

Fractional Distillation

Answer the questions below.

1. Define a hydrocarbon.

A molecule made up of hydrogen and carbon atoms only.

2. Name the alkane that contains four carbon atoms.

Butane

3. State the general formula of the alkanes.

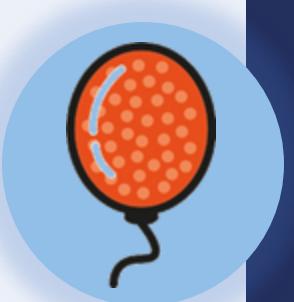
C_nH_{2n+2}

4. Describe what happens when a covalent bond is formed.

Electrons are shared so that each atom gets a full outer shell.

5. Explain why covalent molecules have relatively low boiling points.

There are weak intermolecular forces between molecules which require little energy to overcome.



Fractional Distillation

Do Now:

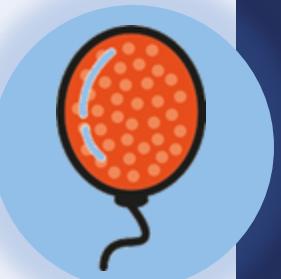
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3. State the general formula of the alkanes.
4. Describe what happens when a covalent bond is formed.
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Drill:

The melting and boiling points of some of the alkanes are given in the table.

1. Identify which state of matter these alkanes would be at room temperature (20 °C).
2. Identify which state of matter these alkanes would be at -50°C.

Alkane	Melting point (°C)	Boiling point (°C)
Methane	-182	-164
Ethane	-183	-89
Propane	-190	-42
Butane	-138	-1



Fractional Distillation

Read Now:

Distillation is a method used to separate a mixture into the different compounds or elements within it based on their boiling points. For example, salt can be separated from sea water by distillation, as when it is heated the water will boil before the salt. The water vapour is then collected into a condenser where it cools down to form a pure liquid. Fractional distillation uses heating to separate the mixture of crude oil into its 'fractions', which are groups of different chemical compounds. Each of these fractions contains hydrocarbons of different lengths which are used for different functions. The shortest hydrocarbon molecules are used as gas fuels, while the longer hydrocarbon molecules are used for heavy fuel oil or bitumen for making tar for roads.

1. State the physical property that distillation uses to separate mixtures.
2. Describe what happens during distillation.
3. Explain why crude oil is a mixture.
4. Explain what is meant by a 'fraction' of crude oil.
5. Give a use of the shorter hydrocarbon chains.



