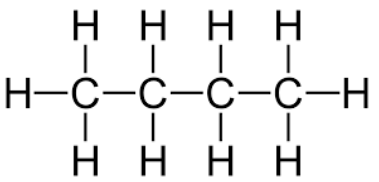
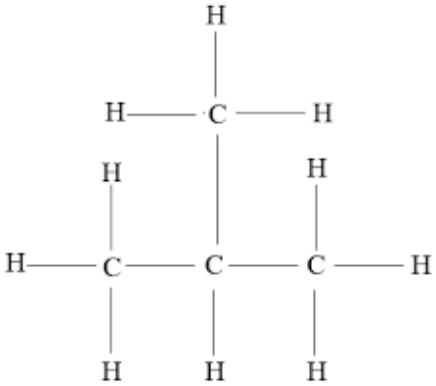
# Isomers

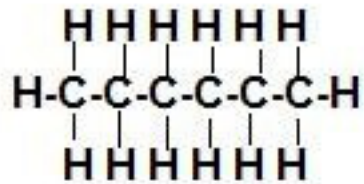
- Structural isomers are two or more compounds that have the same molecular formula but different structural formulae – the atoms are joined together in different ways.

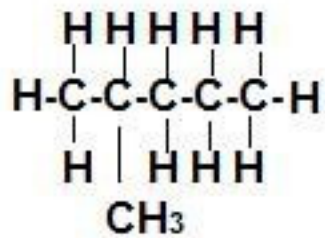
- E.g butane and 2-methylpropane are both isomers of $C_4H_{10}$

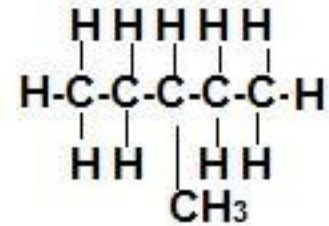


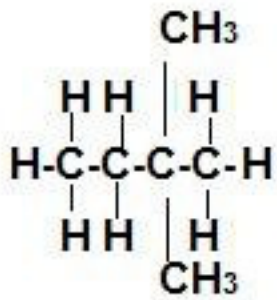


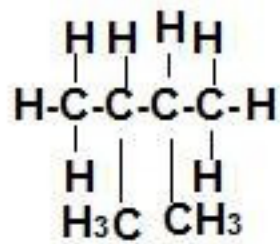
- Make 3D models of all the structural isomers of $C_6H_{14}$ and draw the full structural formula.











# Combustion

- The most important reaction of alkanes is combustion.

- These compounds form the basis of fuels such as petrol and natural gas.

- Complete combustion requires the presence of excess….?
- …..air/oxygen
- The products of complete combustion are….?
- …..carbon dioxide and water

- Draw a balanced symbol equation for the complete combustion of ethane.

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- $2C_2H_6\ (g) + 7O_2\ (g) \rightarrow 4CO_2\ (g) + 6H_2O\ (l)$

- Incomplete combustion occurs when….?

- …..there is a limited supply of air/oxygen

- Paraffin wax contains a mixture of hydrocarbons with between 20 and 40 carbons.

- When we light a candle, we combust paraffin wax. This gives off $CO_2$.

- We can test for $CO_2$.

- What is the formula for calcium hydroxide?

- $Ca(OH)_2$

- If we add carbon dioxide to aqueous calcium hydroxide we observe a reaction. Test this in the lab and explain what is happening with a chemical equation.

- $Ca(OH)_2\,(aq) + CO_2\,(g) \rightarrow CaCO_3\,(s) + H_2O\,(l)$

- Carbon dioxide is not always the product of combustion. Why not?

# Incomplete combustion

- Incomplete combustion results in the formation of carbon monoxide and soot (C)

- What do you think are the products of incomplete combustion. Can you write balanced equations for the incomplete combustion of $C_2H_6$?

- $2C_2H_6\ (g) + 5O_2\ (g) \rightarrow 4CO\ (g) + 6H_2O\ (l)$
- $2C_2H_6\ (g) + 3O_2\ (g) \rightarrow 4C\ (s) + 6H_2O\ (l)$

