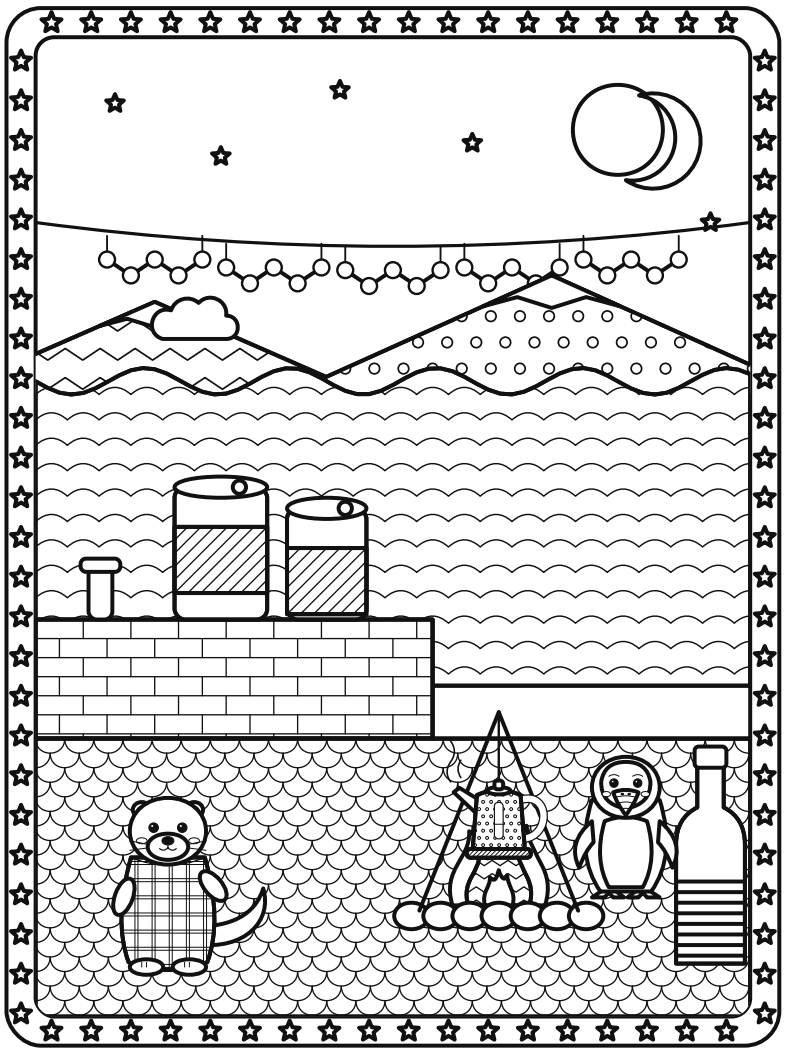
REAL-LIFE CHEMISTRY

Nature's Chemistry

Workbook for National 5 Chemistry

Unit: Nature's Chemistry



C. Blewis

Blewis LEARNING

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How to use this book

This book covers Nature's Chemistry for National 5 Chemistry: hydrocarbons, alkenes and addition reactions, alcohols, carboxylic acids and energy from fuels. Each topic follows the same pattern, so you always know what comes next.

EACH TOPIC HAS

Opener	the story for the topic, what you will learn and the key words
Learn pages	short explanations with diagrams, and questions to try
Practical	You plan the investigation yourself, carry it out safely, take repeat readings, draw a graph and evaluate your method.
Brain break	a calm puzzle or colouring page
Check-up	a few questions to show what you know, and a checklist

PRACTICAL WORK: STAY SAFE

- Only start a practical when an adult says it is OK.
- Read the whole method and the Stay safe table first.
- Tell your teacher about anything that might affect you, like asthma or an allergy.
- Stop and tell an adult if you feel unwell or something goes wrong.

NO LAB TODAY?

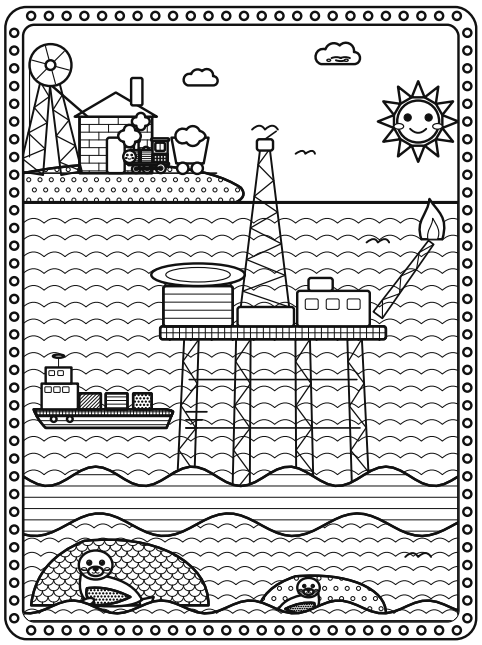
Every practical has a set of example results. If you could not do the experiment, use these to finish the results, graph and conclusion.