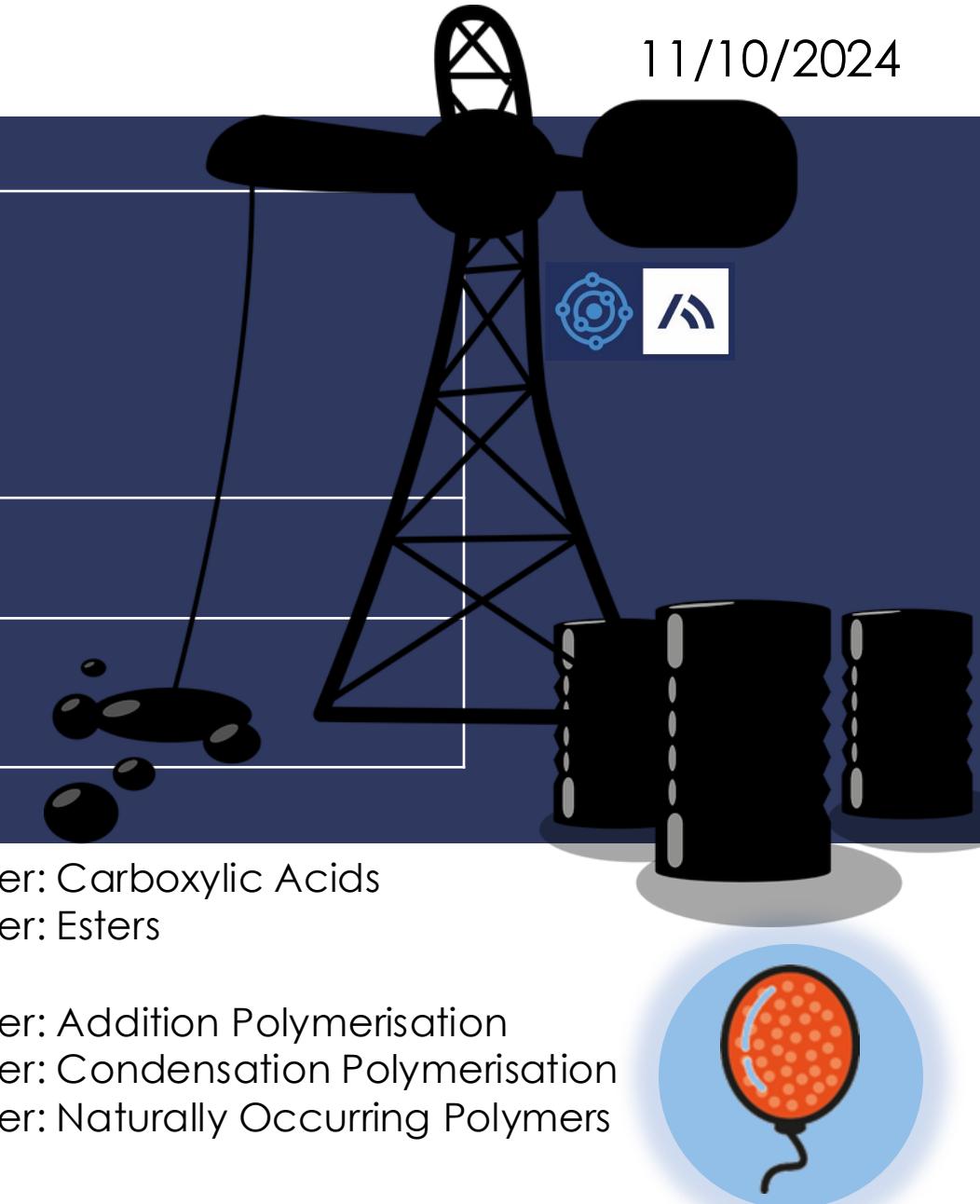
Fractional Distillation

C5.1.3

Science
Mastery

- C5.1.1 Prior Knowledge Review
- C5.1.2 Crude Oil and Hydrocarbons
- **C5.1.3 Fractional Distillation**
- C5.1.4 Combustion of Hydrocarbons
- C5.1.5 Cracking
- C5.1.6 Taking it Further: Alkenes
- C5.1.7 Taking it Further: Alcohols
- C5.1.8 Taking it Further: Producing Ethanol by Fermentation
- C5.1.9 Taking it Further: Producing Ethanol from Ethene

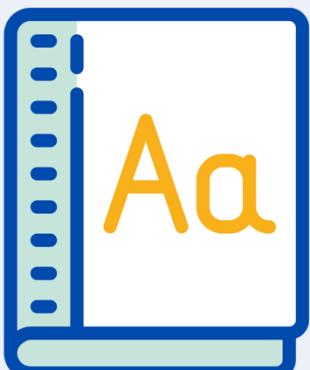
- C5.1.10 Taking it Further: Carboxylic Acids
- C5.1.11 Taking it Further: Esters
- C5.1.12 Polymers
- C5.1.13 Taking it Further: Addition Polymerisation
- C5.1.14 Taking it Further: Condensation Polymerisation
- C5.1.15 Taking it Further: Naturally Occurring Polymers



Following this lesson, students will be able to:

- Describe uses of different fractions of crude oil
- Describe how crude oil is separated by fractional distillation
- Describe and explain trends in the properties of hydrocarbons

Key Words:



fraction

fractional distillation

petrol

diesel

kerosene

viscosity

flammability

This is the fix-it portion of the lesson

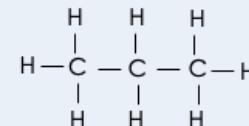
The **fix-it** is an opportunity to respond to gaps in knowledge, especially those identified by the **pre-unit quiz**.