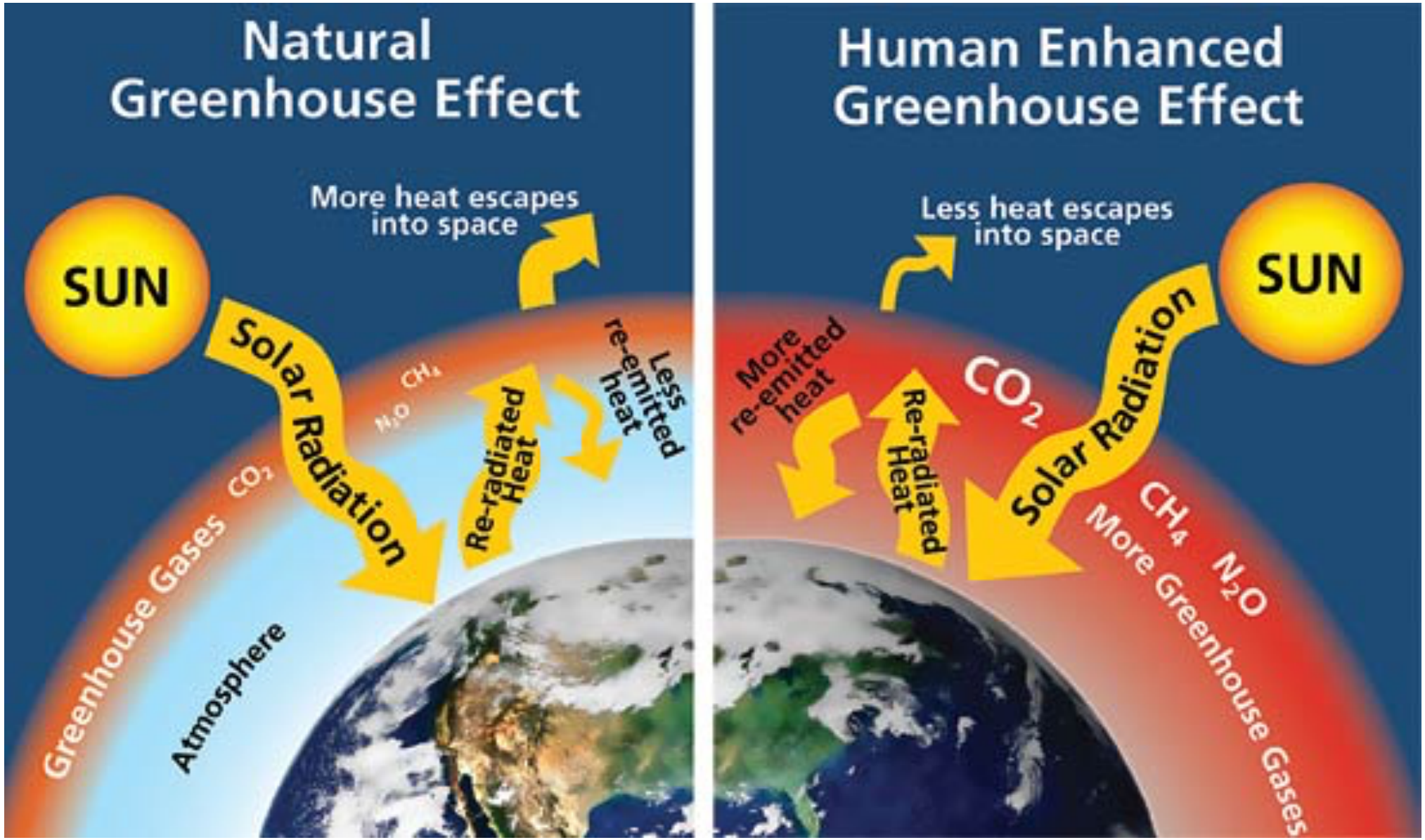
- Why is incomplete combustion dangerous?
- Carbon monoxide is a colourless, odourless poisonous gas.
- Soot particulates, like any fine solid 'dust' is harmful when absorbed on the sensitive tissue of the linings of the nose, throat and lungs.

# Environmental Chemistry

# The greenhouse effect and global warming

- The greenhouse effect is a natural phenomenon necessary for life on earth.

- The earth emits energy in the form of infra red radiation. Some escapes into into space but some is absorbed by molecules in the atmosphere. Some of this is transformed into vibrational and translational energy and heats the lower atmosphere. The reminder is re-emitted in all directions – some is directed back to earth and is reabsorbed heating the earths surface. This is known as the greenhouse effect and without it the average surface temperature of the earth would be about -15 °C. The oceans would be solid and there would be no life on earth.


