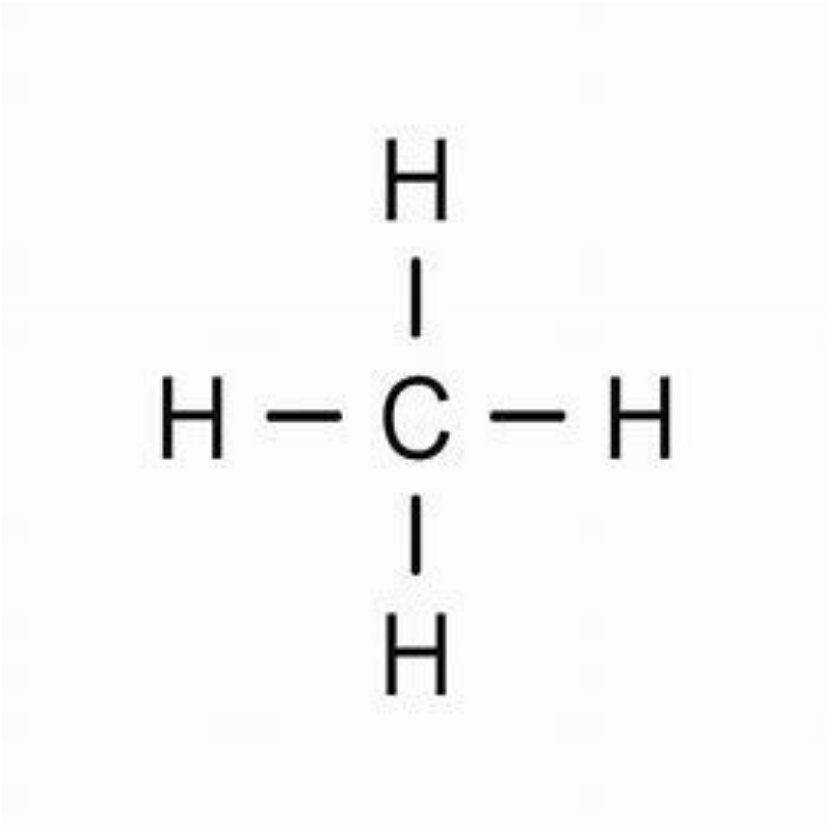
How can this be made into an extended structure?