DOODLE CORNERS

Some pages have a doodle corner. Colour it or doodle in it when you need a short break.

Hydrocarbons

Natural gas, petrol, candle wax and the gas in a camping stove are all made of the same two elements. Which two, and why are they so different?



Theme: the Port Arrin gas terminal. Mia is on work experience at the gas terminal where pipelines from the North Sea come ashore. The gas and liquids arriving are mixtures of hydrocarbons, and Mia's job this week is to sort them into families and give each one its proper name.

IN THIS TOPIC YOU WILL LEARN TO

Skill 1	explain what a homologous series is and use the general formulae of the alkanes and cycloalkanes
Skill 2	draw full and shortened structural formulae, and name straight-chain and branched alkanes
Skill 3	identify isomers, and use bromine water to tell saturated from unsaturated hydrocarbons

KEY WORDS

Hydrocarbon	a compound of hydrogen and carbon only
Homologous series	a family with the same general formula and similar chemical properties
Alkane	a saturated hydrocarbon, C_nH_{2n+2}
Cycloalkane	a saturated ring of carbon atoms, C_nH_{2n}
Isomers	same molecular formula, different structural formula
Saturated	only single carbon to carbon bonds

❶ Families of hydrocarbons

A **hydrocarbon** contains hydrogen and carbon only. Chemists sort hydrocarbons into families called **homologous series**. Members of a series have the **same general formula** and **similar chemical properties**, and their physical properties, such as boiling point, change **gradually** along the series.

The **alkanes** have the general formula $\mathbf{C_nH_{2n+2}}$. Every carbon atom makes four bonds and every carbon to carbon bond is single.

Alkane	Carbons	Molecular formula	Boiling point (°C)
methane	1	CH_4	−162
ethane	2	C_2H_6	−89
propane	3	C_3H_8	−42
butane	4	C_4H_{10}	−1
pentane	5		36
hexane	6		69
heptane	7		98
octane	8		126

WHY BOILING POINTS RISE

Longer molecules have stronger forces of attraction **between** the molecules, so more energy is needed to pull them apart. The bonds inside the molecules do not break when an alkane boils.

1 Use the general formula to complete the molecular formulae in the table.

2 Decane has 10 carbon atoms. Write its molecular formula.

Answer:

3 Room temperature is about 20 °C. Which alkanes in the table are gases at room temperature? Explain how you decided.

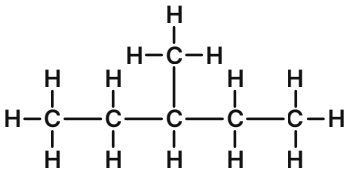
Answer:

4 The gas terminal separates butane from pentane by cooling the mixture. Explain why pentane turns to liquid first.

Answer:

❷ Drawing and naming alkanes

A **full structural formula** shows every atom and every bond. A **shortened structural formula** groups the atoms on each carbon, e.g. propane is $CH_3CH_2CH_3$. A **molecular formula** just counts the atoms, e.g. C_3H_8. A side branch with one carbon is a **methyl** group and with two carbons an **ethyl** group.



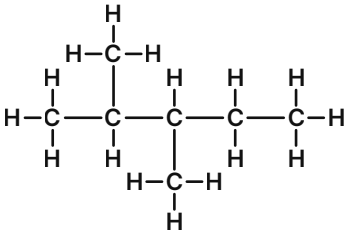
WORKED EXAMPLE

Name this alkane, then write its shortened structural formula.

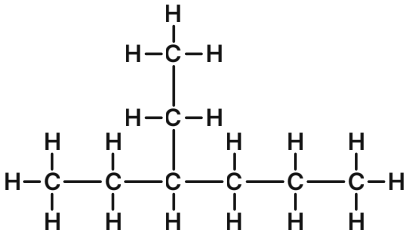
Longest chain	5 carbons in a row, so **pentane**
Number	the branch is on carbon 3 from either end
Branch	one carbon: **methyl**
Name	**3-methylpentane**, $CH_3CH_2CH(CH_3)CH_2CH_3$

Naming rules: find the longest unbroken chain, even if it bends; number from the end nearer the branches; use di or tri for two or three of the same branch, commas between numbers and hyphens between numbers and words, e.g. 2,3-dimethylpentane.

1 Name these two alkanes.



A



B

A: .....

B: .....

2 Draw the full structural formula of 2-methylhexane.

Draw here

3 Isla names an alkane 4-methylpentane. Explain why this name is wrong, and give the correct name.

Answer: .....

PRACTICAL 1

Plan it: which hydrocarbons are unsaturated?

AIM To use **BROMINE WATER** to find out which hydrocarbons are **UNSATURATED**, and to compare how much bromine water each one decolourises.

