

Splitting crude oil into alkanes and alkenes

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet

Name: _____ Date: _____ Class: _____

These 20 problems train you to use the general formulae of alkanes and alkenes, read fractionating column and boiling point diagrams, balance combustion and cracking equations and carry out mole and mass calculations. They are written for GCSE, IGCSE, O Level, CBSE Class 9-10 and NGSS high school chemistry.

Work through them in order: the first five check the basic ideas, the middle ten need calculations or explanations, and the last five are longer questions that combine several steps. Use the A_r values given in each problem.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE C7

Problem 1 Hydrocarbon vocabulary (easy)

Kamau in Nairobi is revising. Complete each sentence.

1. A hydrocarbon contains only _____ and _____ atoms.
2. Alkanes are called _____ hydrocarbons because they have only _____ bonds.
3. The general formula of the alkanes is _____.
4. Crude oil is separated by _____ distillation.

Problem 2 Alkane formulae (easy)

Chiamaka in Lagos writes alkane formulae from their carbon numbers.

1. Write the molecular formula of the alkane with 6 carbon atoms.
2. Write the formula of the alkane with 11 carbon atoms.
3. An alkane has 42 hydrogen atoms. How many carbon atoms does it have?

Problem 3 Spot the alkenes (easy)

Aarav in Pune has a list of hydrocarbons: C_4H_{10} , C_4H_8 , C_5H_{12} , C_3H_6 , C_6H_{12} , C_2H_6 .

1. Which of them are alkenes?
2. State the rule you used.
3. Give the formula of the alkene with 8 carbon atoms.

Problem 4 Test for unsaturation (easy)

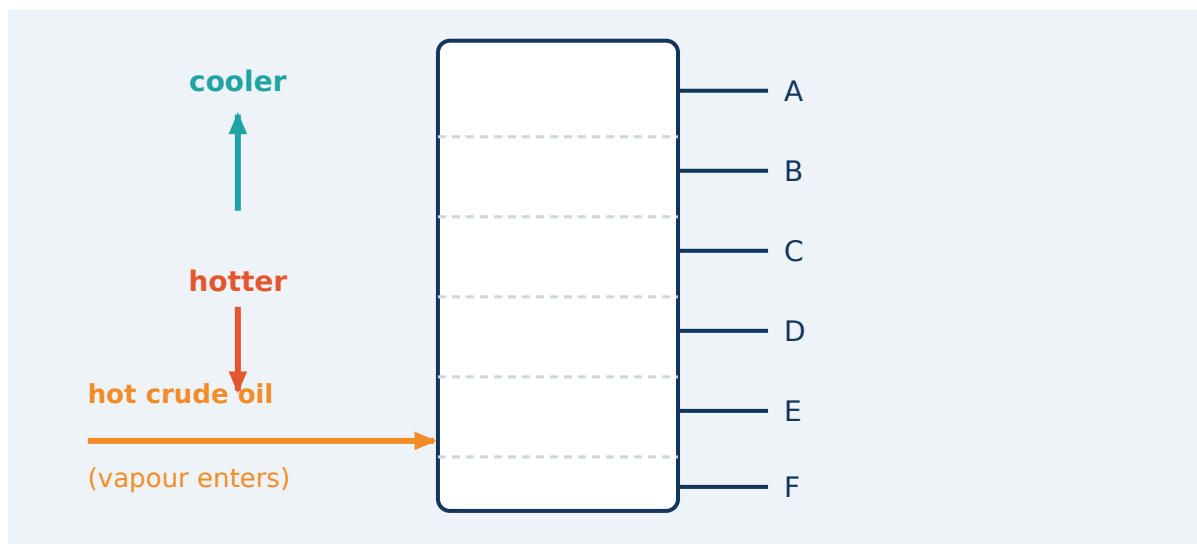
Emma in Leeds has two colourless liquids, hexane and hex-1-ene, in unlabelled bottles. She adds a few drops of orange bromine water to a sample from each bottle and shakes.

1. Predict what she sees with hexane.
2. Predict what she sees with hex-1-ene.

3. Which bottle contains the alkene?

Problem 5 Reading the column (easy)

The diagram shows a fractionating column with exits A to F (top to bottom). Bilal in Lahore knows the fractions leave in this order: refinery gases, petrol, kerosene, diesel, fuel oil, bitumen.



