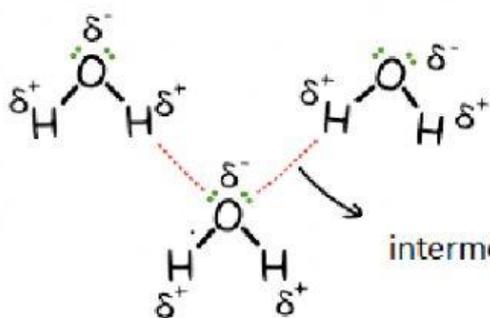


## Organic chemistry IMF (Intermolecular forces)



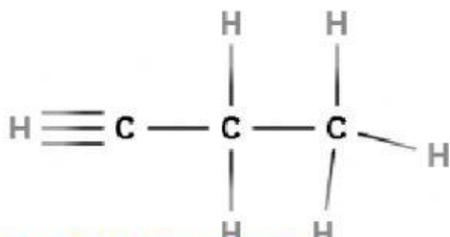
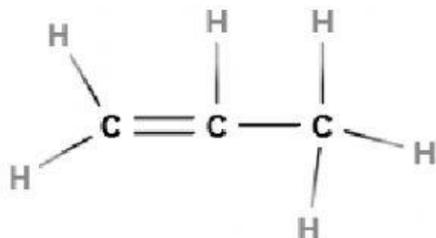
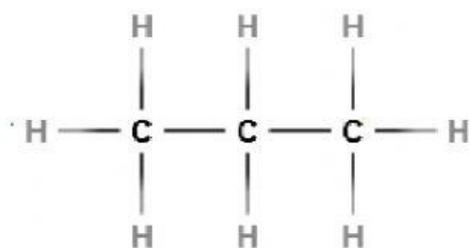
Remember IMF are the forces of attraction between molecules

- ✓ First we need to identify if the molecules in a specific homologous series are polar or non-polar and
- ✓ then we can decide what type of IMF exists between them

### Alkane, alkenes and alkynes

Are all non-polar

\*For a molecule to be polar- it needs to have a slightly negative and slightly positive side of the molecule. Which these 3 homologous series don't have.



Thus the IMF are all Van der Waals, London

The site below is **Super** useful to, not only draw organic molecules but to check their names and properties.

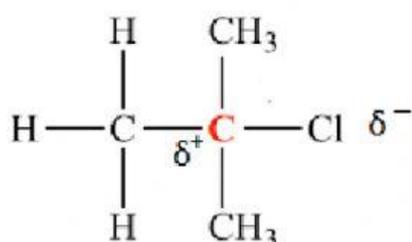
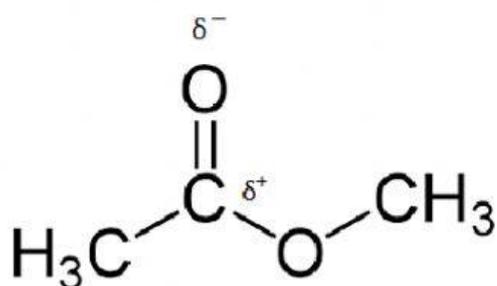
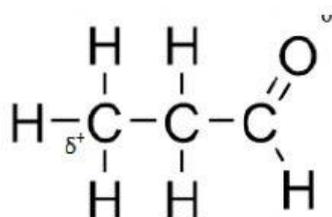
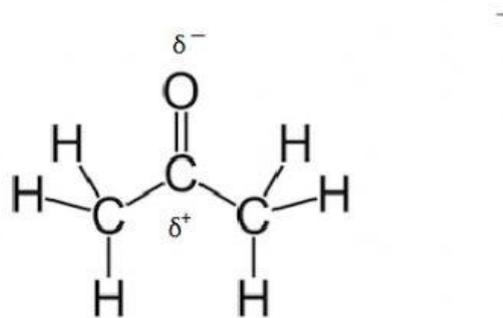
<http://molview.org/>

Just watch this quick video beforehand to show you how to use the site ☺

[https://www.google.com/search?q=molview&source=lmns&bih=1180&biw=2400&client=firefox-b-d&hl=en-GB&ved=2ahUKEwiau4SQtaToAhVE2xoKHXmBCJMQ\\_AUoAHoECAEQAA](https://www.google.com/search?q=molview&source=lmns&bih=1180&biw=2400&client=firefox-b-d&hl=en-GB&ved=2ahUKEwiau4SQtaToAhVE2xoKHXmBCJMQ_AUoAHoECAEQAA)