Teacher demonstration: your teacher does the tests in a fume cupboard while you plan and record.

1 Variables

I will change the independent variable	
I will measure the dependent variable	
I will keep the same controlled variables (give two)	

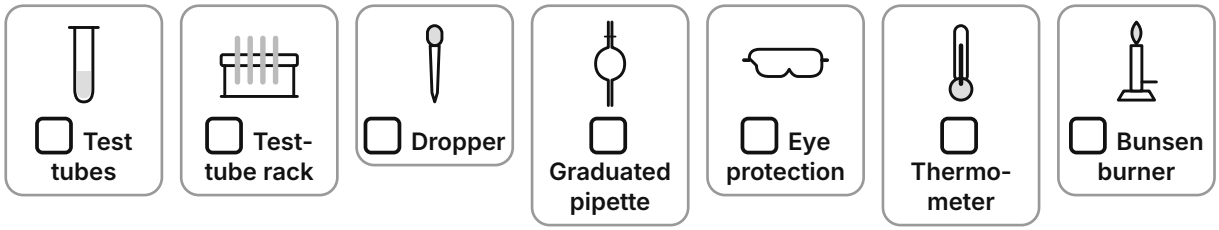
2 Prediction

I think .....

because .....

3 Equipment

Tick the equipment needed. Not everything here is useful.



4 Stay safe

The first row is done for you. Add two more hazards.

Hazard What could cause harm?	**Risk** What could happen?	**Control** How will I stay safe?
Hydrocarbons catch fire easily	A fire or burns	No flames in the room. Small volumes only, kept in a fume cupboard with lids on.

Method and results

5 Write the method

1. How much of each hydrocarbon, and of the solvent, goes into each test tube? How is it measured?

2. How is the bromine water added, and how do you know when to stop counting drops?

3. What must be the same for every hydrocarbon to make it a fair test?

4. How many repeats? How will you find the mean?

6 Results

Complete the headings, including units where needed.

Hydrocarbon					Saturated?

NO LAB TODAY? USE THESE RESULTS

Hydrocarbon	Formula	Run 1	Run 2	Run 3	Mean
heptane	C_7H_{16}	0	0	0	
cyclohexane	C_6H_{12}	0	0	0	
hex-1-ene	C_6H_{12}	13	14	13	
cyclohexene	C_6H_{10}	16	17	16	

Drops of bromine water decolourised by 0.10 cm^3 (2 drops) of each hydrocarbon dissolved in 2.0 cm^3 of a non-flammable solvent. The test stopped when the orange colour stayed after shaking. 0 means the first drop stayed orange.

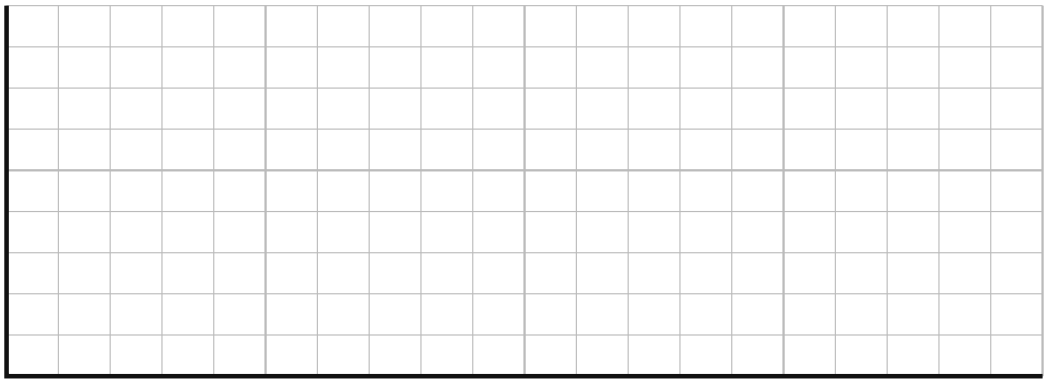
REPEATS AND MEANS

Repeat each test at least three times. Leave out any result that is clearly wrong (an outlier), then add the rest and divide by how many there are. For example, 16, 17 and 16 drops: (16 + 17 + 16) ÷ 3 = 16.3 drops.

Analyse and evaluate

7 Draw a bar chart

Plot the mean number of drops for each hydrocarbon. Choose your own scale and label both axes.



8 Conclusion

The unsaturated hydrocarbons were

9 Evaluate

a Kai says heptane and cyclohexane are isomers. Explain why he is wrong, and say what the bromine water results show about them.

Answer:

b Give one way to make the drop counts more reliable, and one way to make them more accurate.

Answer:

> **ASSIGNMENT LINK**
> For an assignment you could compare your results with a value or description from a textbook or website, and give the reference: title, author or organisation, and date.

FREE SAMPLE

Nature's Chemistry (N5 Chemistry)

This sample shows a few pages. The full printed workbook is available from Amazon.

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