

Covalent bonding tiles

Learning objectives

- 1 Draw dot and cross diagrams for simple covalent molecules
- 2 Identify single, double and triple covalent bonds

Instructions for teachers

This resource contains a sheet of printable covalent bonding tiles which can be printed and cut out into individual tiles to support learners when introducing covalent bonding. The electrons are identified using colour coded dots and crosses to help learners identify single, double and triple bonds. To avoid misconceptions learners will need to be reminded that, although different symbols are used, they all represent a single electron in the outer shell of the atom.

Task 1: Building bonds

In this task, learners familiarise themselves with the tiles in the resource and practice arranging them to make simple covalent molecules. This task is deliberately open ended and there are many possible arrangements for each of the steps in the task. Learners will get used to finding the correct tiles to complete each bond and the arrangements of the tiles which they may sometimes need to place at an angle.

Task 2: Simple covalent molecules

In this task, learners build named molecules based on their chemical formula. In the case of molecules containing oxygen, carbon and nitrogen, learners will need to choose the correct tile to show single, double or triple bonds as required.

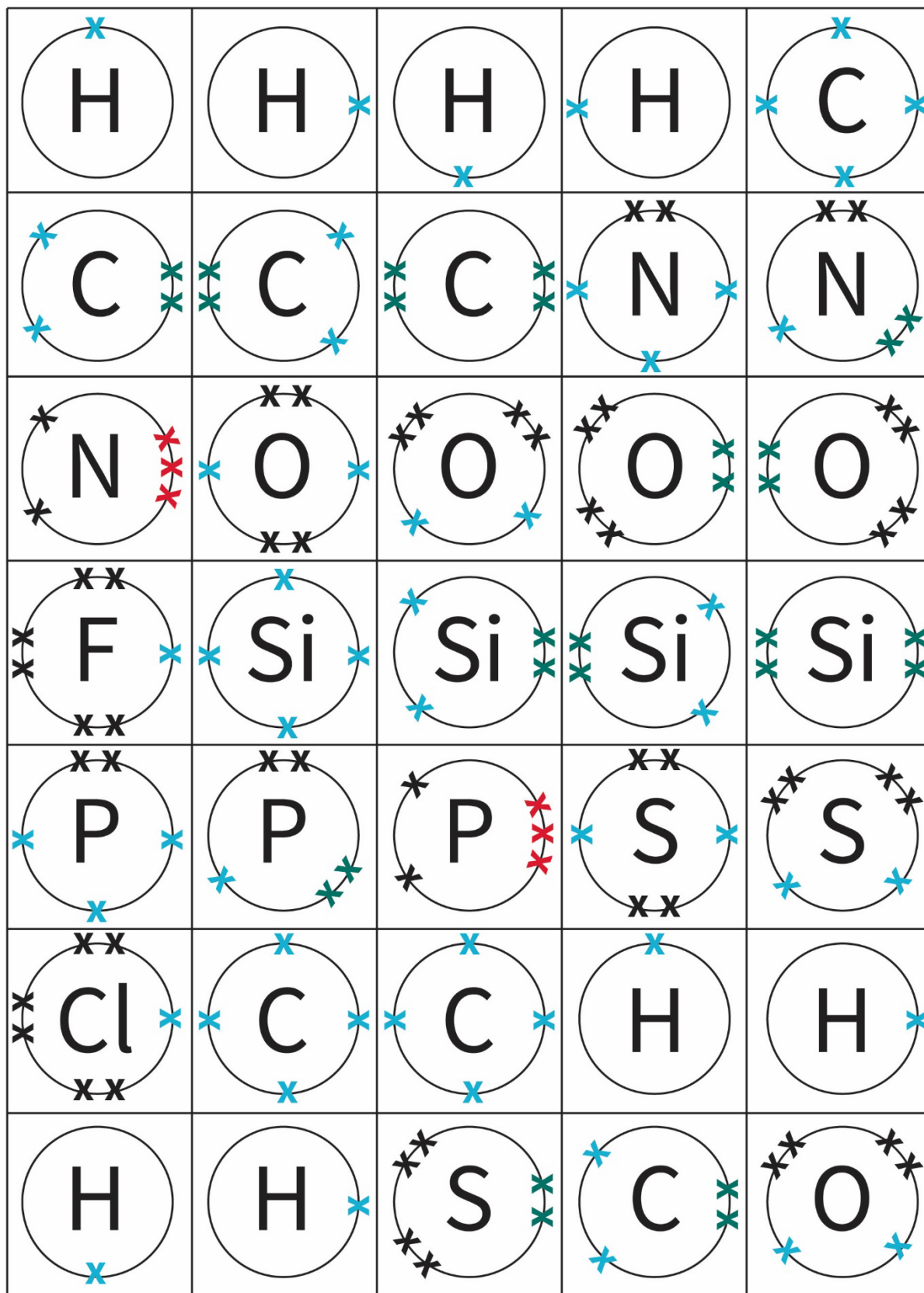
Task 3: Hydrocarbons

In this task, learners use the tiles to explore patterns in the homologous series of alkanes and alkenes. Learners should already be familiar with using the resource (the different stages in task 1 help to explore this) before applying the tiles to chemistry concepts. The tiles can be used to demonstrate the general formulas for the alkanes and alkenes.