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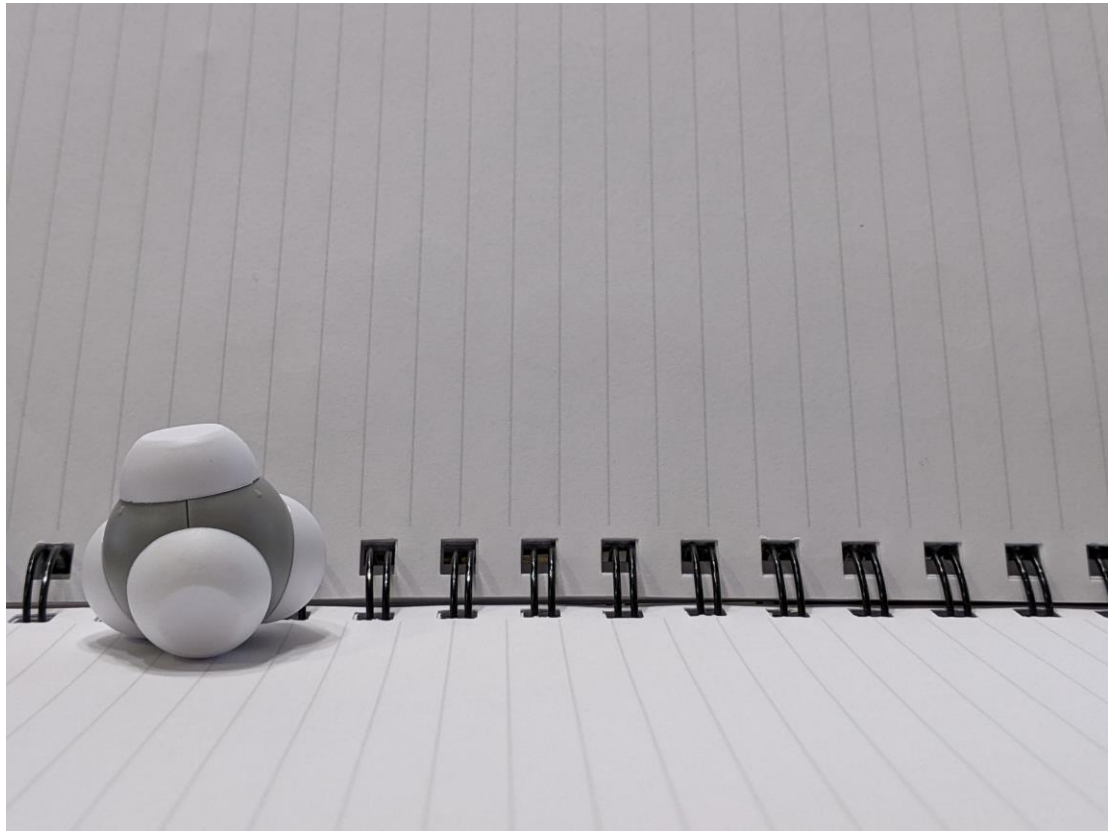
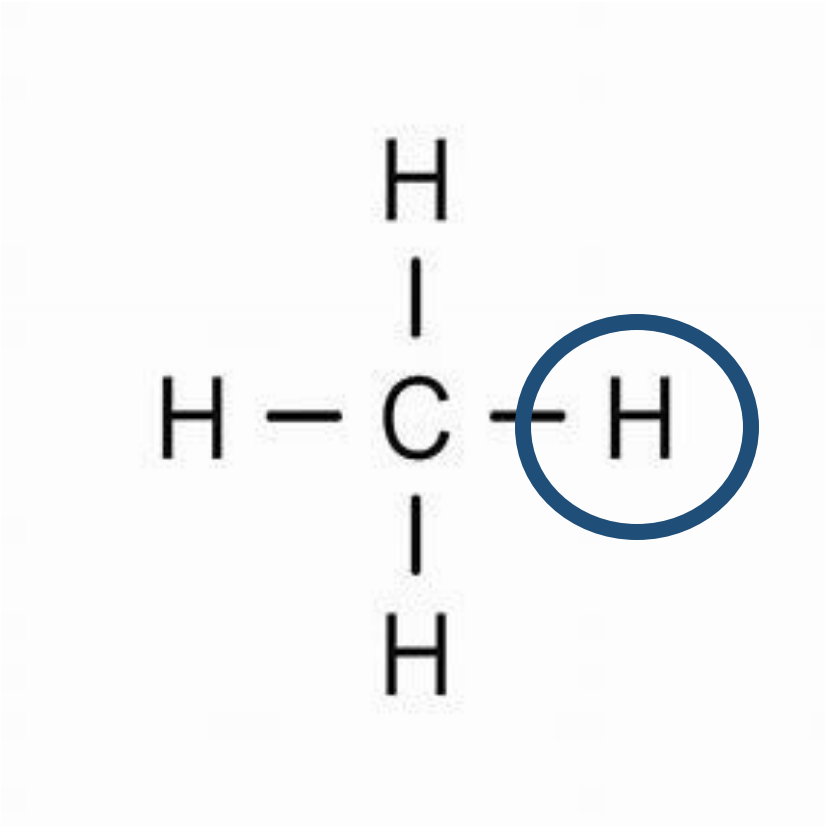




Switching to acid-base models

Create physical representation of the autoionization of water.