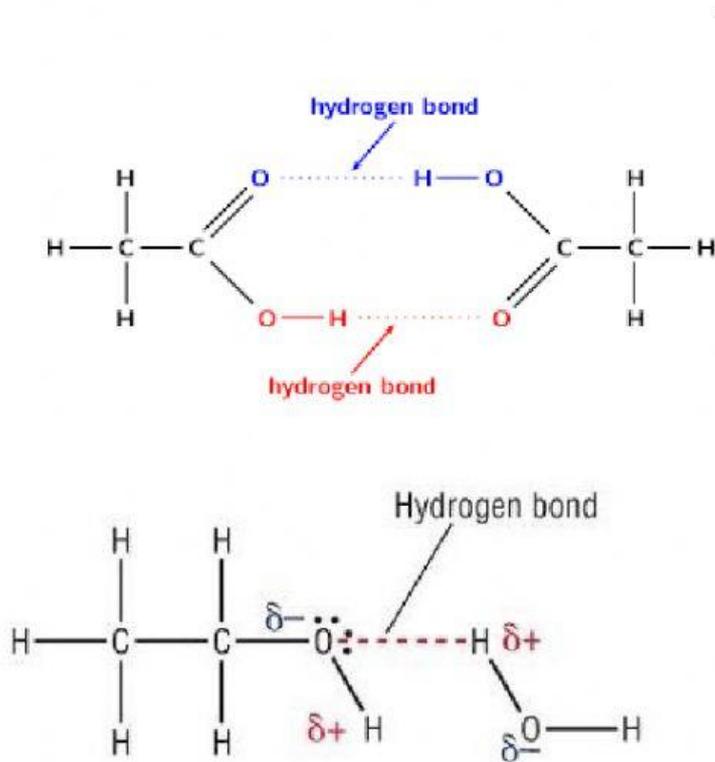
### Halo alkanes/alkyl-halides, esters, ketones and aldehydes

Then there are the polar molecules



The IMF are all Van der Waals, dipole-dipole and Van Der Waals, London (in the rest of the molecule that is not polar)

But alcohols and carboxylic acids have a special type of strong IMF called Hydrogen bonding (this forms between H and N,O or F)



The IMF are: Hydrogen bonding

But remember

Alcohols have 1 site for hydrogen bonding and carboxylic acids have 2 sites for hydrogen bonding

And Van Der Waals, London (in the rest of the molecule that is not polar)