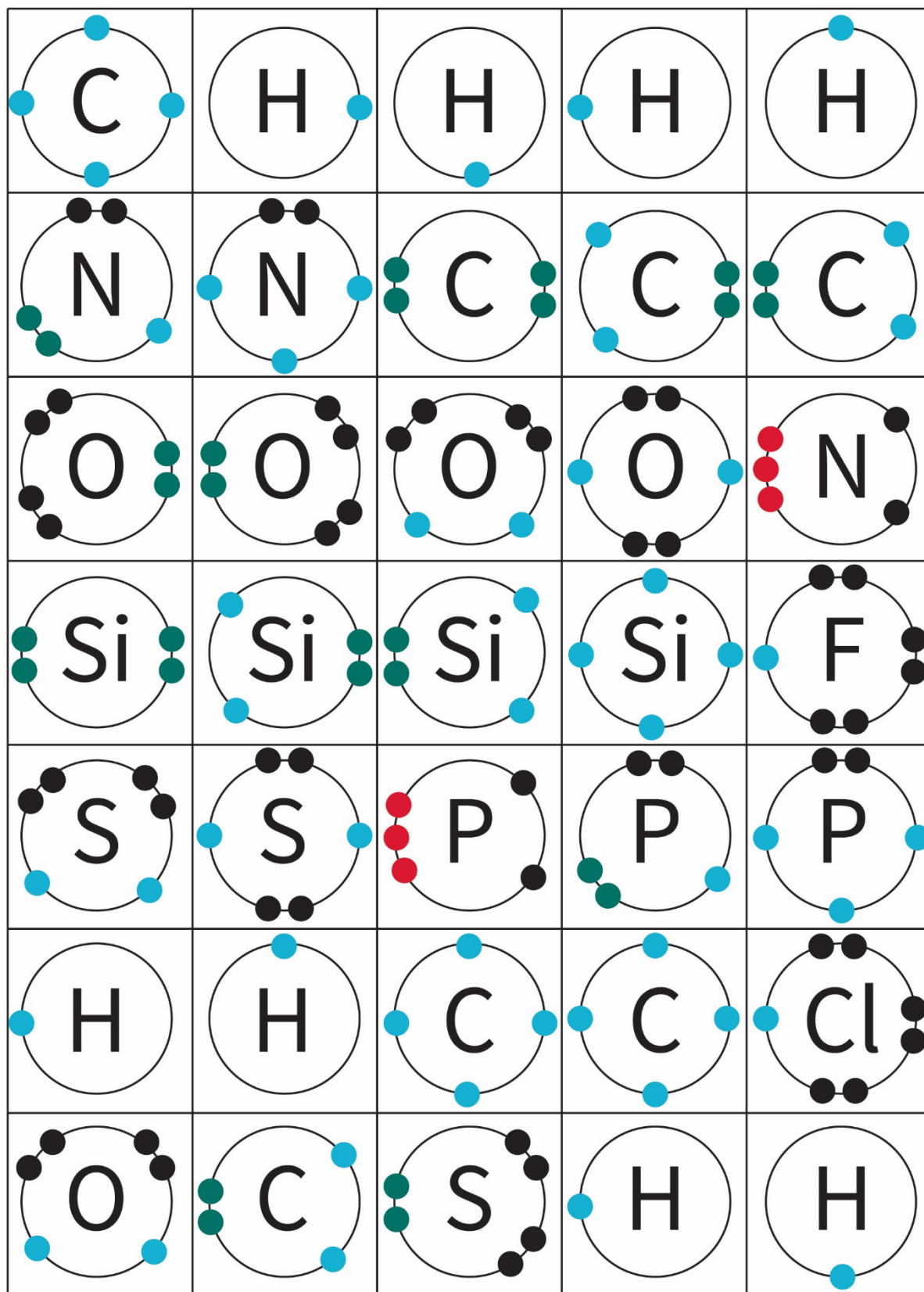
Task 4: Polymerisation

In this final task, learners are asked to create a stop motion animation or GIF to illustrate the process of polymerisation. They will need to use creativity and secure knowledge of structure and bonding to produce their animation.