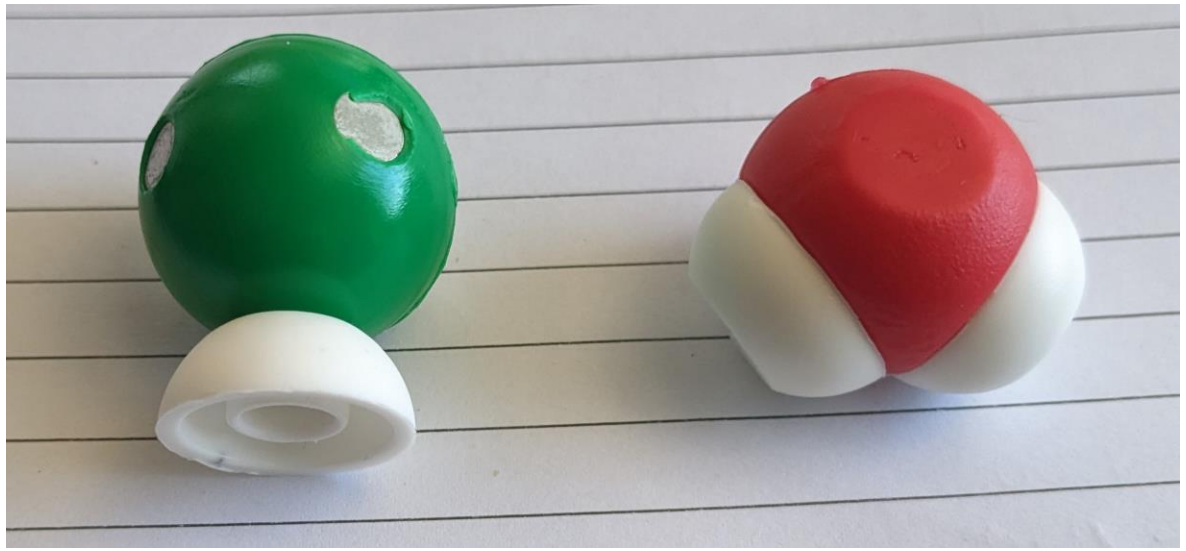
$$H_2O\ (l) \rightleftharpoons H^+\ (aq) + OH^-\ (aq)$$

$$H_2O\ (l) + H_2O\ (l) \rightleftharpoons OH^-\ (aq) + H_3O^+\ (aq)$$

Switching to acid-base models

Create physical representation of the dissociation of hydrochloric acid in water.

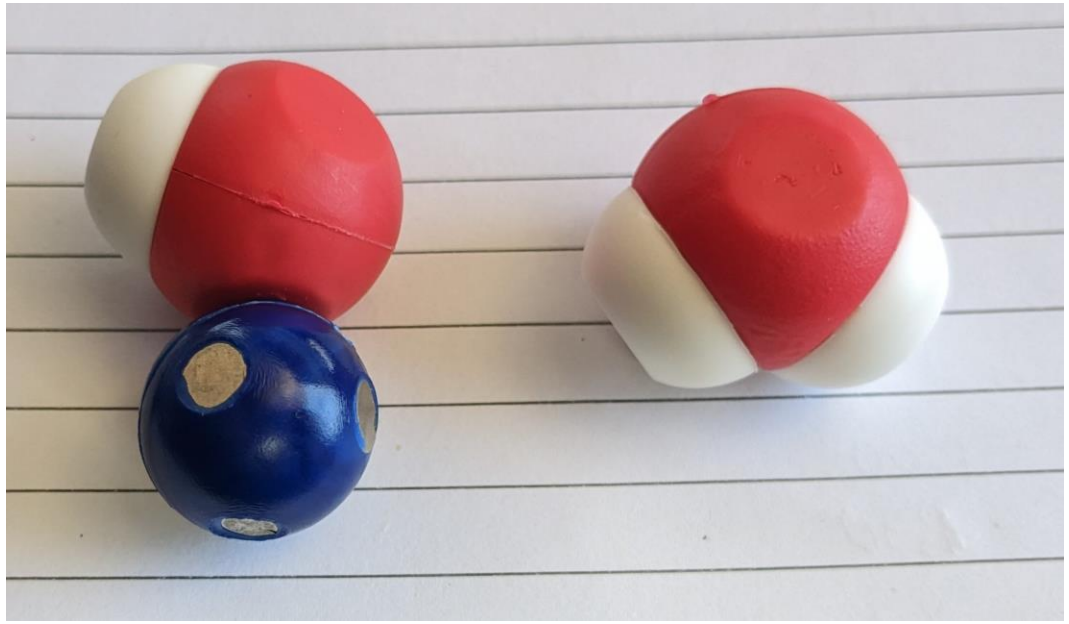
$$HCl\ (aq) + H_2O\ (l) \longrightarrow H_3O^+\ (aq) + Cl^-\ (aq)$$