Strength of IMF decreases

Hydrogen bonding

Van der Waals, dipole-dipole

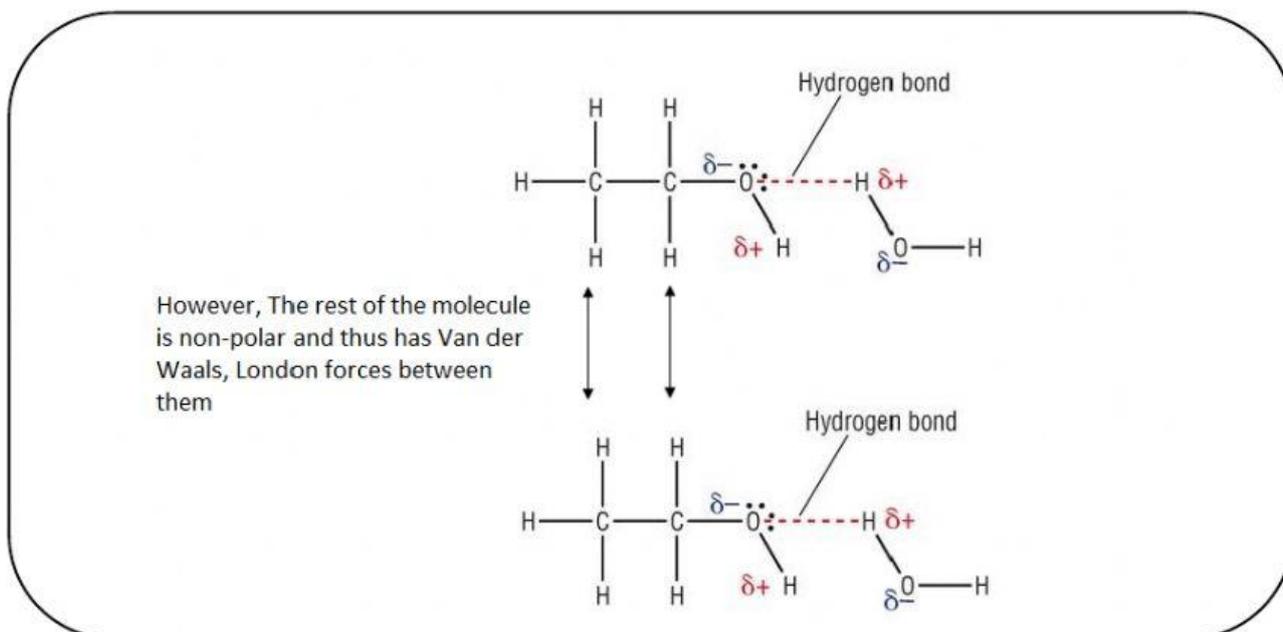
Van der Waals, London

Volatility: How easily the liquid changes to a vapour

Vapour pressure: the pressure caused by the produced vapour. It's an indication of the ease of evaporation of a liquid. The higher the vapour pressure of a liquid at a given temperature the lower the boiling point. (at atmospheric pressure)

Viscosity- measure the resistance of flow a fluid (thickness)

Eg. Water has a low viscosity and honey has a higher viscosity



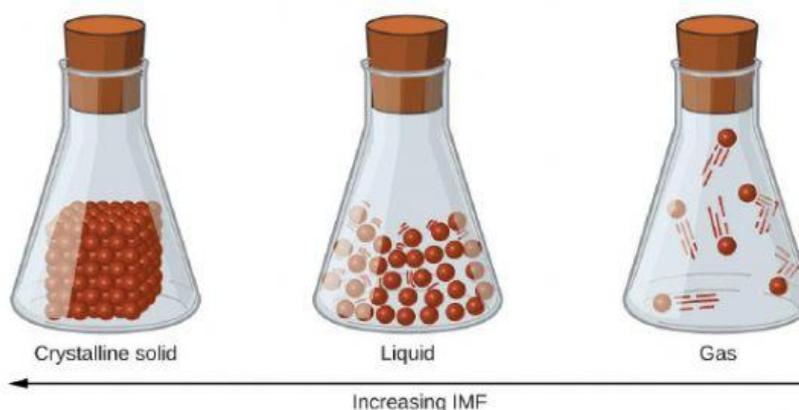
- ✓ The stronger the IMF – the higher the melting and boiling point of a substance, since it would require more energy to overcome intermolecular forces
- ✓ The stronger the IMF – the higher the viscosity of the substance, since it would have a higher resistance to flow.

(Think of a solid, liquid or gas- which of these has a higher viscosity: the solid.

And which has the strongest IMF: the solid

The higher the viscosity of a substance the stronger the IMF)

- ✓ The stronger the IMF of a substance the lower the vapour pressure and volatility (the 2 properties are closely linked). Thus substance is less likely to be a vapour.



It is important to note that when you compare compounds from different homologous series, the molar/molecular masses need to be the same or very close.

## Example 1: comparing different homologous series

The example outlines the **key words** that need to be used when answering the questions

Ensure to compare **all** the compounds that they refer to

| Experiment | Organic compound   | Molar mass (g·mol <sup>-1</sup> ) | Boiling point (°C) |
|------------|--|-----------------------------------|--------------------|
| I          | A CH <sub>3</sub> COOH   | 60,5                              | 118                |
|            | B CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> OH                 | 60,1                              | 97                 |
|            | C CH <sub>3</sub> CH <sub>2</sub> CHO                                | 58,1                              | 48                 |
| II         | D CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> COOH               | 88,1                              | 163                |
|            | E CH <sub>3</sub> (CH <sub>2</sub> ) <sub>3</sub> CH <sub>2</sub> OH | 88,1                              | 137                |
|            | F CH <sub>3</sub> (CH <sub>2</sub> ) <sub>3</sub> CHO                | 88,1                              | 103                |

1.1) Which compound (A, B or C) in experiment 1 has the highest melting point?