Exits A to F of the fractionating column.

1. Which exit gives the fraction with the lowest boiling range?
2. Which exit gives bitumen?
3. Which exit gives the most viscous liquid other than bitumen?
4. Exit B is petrol. Is petrol more or less flammable than diesel (exit D)?

Problem 6 Complete combustion equations (medium)

Mei in Singapore studies fuel gases. Balance each complete combustion equation.

1. $\text{C}_4\text{H}_{10} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
2. $\text{C}_5\text{H}_{12} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
3. Explain why the balanced equation for butane has 13O_2 and not 6.5O_2 .

Problem 7 Trends along the series (medium)

Diego in Texas compares two fractions. Petrol has shorter chains than diesel.

1. Complete the sentence: diesel has a _____ boiling point, a _____ viscosity and is _____ to ignite than petrol. (Use higher or lower, harder or easier.)
2. Explain the trend in boiling point using the size of the molecules.

Problem 8 Balance the cracking (medium)

Wanjiru in Nairobi studies cracking.

1. Complete: $\text{C}_{14}\text{H}_{30} \rightarrow \text{C}_{10}\text{H}_{22} + \text{_____}$.
2. Name the type of hydrocarbon of the second product.

3. Write the equation for cracking $C_{16}H_{34}$ into C_8H_{18} and one other product only.

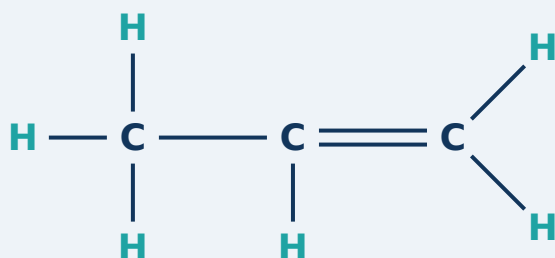
Problem 9 Mass of carbon dioxide (medium)

A camping stove in Leeds burns propane, C_3H_8 . A canister releases 44 g of propane. (A_r : C = 12, H = 1, O = 16.)

1. Write the balanced equation for complete combustion.
2. Calculate the moles of propane burnt.
3. Calculate the mass of carbon dioxide produced.

Problem 10 Reading a molecule (medium)

Priya in Chennai draws a compound Z.



compound Z

Displayed formula of compound Z.

1. Count the carbon and hydrogen atoms and write its molecular formula.
2. State whether Z is saturated or unsaturated and give the reason.
3. Predict its result with bromine water.

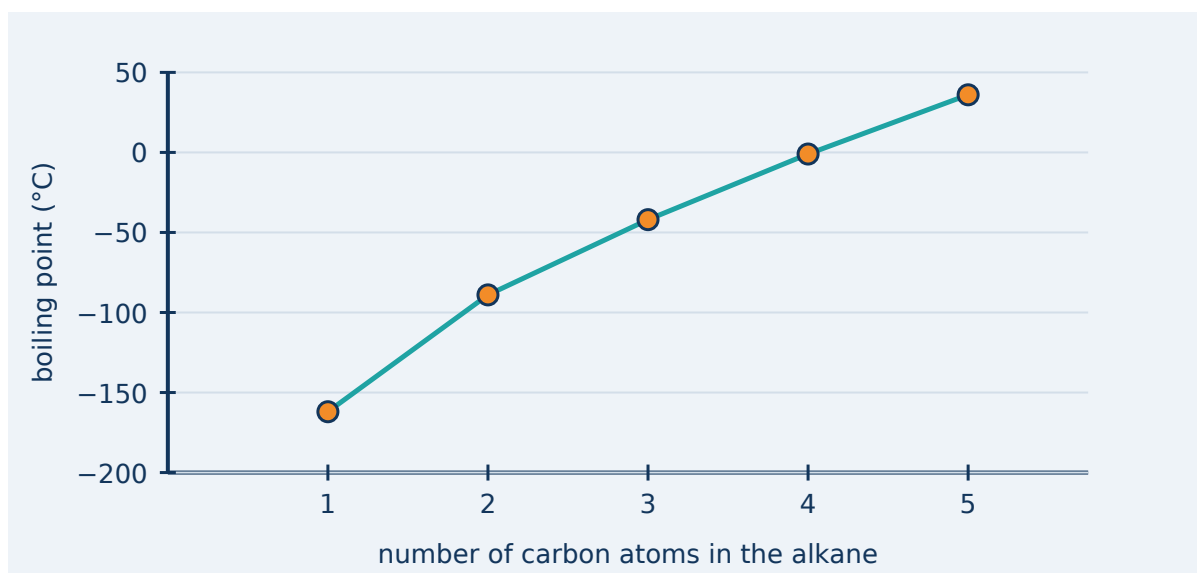
Problem 11 Carbon percentage and soot (medium)

Fatima in Kano compares three fuels. (A_r : C = 12, H = 1.)

