

### 11.3 Fuels

I can:

- 1 Name the fossil fuels: coal, natural gas and petroleum
- 2 Name methane as the main constituent of natural gas
- 3 State that hydrocarbons are compounds that contain hydrogen and carbon only
- 4 State that petroleum is a mixture of hydrocarbons
- 5 Describe the separation of petroleum into useful fractions by fractional distillation
- 6 Describe how the properties of fractions obtained from petroleum change from the bottom to the top of the fractionating column, limited to:
  - (a) decreasing chain length
  - (b) higher volatility
  - (c) lower boiling points
  - (d) lower viscosity
- 7 Name the uses of the fractions as:
  - (a) refinery gas fraction for gas used in heating and cooking
  - (b) gasoline /petrol fraction for fuel used in cars
  - (c) naphtha fraction as a chemical feedstock
  - (d) kerosene /paraffin fraction for jet fuel
  - (e) diesel oil/ gas oil fraction for fuel used in diesel engines
  - (f) fuel oil fraction for fuel used in ships and home heating systems
  - (g) lubricating oil fraction for lubricants, waxes and polishes
  - (h) bitumen fraction for making roads

### 10.3 Air quality and climate

I can:

- 2. State the source of each of these air pollutants, limited to:
  - (a) carbon dioxide from the complete combustion of carbon-containing fuels
  - (b) carbon monoxide and particulates from the incomplete combustion of carbon-containing fuels
  - (c) methane from the decomposition of vegetation and waste gases from digestion in animals
  - (d) oxides of nitrogen from car engines
  - (e) sulfur dioxide from the combustion of fossil fuels which contain sulfur compounds

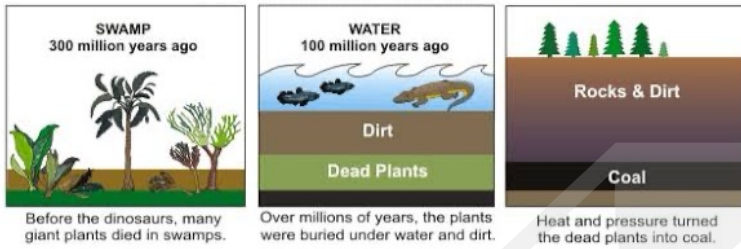
# Fuels summary

**Organic chemical**: compounds that contain carbon covalently bonded to Hydrogen  
(may also include other elements (ex: Oxygen, Nitrogen, Sulfur))

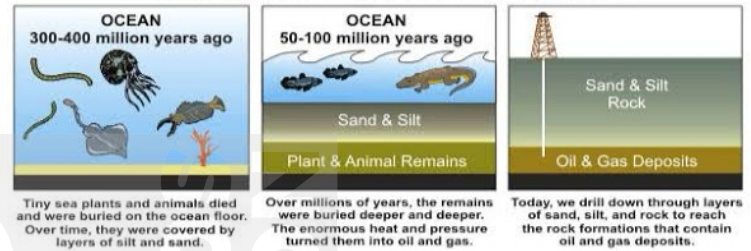
↳ **hydrocarbon**: contains Carbon and Hydrogen atoms only ex:  $\text{CH}_4$   $\text{C}_2\text{H}_6$   $\text{C}_6\text{H}_{12}\text{O}_6$   $\text{CO}_2$   
✓ ✓ x x