A

Since it has the **strongest IMF (2 sites for Hydrogen bonding)**

Thus it **requires the most energy to weaker the intermolecular forces**

Compared to

B which has **slightly weaker Hydrogen bonding (because it only one site for Hydrogen bonding)**

And compared to

C which has the **weakest IMF of the three (Van der Waals, dipole-dipole)**

1.2) Which compound (A, B or C) in experiment 1 has the highest viscosity?

A

Since it has the **strongest IMF (2 sites for Hydrogen bonding)**

Thus it **has the greatest resistance to flow**

Compared to

B which has **slightly weaker Hydrogen bonding (because it only one site for Hydrogen bonding)**

And compared to

C which has the ***weakest IMF of the three (Van der Waals, dipole-dipole)***

1.3) Which compound (A, B or C) in experiment 1 has the highest volatility?

C

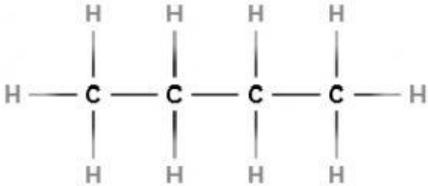
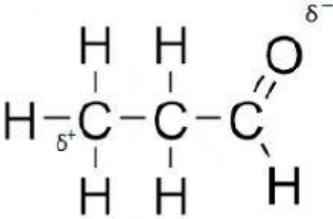
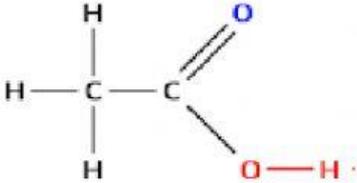
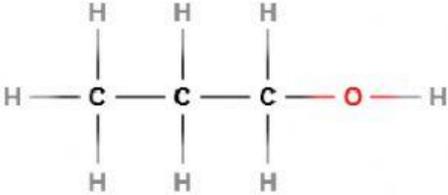
Since it has the ***weakest IMF of the three (Van der Waals, dipole-dipole)***

*Compared to*

B which has **stronger Hydrogen bonding (one site for Hydrogen bonding)**

While A has the ***strongest IMF (2 sites for Hydrogen bonding)***

## Question 2

| Molecule  | Type of IMF   | Molar mass (g.mol <sup>-1</sup> ) |
|---|---|-----------------------------------|
|    | 2.1a) Van der Waals, London<br><br>Van der Waals, Dipole-Dipole<br><br>Hydrogen bonding | 58g.mol <sup>-1</sup>             |
|    | b) Van der Waals, London<br><br>Van der Waals, Dipole-Dipole<br><br>Hydrogen bonding    | 58g.mol <sup>-1</sup>             |
|   | c) Van der Waals, London<br><br>Van der Waals, Dipole-Dipole<br><br>Hydrogen bonding    | 60g.mol <sup>-1</sup>             |
|  | d) Van der Waals, London<br><br>Van der Waals, Dipole-Dipole<br><br>Hydrogen bonding    | 60g.mol <sup>-1</sup>             |