Switching to acid-base models

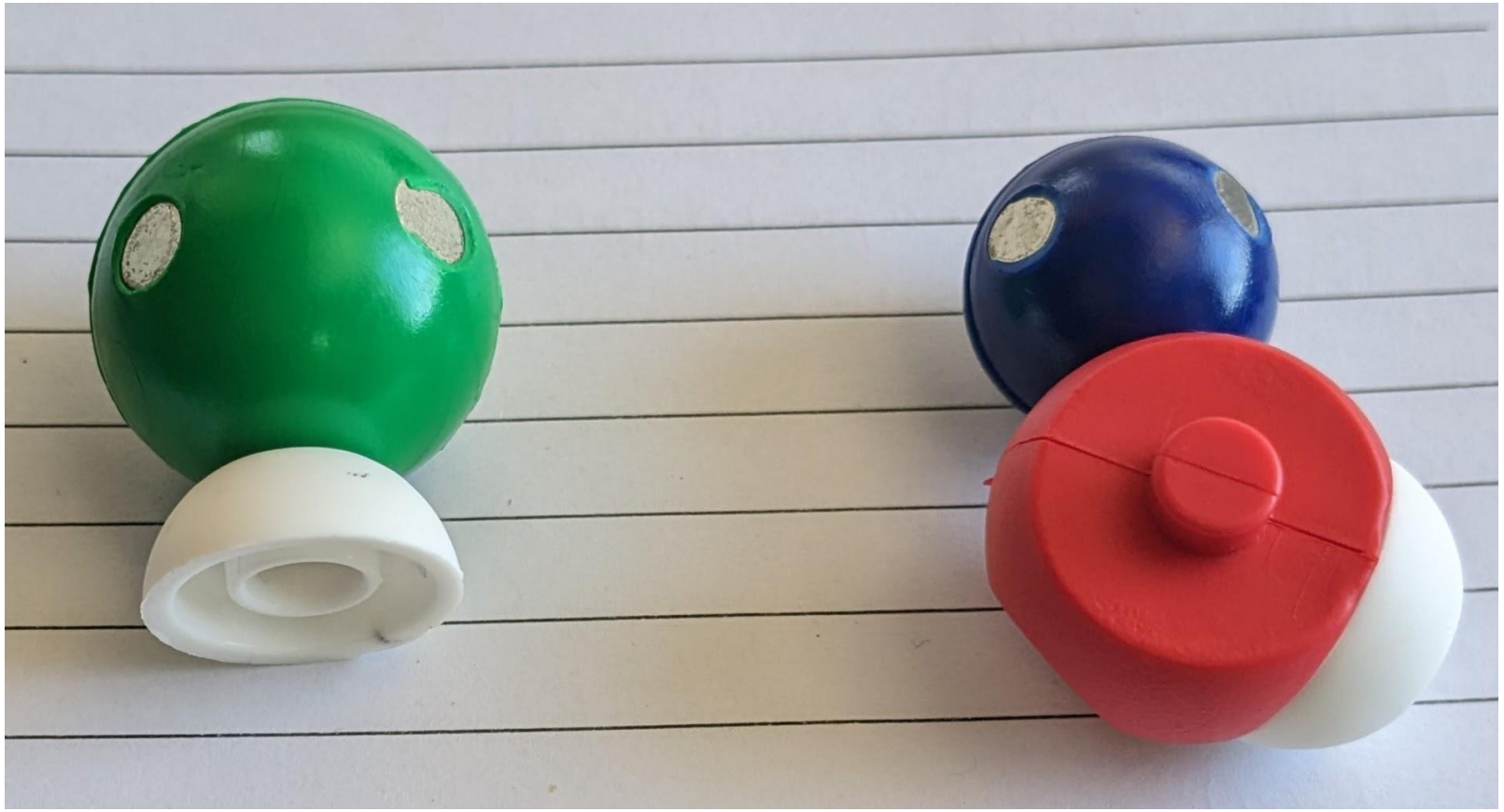
Create physical representation of the dissociation of sodium hydroxide in water.