- The teacher should customise this slide as needed, to facilitate
 - **reteach, explanation, demonstration or modelling** of ideas and concepts that students have not yet grasped or have misunderstood.
 - **practise** answering specific questions or of key skills.
 - **redrafting** or **improving** previous work.

Answer the questions below.

1. Which alkane is this?

- A. Ethane
- B. Propane
- C. Butane



2. An alkane has 15 carbons. How many hydrogen atoms would it have?

- A. 30
- B. 32
- C. 34

3. What is crude oil?

- A. A finite resource formed from ancient plankton biomass
- B. A finite resource formed from rocks
- C. A finite resource containing compounds of carbon and water

Fractional Distillation

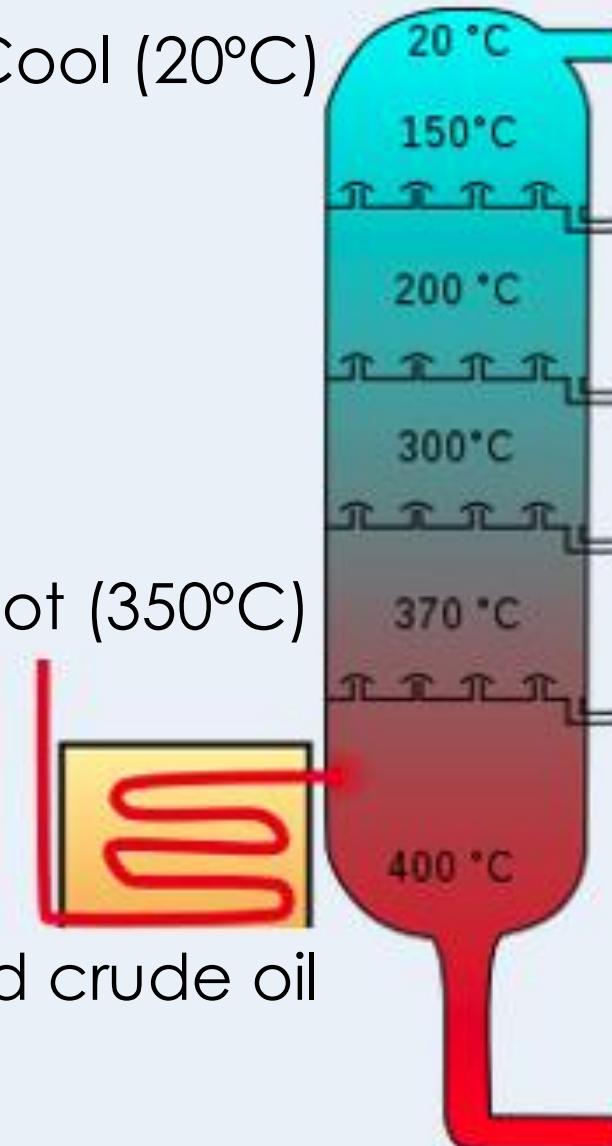
Crude oil is a **mixture** of different hydrocarbons.

It can be separated into **fractions**, each of which contains molecules with a similar number of **carbon atoms**, by **fractional distillation**.

- Crude oil is heated
- Hydrocarbons evaporate
- Fractions cool as they rise up the column (as it is cooler at the top)
- Fractions condense at their boiling points