Covalent bonding cross files



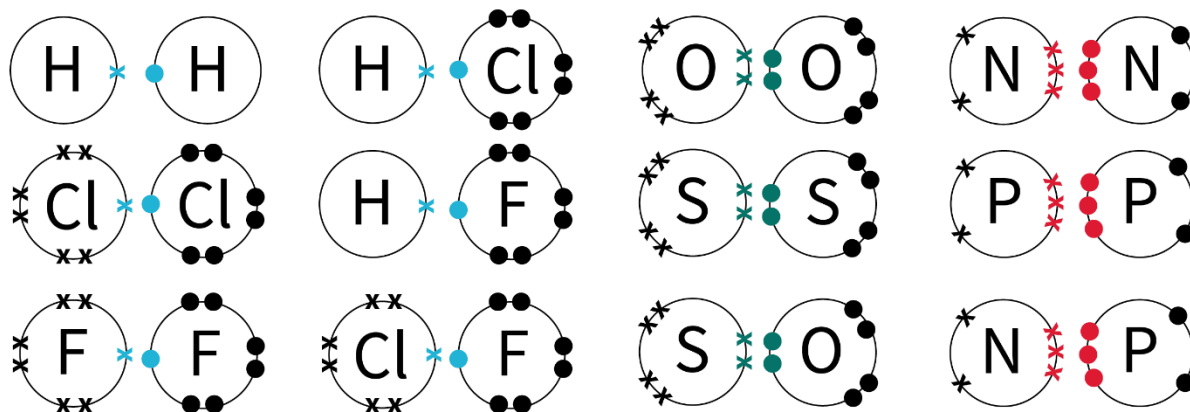
Covalent bonding dot tiles



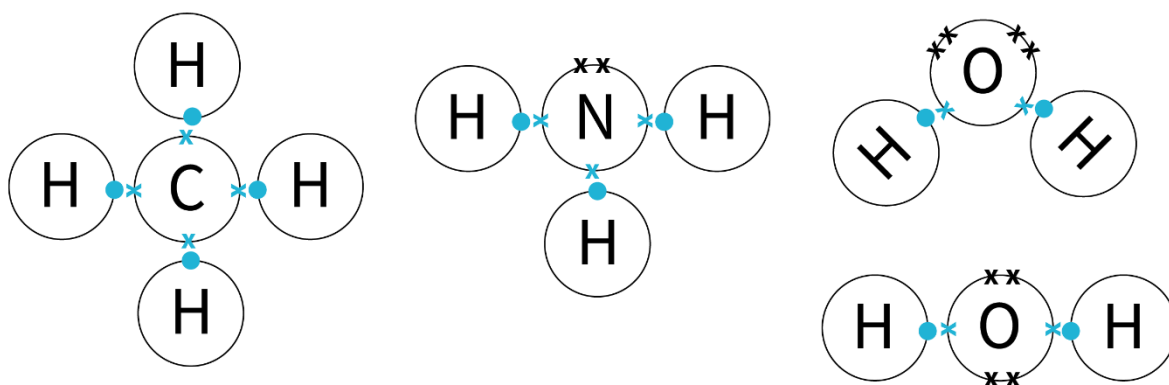
Answers

Task 1: Building bonds

1. Learners may have some or all of the following combinations of tiles:



2. Learners may have assembled some or all of the following simple covalent molecules:



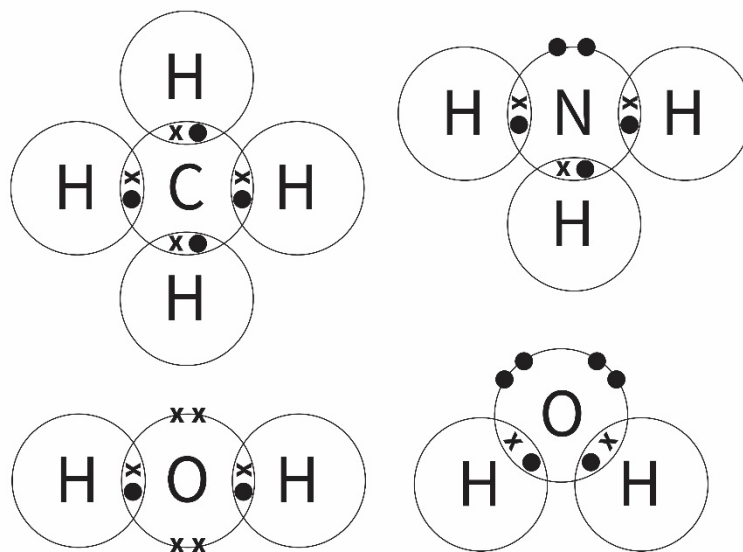
(a) Differences:

- These molecules are all larger
- They only contain single covalent bonds
- They all have a different shape

(b) The two oxygen tiles are to allow different structures and shapes to be arranged. Both the oxygen tiles have 2 single covalent bonds but in one the bonds are adjacent to each other and in the other the bonds are opposite each other.

(c) CH_4 , NH_3 , H_2O

(d)



3.

- (a) The smallest molecule you can make is O_2 as it contains only two atoms.
- (b) There are lots of possible combinations of three tiles. All learners should be able to arrange 5–8 different molecules, many will be able to arrange 8–10 molecules and some will arrange 10–16 molecules. Examples include: CO_2 , SiO_2 , CS_2 , SiS_2 , NOH , POH , HNS , HPS , $PSCI$, PSF , $POCl$, POF , $NOCl$, NOF , $NSCl$ and NSF .
- (c) There are a great many molecules that can be arranged with four tiles. Challenge learners to arrange 10 or more combinations of tiles. Some examples are: H_2CO , COF_2 , Cl_2CO , $CSCl_2$, CF_2S , CH_2S , C_2O_2 , O_2Si_2 , H_2SiO , $SiOF_2$, Cl_2SiO , $SiSCl_2$, SiF_2S and SiH_2S .

Challenge

This is open ended and you could end up with any number of combinations of weird and wonderful molecules. Depending on the interest and ability of your group you could steer learners towards building large hydrocarbons, especially if you want them to be able to name their molecule in part (c).

- (a) This will depend on the structure they have arranged with their tiles.

Tip: Get learners to take a photo of the tiles before they try to draw their dot and cross diagram. This will prevent any problems with the tiles moving while they are drawing and give them something to compare to once the tiles have been tidied away.

- (b) The simplest way to write a formula is to count the number of atoms of each element. To challenge learners even further ask them how they decided which element to write down first.

Extension: You could tell learners about the 'Hill system' of ordering the elements within chemical formulas. To take it even further you could introduce condensed formulas which give even more information about the structure of the molecule.

- (c) If learners have built a 'real' molecule they should be able to search online using the formula to find out if it has a chemical name.