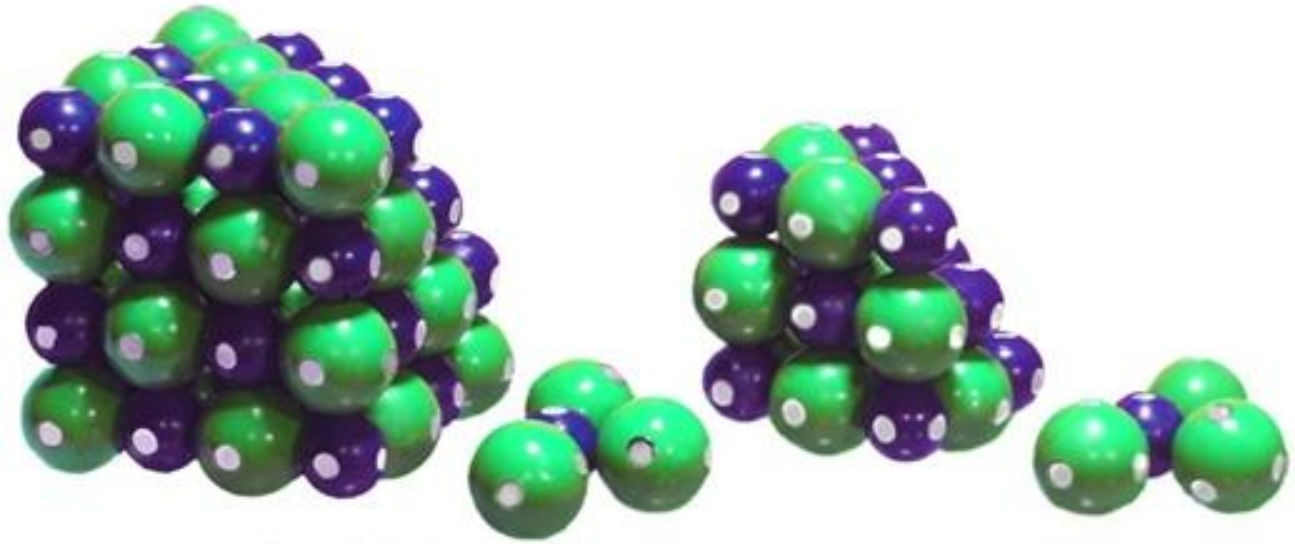
$$NaOH\,(s) \longrightarrow Na^{+}(aq) + OH^{-}\,(aq)$$



Switching to acid-base models

Create physical representation of a neutralization reaction using the parts from the Water Kit.





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What patterns do you see?

How are these complex structures similar?

How are they different?