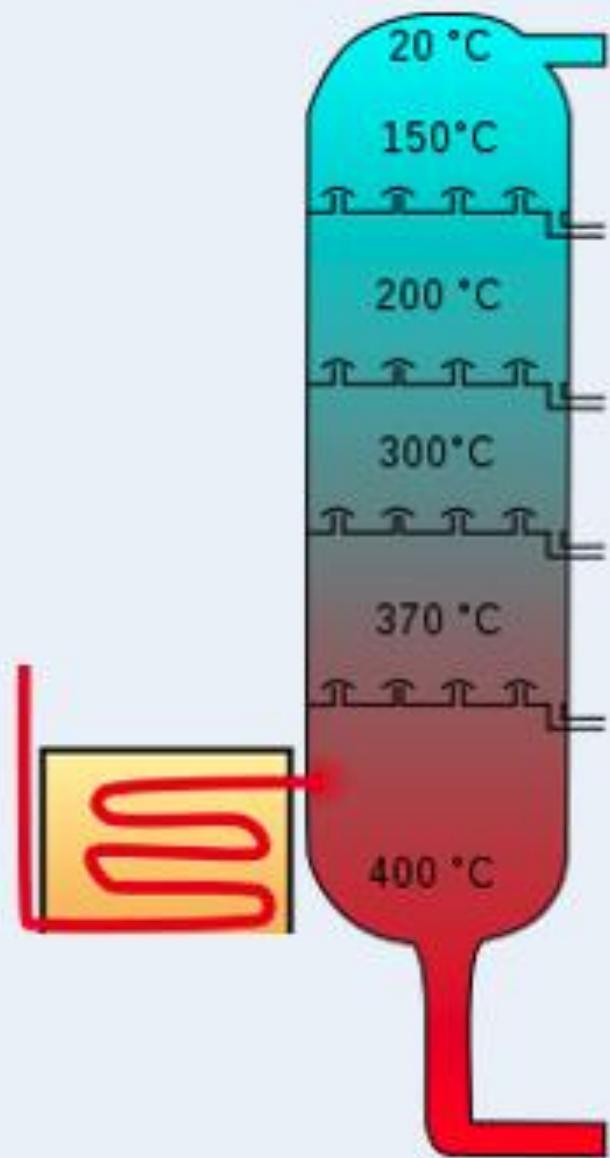
Fractionating Column

Cool (20°C)