**Fossil fuels**: hydrocarbon-containing material formed from the remains of dead plant and animals

↳ **Coal**

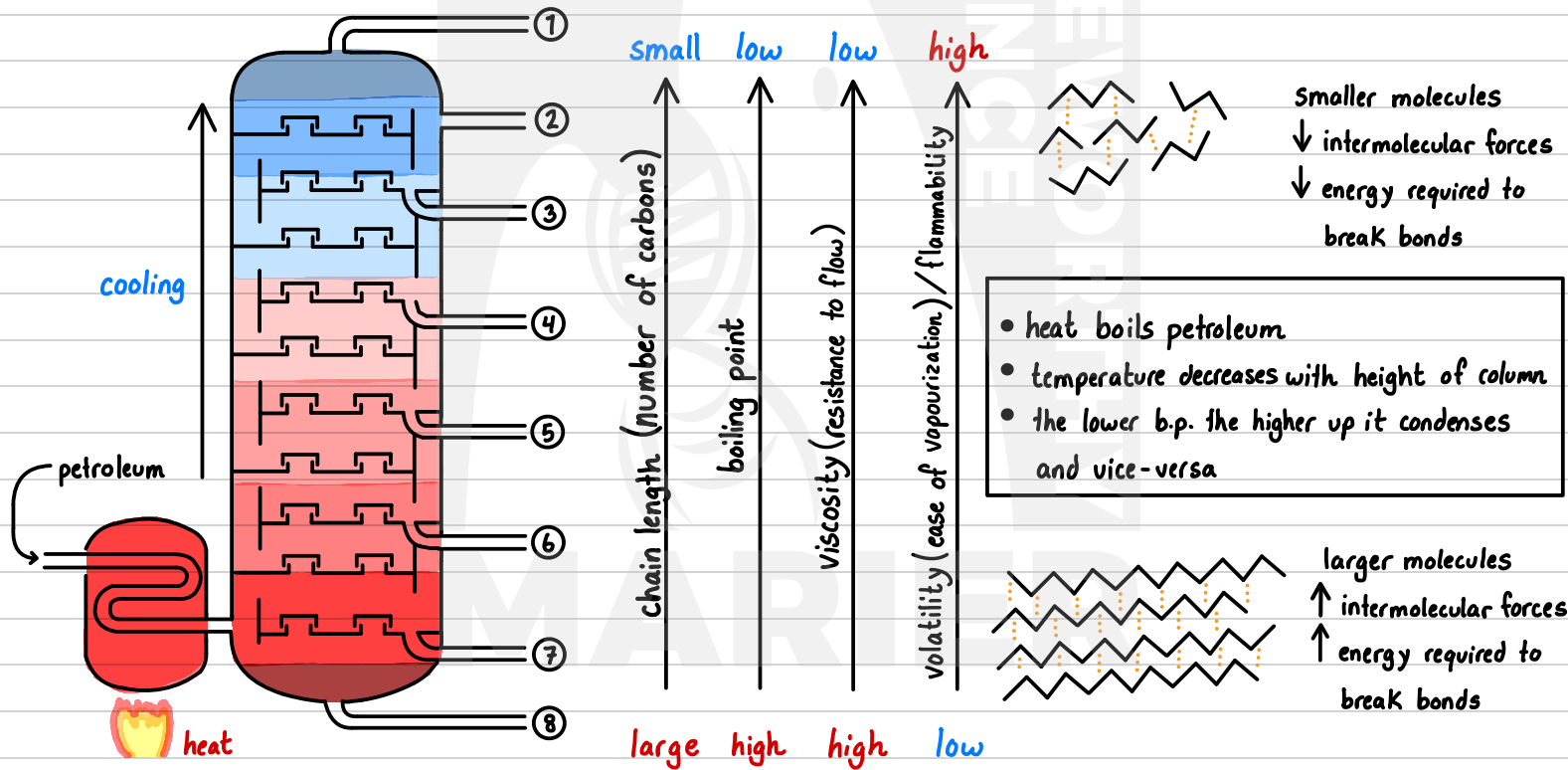


↳ **petroleum (crude oil) and natural gas (methane)**



Petroleum (crude oil) is a mixture of hydrocarbons of varying chain lengths

↳ it can be separated into useful fractions using **fractional distillation**: separation based on boiling points



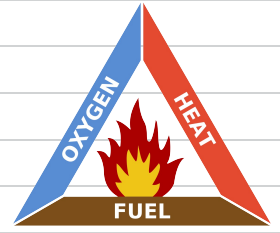
Fraction uses:

- ① refinery gas → bottled gas used in heating and cooking
- ② gasoline / petrol → fuel used in cars
- ③ naphtha → chemical feedstock - base in manufacturing other chemicals ex: paint solvents
- ④ kerosene / paraffin → jet fuel
- ⑤ diesel oil / gas oil → fuel used by diesel engines ex: trucks
- ⑥ lubricating oil → lubricants, waxes, polishes
- ⑦ fuel oil → fuel used in ships and home heating systems
- ⑧ bitumen → making roads (tarmac)

# Air quality and climate summary

**Fuel** : chemical substance that when reacted (combustion) releases energy

**Combustion** : when fuel reacts with oxygen to release energy (heat, light)



## ↳ Complete combustion

- when fuel burns completely in constant / abundant supply of oxygen

general: fuel + oxygen  $\longrightarrow$  carbon dioxide + water



- features:  $\uparrow \text{O}_2$  available  $\uparrow$  energy released  $\downarrow$  / no smoke  blue flame

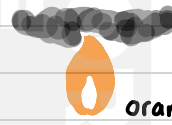
## ↳ Incomplete combustion

- when fuel burns incompletely due to insufficient supply of oxygen

general ex: fuel + oxygen  $\longrightarrow$  carbon dioxide + carbon monoxide + water

fuel + oxygen  $\longrightarrow$  carbon + water

- features:  $\downarrow \text{O}_2$  available  $\downarrow$  energy released  $\uparrow$  smoke  orange flame



Air pollutant	Source	Negative impact
carbon dioxide ( $\text{CO}_2$ )	Complete combustion of carbon-based fuels	Greenhouse gas which contributes to enhanced greenhouse effect $\rightarrow$ climate change
carbon monoxide ( $\text{CO}$ )	Incomplete combustion of carbon-based fuels	toxic to humans, causing suffocation and death (odorless and tasteless) $\rightarrow$ requires detector
carbon (particulate)		<ul style="list-style-type: none"> <li>• can be inhaled causing respiratory problems</li> <li>• deposited on buildings (decreasing aesthetics)</li> </ul>
methane ( $\text{CH}_4$ )	decomposition of vegetation and waste gas from digestion in animals (cows)	Greenhouse gas which contributes to enhanced greenhouse effect $\rightarrow$ climate change
oxides of nitrogen ( $\text{NO}_x$ )	exhaust from internal combustion of car engines	mix with water in atmosphere $\rightarrow$ acid deposition $\hookrightarrow \text{HNO}_3(\text{aq})$ $\hookrightarrow \text{H}_2\text{SO}_4(\text{aq})$
sulfur dioxide ( $\text{SO}_2$ )	combustion of fossil fuels that contain sulfur compounds	<ul style="list-style-type: none"> <li>• damages aquatic ecosystems and organisms</li> <li>• damages leaves, roots, soil of coniferous trees</li> <li>• causes smog <math>\rightarrow</math> impacts human respiration</li> <li>• damages architecture (limestone and marble)</li> </ul>