1. Calculate the percentage by mass of carbon in methane CH_4 .
2. Calculate the same for ethane C_2H_6 and ethene C_2H_4 .
3. Which of the three would be expected to burn with the sootiest flame? Explain.

Problem 12 Boiling points of alkanes (medium)

Kofi in Accra plots boiling points of the first five alkanes.



Boiling point of alkanes against number of carbon atoms.

1. Read the boiling point of propane from the graph.
2. State whether pentane is a gas or a liquid at 25 °C and give the reason.
3. Describe the trend. The rises between points were 73, 47, 41 and 37 °C. Estimate the boiling point of hexane if the next rise is about 33 °C.

Problem 13 Fuel tank conversion (medium)

A motorbike tank in Pune holds 45 dm³ of petrol. The density of petrol is 0.74 g/cm³.

1. Convert 45 dm³ to cm³.
2. Calculate the mass of petrol in grams.
3. Convert the mass to kilograms.

Problem 14 Why fractions separate (medium)

Nia in Cardiff asks why hot vapour that enters the bottom of the column leaves at different heights.

1. Explain what happens to a petrol vapour molecule as it rises.
2. Explain why a bitumen molecule does not rise far.
3. Suggest why the top of the column is kept cooler than the bottom.

Problem 15 Supply and demand (hard)

A refinery in Houston processes 5000 tonnes of crude oil. It yields 18 % petrol and 24 % fuel oil. Half of the fuel oil is cracked, and 40 % by mass of the cracked fuel oil becomes petrol-range hydrocarbons.

1. Calculate the mass of petrol obtained by distillation.
2. Calculate the mass of fuel oil cracked and the extra petrol made.
3. Calculate the percentage increase in petrol.

Problem 16 Ethene from a big alkane (hard)

Cracking can be written $C_{16}H_{34} \rightarrow C_8H_{18} + 4C_2H_4$. (A_r : C = 12, H = 1.)

1. Show that the equation is balanced.
2. Calculate the relative formula mass of $C_{16}H_{34}$.
3. Calculate the mass of ethene formed from 1.0 kg of $C_{16}H_{34}$ if the reaction goes to completion.

Problem 17 Bromine addition by mass (hard)

Ethene reacts with bromine: $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$. A sample of 2.8 g of ethene is passed into excess bromine. (A_r : C = 12, H = 1, Br = 80.)

1. Calculate the moles of ethene.
2. Calculate the mass of bromine that reacts.
3. Calculate the mass of $C_2H_4Br_2$ formed and show that mass is conserved.

Problem 18 Design an identification test (hard)

Three colourless liquids are known to be hexane, hex-1-ene and water, but the labels were lost. Hexane and hex-1-ene do not mix with water.

1. Describe a simple test, using only bromine water, that can identify the alkene.
2. Explain how you can tell hexane from water by looking at the mixture with bromine water.
3. Explain why hex-1-ene reacts but hexane does not.

Problem 19 Air needed for burning (hard)

In a workshop in Lahore 2.0 dm^3 of propane gas burns completely. All gas volumes are measured at the same temperature and pressure. Air is 21 % oxygen by volume.

1. Write the balanced equation.
2. Calculate the volume of oxygen needed.
3. Calculate the volume of air needed and the volume of carbon dioxide produced.

Problem 20 Find the faulty statements (hard)

Student notes: (a) "Alkenes are saturated because they contain many hydrogen atoms." (b) "Cracking is a chemical change that needs a high temperature." (c) "Fractional distillation breaks C-C bonds." (d) "The fraction at the top of the column has the highest viscosity."

1. Decide which statements are wrong.
2. Rewrite each wrong statement correctly.