

# GCSE Chemistry

## Worksheet: Fractional distillation and petrochemicals

|                       |                          |                              |                                   |
|-----------------------|--------------------------|------------------------------|-----------------------------------|
| TIME<br><b>25 min</b> | TOTAL<br><b>25 marks</b> | CALCULATOR<br><b>Allowed</b> | DIFFICULTY<br><b>Easy, Medium</b> |
|-----------------------|--------------------------|------------------------------|-----------------------------------|

**Topics:** Fractional distillation and petrochemicals

|             |              |             |
|-------------|--------------|-------------|
| <b>NAME</b> | <b>CLASS</b> | <b>DATE</b> |
|-------------|--------------|-------------|

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Answer all questions in the spaces provided.
- In all calculations, show clearly how you work out your answer.
- The marks for questions are shown in brackets.

|   |   |
|---|---|
| 0 | 1 |
|---|---|

|   |   |   |   |
|---|---|---|---|
| 0 | 1 | . | 1 |
|---|---|---|---|

 Which property mainly determines the height at which a hydrocarbon condenses inside a fractionating column?

Tick (✓) **one** box.

Its colour

☐

Its boiling point

☐

Its density as a solid

☐

Its reactivity with bromine water

☐

[1 mark]

|   |   |   |   |
|---|---|---|---|
| 0 | 1 | . | 2 |
|---|---|---|---|

 Where in the fractionating column is the fraction with the lowest boiling points collected?

.....

.....

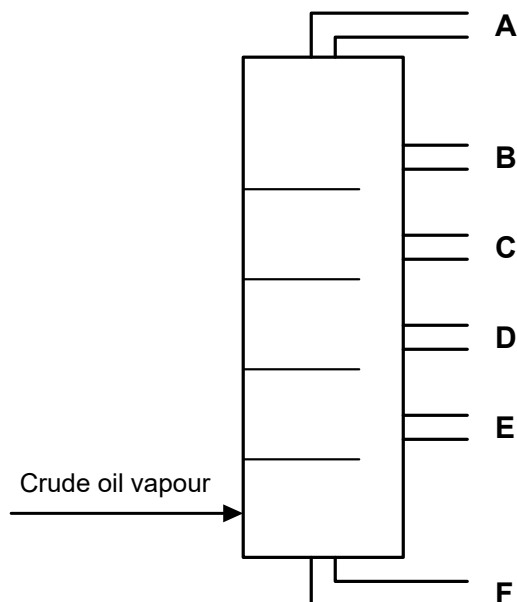
.....

[1 mark]

0 2

Crude oil is separated into fractions by fractional distillation.  
Figure 1 shows a fractionating column.

Figure 1



0 2 . 1

What is a fraction?

.....

.....

[1 mark]

0 2 . 2

Which part of the column is the hottest?

Tick (✓) **one** box.

The top

The middle

The bottom

☐

☐

☐

[1 mark]

0 2 . 3

Name **two** fuels produced from crude oil.

.....

.....

.....

.....

[2 marks]

0 2 . 4

Which **two** of these useful materials are produced by the petrochemical industry?

Tick (✓) **two** boxes.

Solvents

☐

Lubricants

☐

Cement

☐

Copper

☐

Glass

☐

[2 marks]

0 3

Crude oil straight from the ground is a complex mixture of many different hydrocarbons.

0 3 . 1

Explain why crude oil itself is not very useful until it has been separated into fractions.

.....

.....

.....

.....

[2 marks]

0 4

The fractions from crude oil are processed to produce fuels and feedstock for the petrochemical industry.

0 4 . 1

What is meant by feedstock?

.....

.....

[1 mark]

0 4 . 2

Explain why there is a vast array of different carbon compounds.

.....

.....

.....

.....

[2 marks]

0 4 . 3

Explain how modern life depends on the products from crude oil.  
Give examples in your answer.

.....

.....

.....

.....

.....

.....

[3 marks]

0 5

Table 1 gives information about some fractions from crude oil. The fractions are collected at different heights in a fractionating column.

Table 1

| Fraction | Boiling range in °C | Number of carbon atoms per molecule |
|----------|---------------------|-------------------------------------|
| A        | below 25            | 1 to 4                              |
| B        | 25 to 175           | 5 to 10                             |
| C        | 175 to 250          | 10 to 16                            |
| D        | 250 to 350          | 14 to 20                            |
| E        | above 350           | more than 20                        |

0 5 . 1

Which fraction contains the largest molecules?

.....

.....

.....

.....  
[1 mark]

0 5 . 2

A hydrocarbon has a boiling point of 216 °C.  
In which fraction would it be collected?

.....

.....

.....