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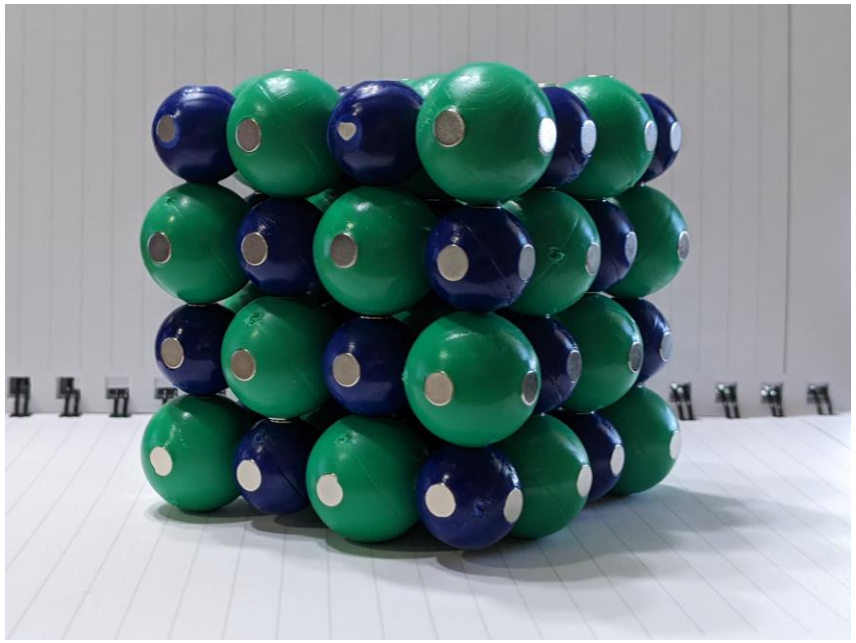

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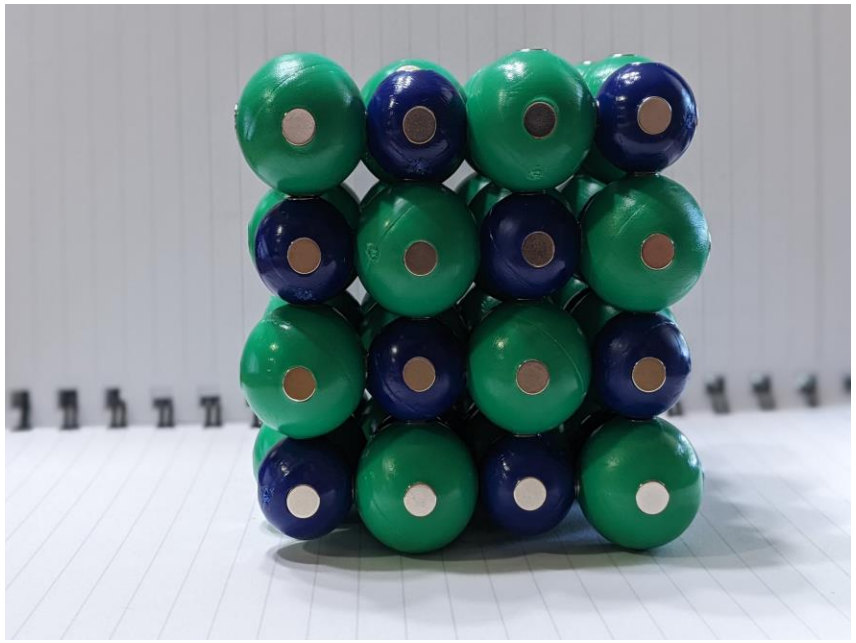

