In context

Subject area: Organic chemistry	Level: 14–16 years (Higher)
Topic: Crude oil	**Source: rsc.li/311PrTF**

1) **This question is about how trends in properties of the fractions from crude oil change with the chain length of the molecule.**

a) **Complete the table by writing the words: 'decrease', 'increase' or 'stays the same' into the right-hand column.**

Property	Trend in property as carbon chain length increases
Boiling point	***Answer***: *Increases.*
Viscosity	***Answer***: *Increases.*
Flammability	***Answer***: *Decreases.*

b) **Place these fractions from crude oil in order of their boiling point.**

diesel	kerosene	petroleum gas	petrol	bitumen

Write your answers below.

Name of fraction	
Answer: Petroleum gas.	
Answer: Petrol.	Increasing boiling point
Answer: Kerosene.	
Answer: Diesel.	
Answer: Bitumen.	

2) A sample of petrol (gasoline) was analysed by a chemist.

She recorded a mass of petrol of 5.20 g.

The analysis found a substance called decane in the petrol.

The percentage of decane in the petrol sample was 4.8%, by mass.

Source: Envato Elements

Decane is an alkane containing ten carbon atoms in its molecule.

a) Which two elements are present in alkanes?
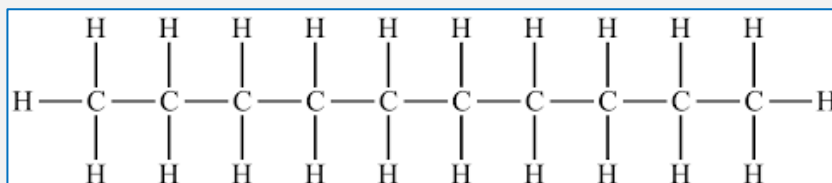
Answer: Hydrogen and carbon.

b) What is the general formula for an alkane?

Answer: $C_nH_{(2n+2)}$

c) Use your answer to part b) to work out the molecular formula for decane.

Answer: $C_{10}H_{22}$

d) Draw the structure of a decane molecule.

e) Explain why a decane molecule is described as 'saturated'.

Answer: It contains carbon single bonds only.

f) Calculate the mass of decane in the petrol sample.

Give your answer to 3 significant figures.
Show your working.

Answer: The mass of decane = $\frac{4.8}{100}$ × 5.2 = 0.2496 g.

And to 3 significant figures, this would be 0.250 g.

g) What mass of petrol would contain exactly 10.0 g of decane?

Give your answer to 1 decimal place.
Show your working.

Answer: The percentage by mass of decane in the petrol is 4.8%.
So $\frac{4.8}{100}$ × mass of petrol = 10.0 g.
*So the mass of petrol = 10.0 × $\frac{100}{4.8}$ = 208.3… g.*
And this is 208.3 g to 1 decimal place.

3) Crude oil is a complex mixture of hydrocarbons, many of which are alkanes.

The boiling points of the first six members of the alkane homologous series are shown in the table below.

Number of carbon atoms in alkane	Boiling point in °C
1	−162
2	−89
3	−42
4	−0.5
5	36
6	69

a) **Plot the number of carbon atoms on the horizontal axis and the boiling point on the vertical axis on the graph below.**
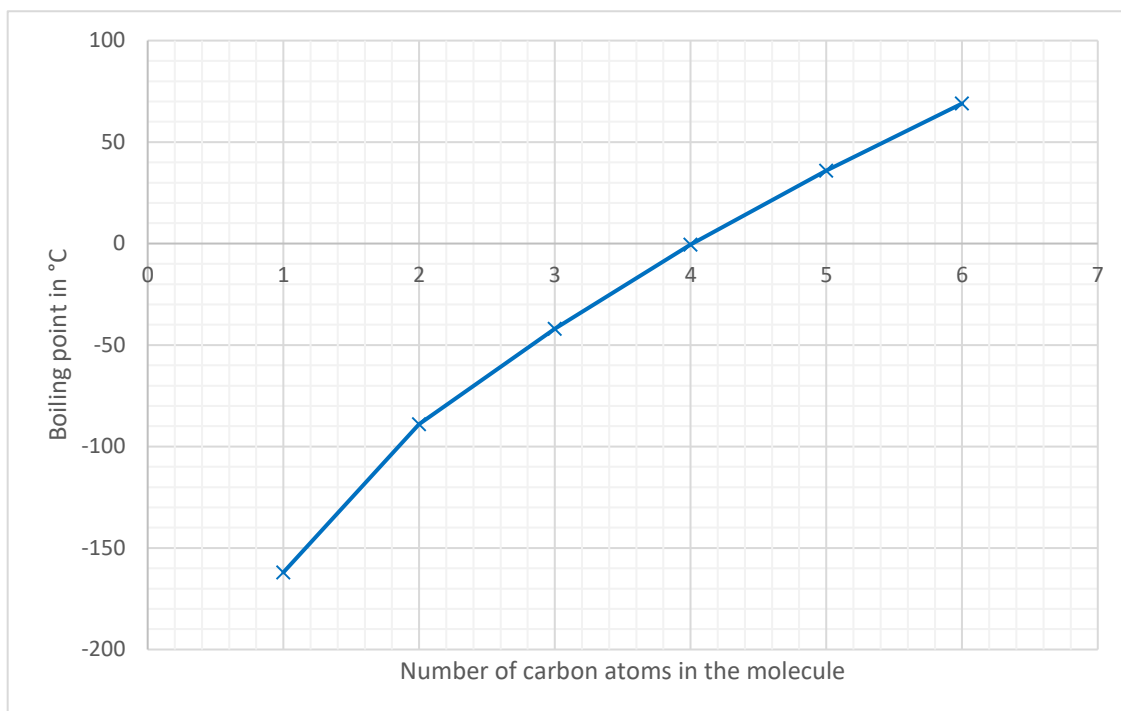
b) **Draw a best fit line through these points.**

Answer: See graph for answer.

c) **Describe how the boiling point changes from two carbon atoms to six carbon atoms.**

Answer: Almost linearly.

d) **Use your graph to determine the boiling point of the alkane with seven carbon atoms.**

Answer: c.a. 100 °C.

e) **Which of the hydrocarbons are gases at room temperature, 20°C?**

Answer: The first four members are gases.

f) **Dane and Debbie have a discussion about the best graph to draw to show the data in the table.**

Dane suggests that a line is a good idea, but Debbie suggests a bar chart would be better.
State who you think is correct. Give a reason.

> *Answer: A continuous line shows the trend in data clearly, and it can be used for extrapolating to another point, for example. However, this data is discontinuous or discrete, so a bar chart should be drawn. It is important to realise that each method has its advantages and disadvantages although a bar chart is the more acceptable representative form for displaying discrete data. Clearly, values between, for example, one and two carbon atoms have no meaning, so a line is drawn to show the trend in values.*