.....  
[1 mark]

0 5 . 3

Explain how the hydrocarbons in fraction C are separated from the rest of the crude oil.

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---

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[3 marks]

0 5 . 4

Fraction A leaves the top of the column as a gas.  
Explain why.

---

---

[1 mark]

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0 6

Fractional distillation separates crude oil using a fractionating column with a temperature gradient (hot at the bottom, cooler at the top).

0 6 . 1

Explain, in terms of forces between molecules, why larger hydrocarbon molecules have higher boiling points, and explain how this fact makes fractional distillation possible.

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[3 marks]

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**END OF QUESTIONS**

Original practice questions written to match the specification. Not produced by, affiliated with or endorsed by AQA.

# Mark scheme

## GCSE Chemistry · Worksheet: Fractional distillation and petrochemicals · 25 marks

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### Question 1 (2 marks)

01.1 [1 mark]

**Correct:** Its boiling point

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01.2 [1 mark]

**Answer:** At the top

- at the top (of the column) (1)
- 

### Question 2 (6 marks)

02.1 [1 mark]

**Answer:** A mixture of hydrocarbons with similar numbers of carbon atoms (similar boiling points).

- a mixture of hydrocarbons with similar numbers of carbon atoms / similar boiling points (1)
- 

02.2 [1 mark]

**Correct:** The bottom

---

02.3 [2 marks]

**Answer:** Petrol and diesel oil.

- petrol (1)
- diesel oil (1)
- kerosene (1)
- heavy fuel oil (1)
- liquefied petroleum gases (LPG) (1)

Any 2 of the points above.

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02.4 [2 marks]

**Correct:** Solvents; Lubricants

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### Question 3 (2 marks)

#### 03.1 [2 marks]

**Answer:** The different hydrocarbons in the mixture have very different properties (such as boiling point and viscosity) and uses, so a single unseparated mixture is not well suited to any particular use, such as being a fuel for a specific engine.

- crude oil is a mixture of many different hydrocarbons with different properties (e.g. boiling point, viscosity) and different uses (1)
  - so the unseparated mixture is not well suited to specific uses, such as being an efficient fuel for a particular type of engine (1)
- 

### Question 4 (6 marks)

#### 04.1 [1 mark]

**Answer:** A raw material used to make other chemicals.

- a raw material used to make other chemicals / products (1)
- 

#### 04.2 [2 marks]

**Answer:** Carbon atoms can bond to other carbon atoms, forming chains of different lengths and families of similar compounds.

- carbon atoms can form (covalent) bonds with other carbon atoms (1)
  - to make chains (or rings) of different lengths / families of similar compounds (homologous series) (1)
- 

#### 04.3 [3 marks]

**Answer:** Fuels for transport (petrol, diesel oil, kerosene) and heating; polymers made from petrochemicals; solvents, lubricants and detergents.

- fuels for transport, e.g. petrol, diesel oil or kerosene for aircraft (1)
- fuels for heating, cooking or power, e.g. liquefied petroleum gases or heavy fuel oil (1)
- polymers (plastics) made from petrochemicals (1)
- solvents, lubricants or detergents (1)

Any 3 of the points above.

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## Question 5 (6 marks)

05.1 [1 mark]

**Answer:** E

- E (1)

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05.2 [1 mark]

**Answer:** C

- C (1)

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05.3 [3 marks]

**Answer:** The crude oil is heated so it evaporates; the vapour rises up the column, which is cooler higher up; the hydrocarbons in C condense where the temperature falls below their boiling points (175–250 °C) and are collected.

- the crude oil is heated so that it evaporates (1)
- the vapour rises up the column, which is cooler towards the top (1)
- the hydrocarbons in fraction C condense (and are collected) at the level where the temperature is below their boiling points (175 to 250 °C) (1)

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05.4 [1 mark]

**Answer:** Its boiling points are lower than the temperature at the top of the column, so it does not condense.

- its boiling points are below the temperature at the top of the column, so it does not condense (1)

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## Question 6 (3 marks)

06.1 [3 marks]

**Answer:** Larger molecules have stronger intermolecular forces, so more energy (a higher temperature) is needed to separate them into a gas; this means different-sized hydrocarbons boil (and condense) at different, characteristic temperatures, so they separate out at different heights in the column, according to the temperature at that height.

- larger hydrocarbon molecules have stronger intermolecular forces (forces between the molecules), so need more energy (a higher temperature) to boil / evaporate (1)
  - this means different-sized hydrocarbons have different, characteristic boiling points (1)
  - so as vapour rises and cools, each hydrocarbon condenses at the height in the column where the temperature falls below its own particular boiling point, separating the mixture (1)
-