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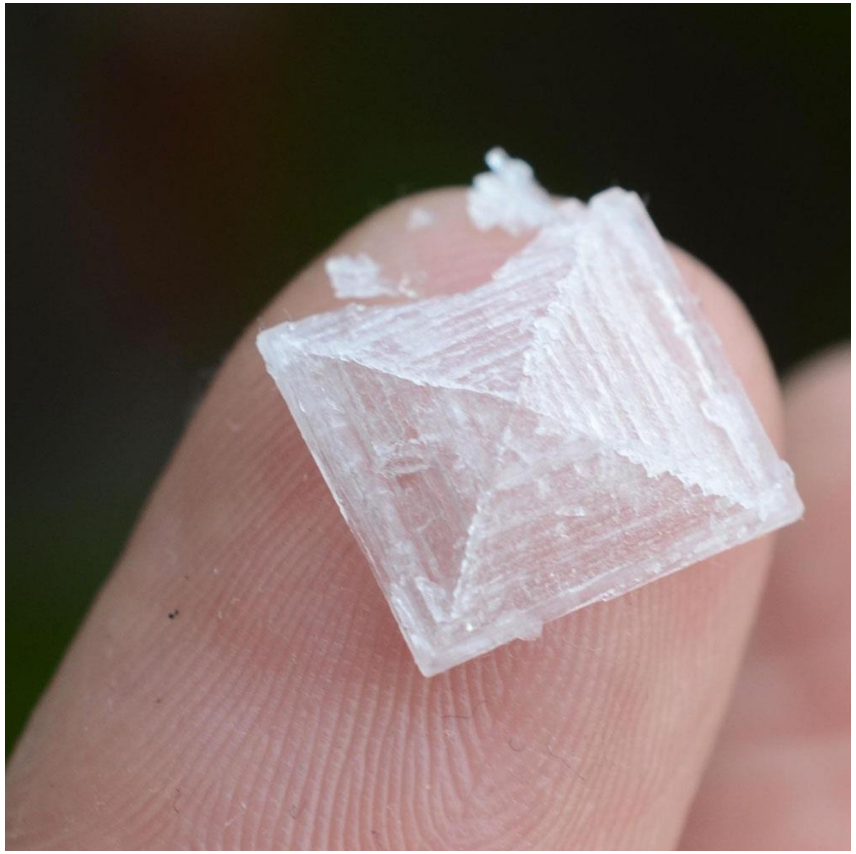

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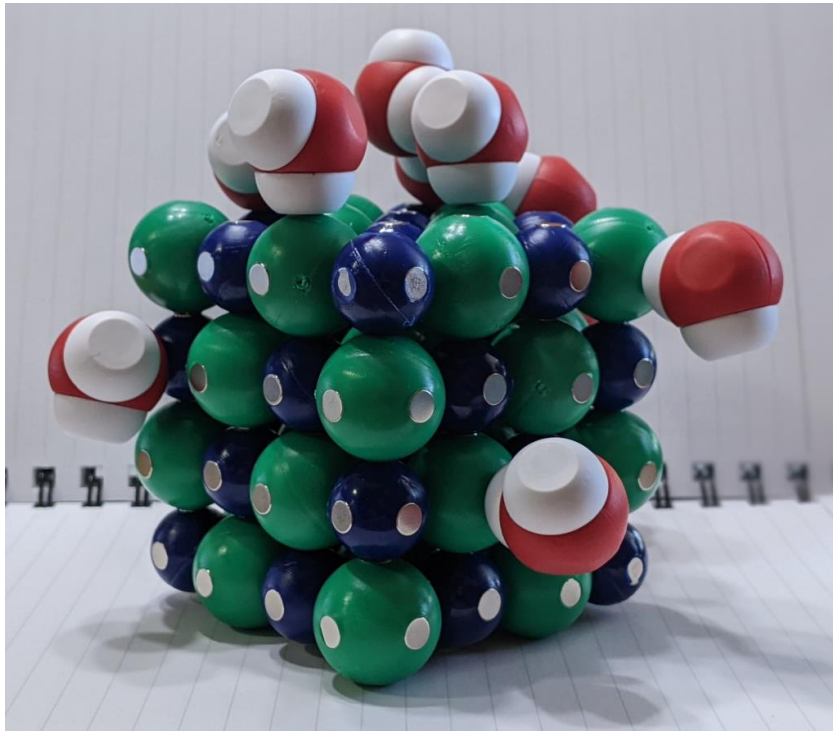
Challenge Time

How could you use the NaCl lattice and the Water Kit to support that the total weight of matter doesn't change when sodium chloride is dissolved in water?