Fractions of Crude Oil

Fractionating Column



Liquefied petroleum gases

Used for domestic heating and cooking

Petrol

Used as fuel for cars

Kerosene

Used as fuel for aircraft

Diesel

Used as fuel for some cars and trains

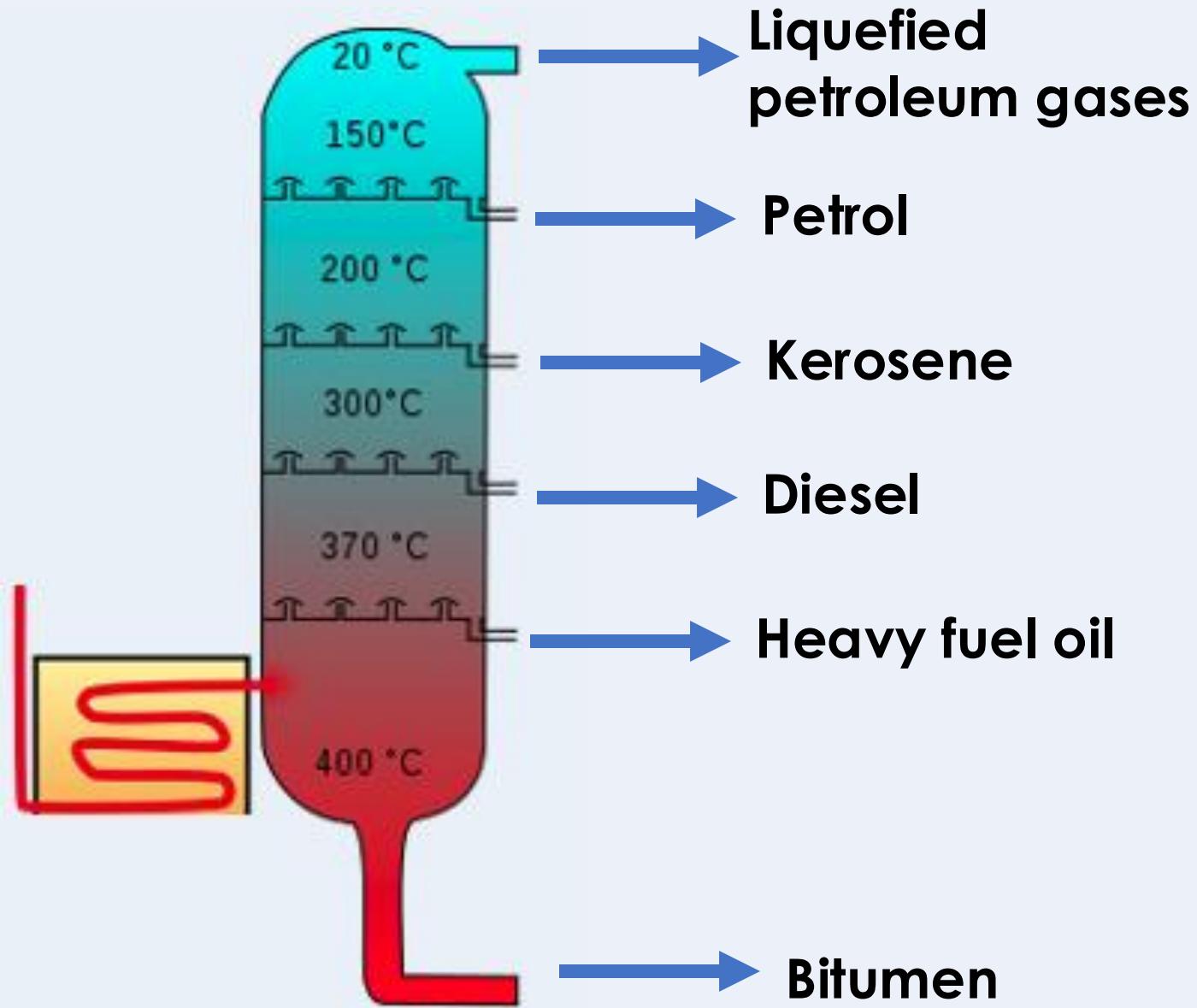
Heavy fuel oil

Used as fuel for ships and power stations

Bitumen

Used in roads and roofing

Properties of Crude Oil Fractions



Small molecules (few carbons in alkane chain)

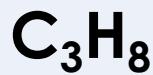
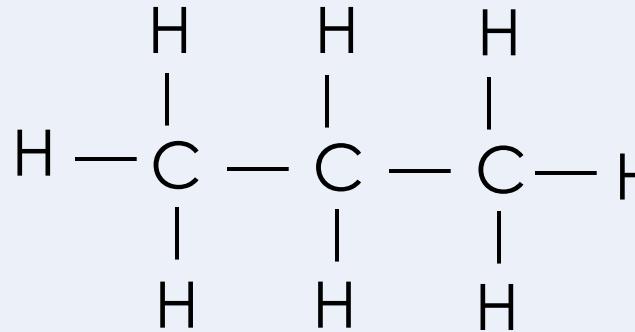
- Low boiling point
- Highly volatile
- Flows easily (low viscosity)
- Highly flammable

- High boiling point
- Low volatility
- Does not flow easily (high viscosity)
- Not very flammable

Large molecules (many carbons in alkane chain)

Molecule Size and Boiling Point

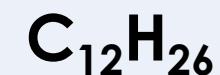
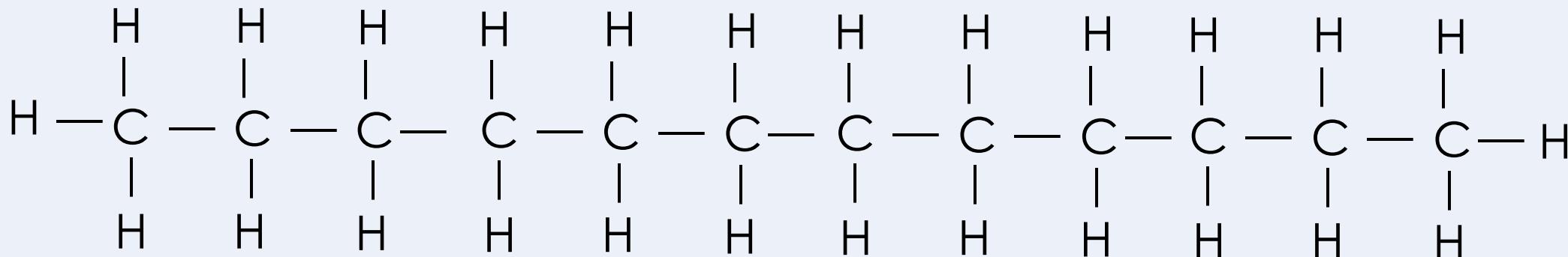
Propane



As molecules get larger, the **intermolecular forces** between them **increase**.