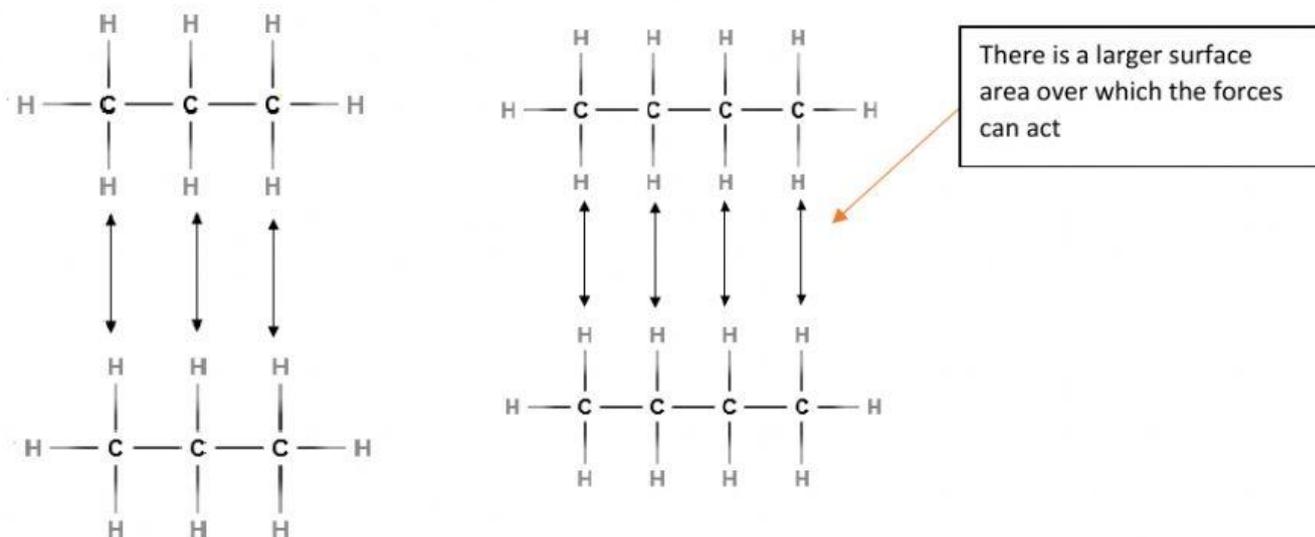
2.2) State the IUPAC name of the compound above that has the highest melting point.

2.3) State the IUPAC name of the compound above that has the lowest viscosity.

2.4) State the IUPAC name of the compound above that has the highest vapour pressure.

2.5) What is the controlled variable in the above experiment.

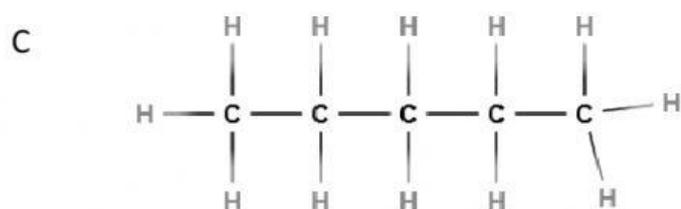
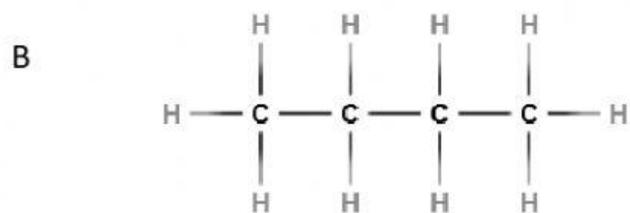
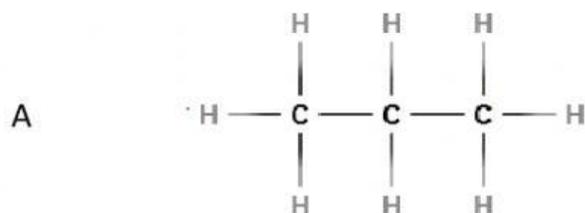
## Chain length and IMF strength



The longer the chain of carbons the

- ✓ stronger the IMF (Van der Waals, London)
- ✓ since it has a larger surface area

Example 1



1.1) Which molecule has the highest boiling point?

- C
- Since it has the largest surface area
- Thus the strongest intermolecular forces (Van der Waals, London)
- Thus requires the most energy to weaken the intermolecular forces

1.2) Which molecule has the lowest viscosity?

- A
- Since it has the largest surface area
- Thus the weakest intermolecular forces (Van der Waals, London)
- Thus it has the lowest resistance to flow.

1.3) Which molecule has the lowest vapour pressure?

- C
- Since it has the largest surface area
- Thus the strongest intermolecular forces (Van der Waals, London)
- Thus is least likely to be a vapour.

## Question 2

|   |             |
|---|-------------|
| A | Ethanol     |
| B | Propan-1-ol |
| C | Butan-1-ol  |
| D | Pentan-1-ol |

State only the letter of the correct option:

2.1) Which compound has the highest boiling point?

A            C

B            D

2.2) Which compound has the lowest viscosity?

A            C

B            D

2.3) Which compound has the highest vapour pressure?

A            C

B            D