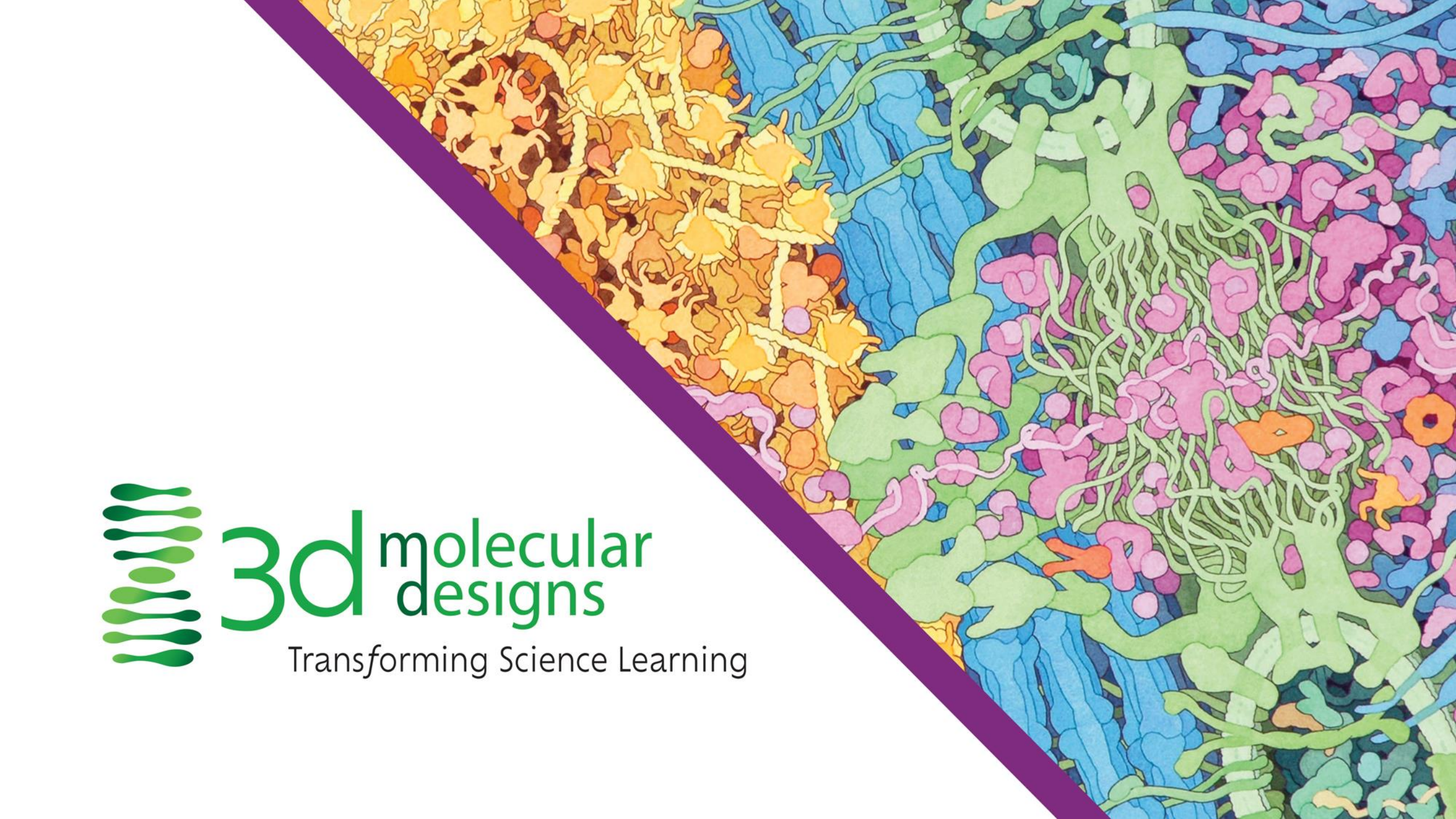
Workshop NGSS Connections

(and/or other applicable standards)

SEPs	CCCs	DCIs
Using Mathematics and Computational Thinking	Scale, Proportion, and Quantity	HS-PS1-3
Developing and Using Models	Patterns	MS-PS1-1
Planning and Carrying Out Investigations	Stability and Change	HS-PS1-7

We value your opinion! Let us know what you think.

Scan the QR Code and complete this short survey.



3d molecular designs

Trans*forming* Science Learning