Natural
Greenhouse Effect
More heat escapes
into space
SUN
Solar Radiation
Re-radiated
Heat
Less
re-emitted
heat
$CH_4$
$N_2O$
$CO_2$
Greenhouse Gases
Atmosphere
Human Enhanced
Greenhouse Effect
Less heat escapes
into space
SUN
Solar Radiation
More
re-emitted
heat
Re-radiated
Heat
$CO_2$
$CH_4$ $N_2O$
More Greenhouse Gases

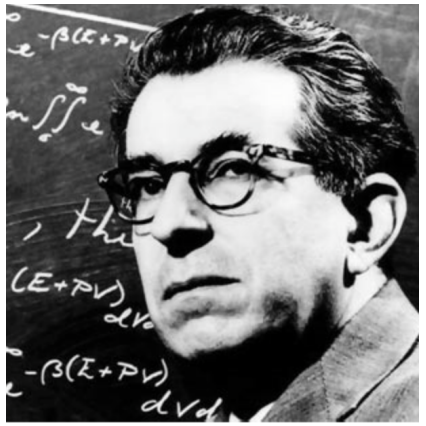
- The average temperature has risen by over 0.5 °C over the last 100 years.

- There is broad consensus that this is due to human activity, particularly the increase in the concentrations of $CO_2$.

- Most experts agree that the main source of additional $CO_2$ is due to the burning of fossil fuels.

# Boiling Points in a homologous series

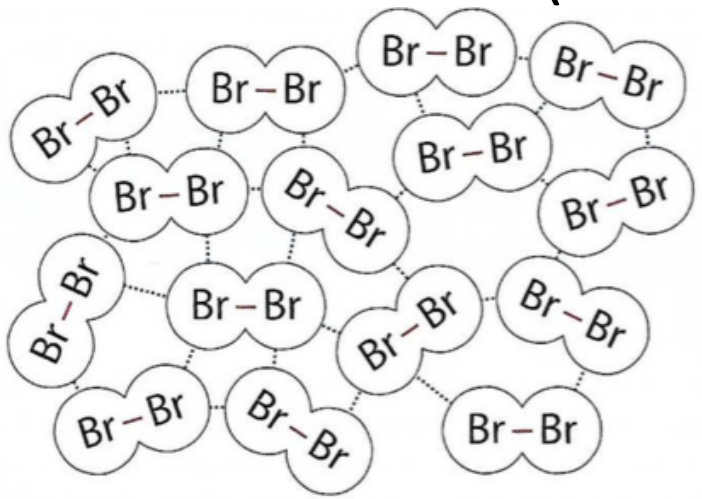
# London forces



Fritz Wolfgang London (1900 – 1954)

- The main type of intermolecular force between non-polar atoms/molecules is the **London (dispersion) force**.

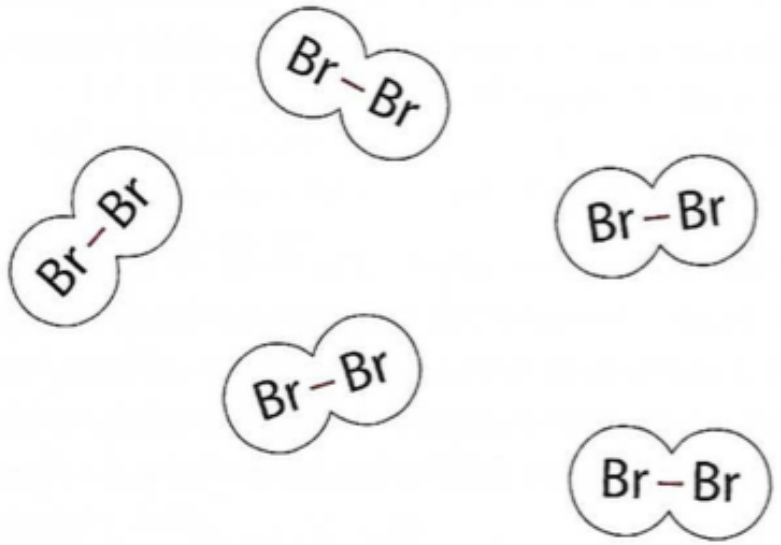
- Bromine molecules ($Br_2$) in the liquid phase. **Intra**molecular forces (covalent bonds) are shown in red. **Inter**molecular forces (London forces) are the dashed blue lines.




- How can we gauge the strength of the intermolecular forces?
- What happens when we boil bromine?

Picture taken from Chemistry for the IB diploma, S Owen

- In gaseous bromine the **intra**molecular forces (covalent bonds) are still present but the **inter**molecular forces have been overcome. For simple molecules, the boiling point gives us information about how much energy is needed to overcome the **inter**molecular forces (how strong the intermolecular forces are).

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Picture taken from Chemistry for the IB diploma, S Owen

- In general, London forces get stronger as the relative molecular mass increases.

- This is because as the $M_r$ increases.

- Does ethane have a higher or lower boiling point than butane?

- Butane has a higher $M_r$ than ethane and so the London forces between butane molecules are stronger than those between ethane molecules.