This means that **more energy** is required to overcome the forces, **increasing** the **boiling point**.

Dodecane



Which statements do you agree with?

Fractions with larger molecules are more flammable than fractions of small molecules

Fractions with larger molecules are more viscous than fractions of small molecules

Fractions with larger molecules have higher boiling points than fractions of small molecules

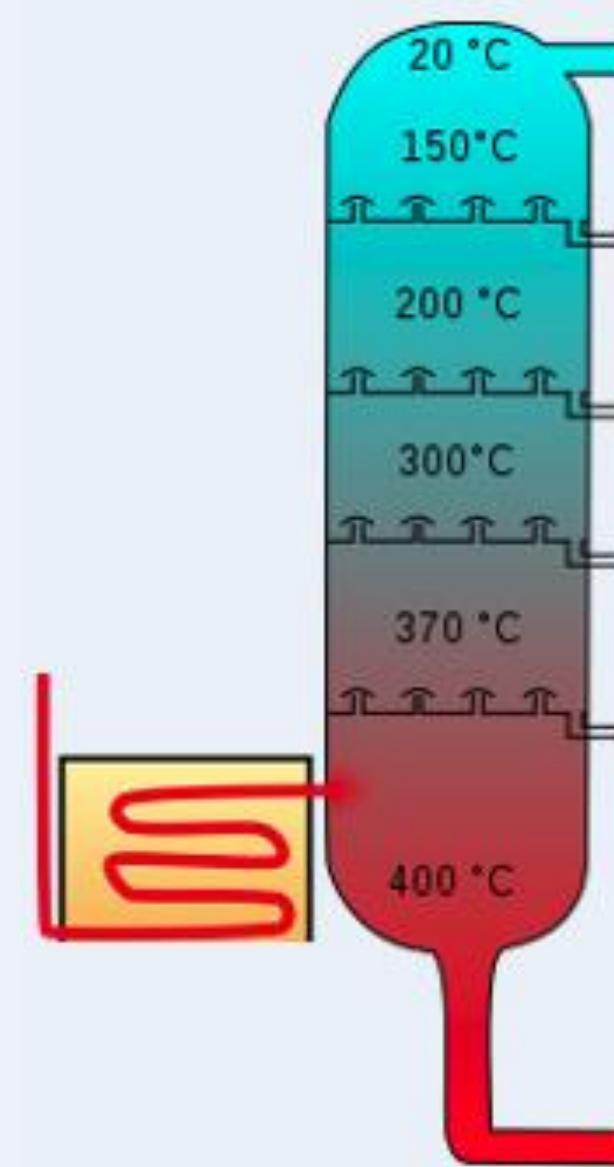
Fractions with larger molecules are more volatile than fractions of small molecules

Describe the process of fractional distillation

Describe how fractional distillation is used to separate crude oil into fractions.

Your answer should include the words:

- crude oil
- fractions
- hydrocarbons
- heated
- evaporate
- boiling point
- condense
- cooling
- height of the fractionating column



Put the stages of fractional distillation in order

Put these steps in order to describe how fractional distillation is used to separate crude oil into fractions.

- A. Hydrocarbons evaporate
- B. Vapours condense
- C. Condensing happens at different boiling points (at different heights in the column)
- D. The fractionating column is hotter at the top (or cooler at the bottom)
- E. Crude oil is heated

E → A → D → B → C

Determine if each of these statements are true or false

1. Fractions of crude oil are compounds **False**
2. The fractions with the largest molecules have the highest boiling points **True**
3. Only the fractions with small molecules are used as fuels **False**
4. Petrol contains smaller molecules than diesel **True**
5. Fractions with the largest molecules are the least volatile **True**

Drill

1. Explain why crude oil is a mixture.
2. Name the piece of equipment used to separate crude oil into fractions.
3. State the physical property that fractions are separated based on.
4. Name the fraction with the smallest molecules.
5. Name the fraction with the largest molecules.
6. Give two fractions that are used as fuels for transport.
7. Describe the relationship between size of molecules and boiling point.
8. Explain the relationship between size of molecules and boiling point.