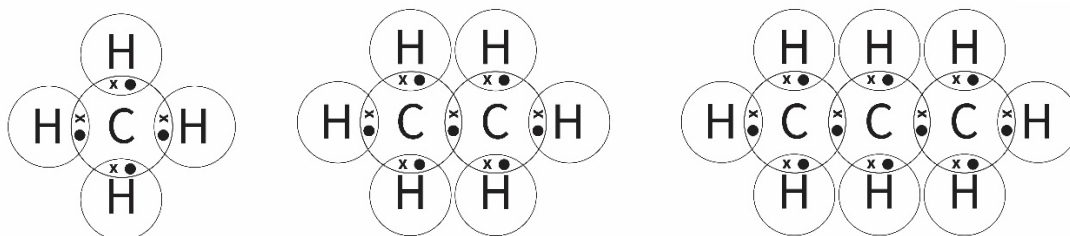
Task 2: Simple covalent molecules

Name of molecule	Formula	Draw the dot and cross diagram
Water	H ₂ O	
Hydrochloric acid	HCl	
Carbon dioxide	CO ₂	
Methane	CH ₄	
Nitrogen	N ₂	
Ammonia	NH ₃	
Extension: Name of molecule	Formula of molecule	Any simple covalent compound made using the tiles eg. O ₂ , C ₂ H ₄ , NOH etc

Task 3: Hydrocarbons

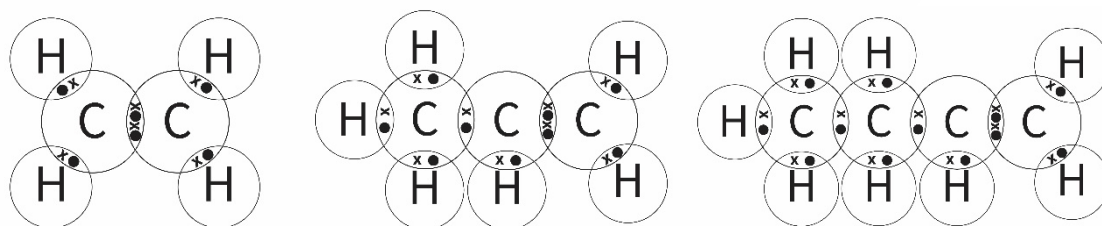
Alkanes

1. n/a
2. See table
- 3.



Alkenes

4. The alkene homologous series contains a carbon-carbon double bond. You cannot have a carbon-carbon double bond in a molecule with just one carbon atom.
5. See table
- 6.

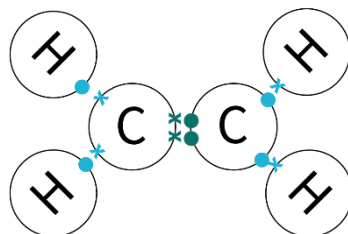


Alkane series	Formula	Alkene series	Formula
Methane	CH_4		
Ethane	C_2H_6	Ethene	C_2H_4
Propane	C_3H_8	Propene	C_3H_6
Butane	C_4H_{10}	Butene	C_4H_8
Pentane	C_5H_{12}	Pentene	C_5H_{10}
Hexane	C_6H_{14}	Hexene	C_6H_{12}
Heptane	C_7H_{16}	Heptene	C_7H_{14}
Octane	C_8H_{18}	Octene	C_8H_{16}
Nonane	C_9H_{20}	Nonene	C_9H_{18}
Decane	$\text{C}_{10}\text{H}_{22}$	Decene	$\text{C}_{10}\text{H}_{20}$

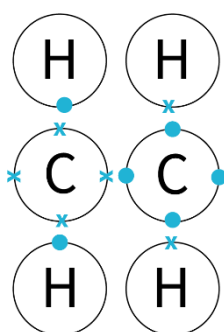
7. Learners should notice the patterns which lead to the general formula for the alkanes ($\text{C}_n\text{H}_{2n+2}$) and the alkenes (C_nH_{2n}).

Task 4: Polymerisation

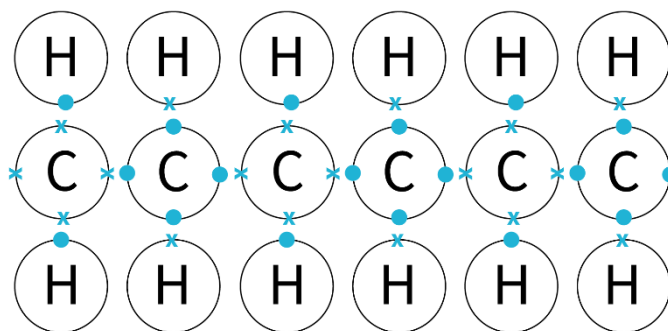
1.



2.



3.



4. See an example of a stop motion video using the covalent bonding tiles from this resource at <https://rsc.li/3eiWEVv>