Drill answers

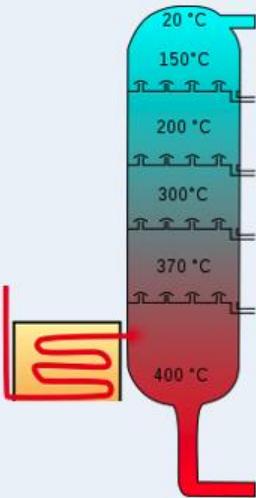
1. It contains different compounds.
2. Fractionating column
3. Boiling point
4. Liquefied petroleum gases
5. Bitumen
6. Petrol, kerosene, diesel, heavy fuel oil
7. Boiling point increases with increasing molecule size
8. As molecules get larger, intermolecular forces between them increase, requiring more energy to overcome.

Check for understanding

I: Describe: to recall facts, events or processes in an accurate way

Example question:

Describe how viscosity changes with increasing molecule size in fractions of crude oil.



Model answer:

- Fractions with larger molecules are more **viscous** than fractions with smaller molecules
- **Viscosity increases with increasing molecule size**

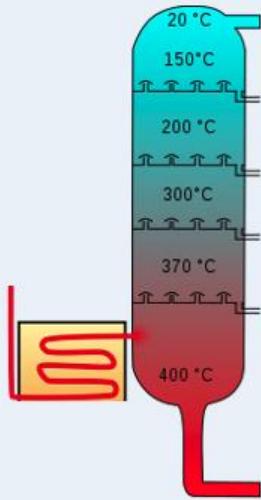
To 'describe', your answer should:

- Use **bullet points**.
- Include each step of the process in a **logical order**.
- Use **keywords** throughout the answer
- Stay **focused** on the question.

We: **Describe**: to recall facts, events or processes in an accurate way

Example question:

Describe how volatility changes with increasing molecule size in fractions of crude oil.



Model answer:

- Fractions with larger molecules are less **volatile** than fractions with smaller molecules
- **Volatility decreases** with **increasing molecule size**

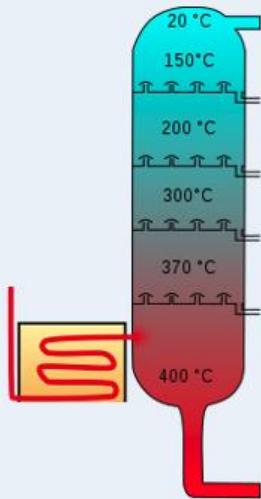
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You: **Describe**: to recall facts, events or processes in an accurate way

Example question:

Describe how boiling point changes with increasing molecule size in fractions of crude oil.



Model answer:

- Fractions with larger molecules have **higher boiling points** than fractions with smaller molecules
- **Boiling point increases** with **increasing molecule size**

To 'describe', your answer should:

- Use **bullet points**.
- Include each step of the process in a **logical order**.
- Use **keywords** throughout the answer
- Stay **focused** on the question.

Answer the questions below.

1. How does fractional distillation separate crude oil into fractions?
 - A. Each fraction has a different viscosity
 - B. Each fraction has a different melting point
 - C. Each fraction has a different boiling point

2. Which fraction is used for producing material for roads?
 - A. Liquefied gases
 - B. Petrol
 - C. Bitumen

3. Which best explains the pattern in boiling points of the alkanes?
 - A. As the alkanes get longer, boiling points increase because there are more atoms
 - B. As the alkanes get longer, boiling points decrease because they are more likely to be liquid
 - C. As the alkanes get longer, boiling points increase because the intermolecular forces increase

Lesson C5.1.3

What was good about this lesson?

What can we do to improve this lesson?

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Thank you!