Demonstrate understanding of aspects of carbon chemistry – collated questions

Contents

Checklist

Aspects of carbon chemistry will be selected from:

- ❒ Structure
  - names of carbon compounds using systematic nomenclature
  - structural formulae
  - covalent bonding between atoms.
- ❒ Properties
  - solubility in water
  - trends in melting and/or boiling points
  - complete and incomplete combustion reactions
  - polymerisation reactions of ethene and propene.
- ❒ Production
  - fractional distillation of crude oil
  - cracking of fractions
  - fermentation
  - methanol from natural gas.
- ❒ Uses and importance
  - fuels
  - polymers from ethene and propene.
- ❒ Effects of combustion products on human health and the environment.
- ❒ Carbon compounds are restricted to:
  - straight chain alkanes
  - ethene and propene
  - methanol and ethanol
  - Structures and names of alkanes are limited to alkanes which contain no more than eight carbon atoms.

Answers are here: https://www.nzqa.govt.nz/ncea/assessment/search.do?query=Chemistry&view=reports&level=01

Alkanes and combustion – chemical reactions

2019:1

(a) Butane can be used as a fuel, and can undergo both complete and incomplete combustion. Compare and contrast the complete and incomplete combustion of butane. In your answer, you should:
- outline the conditions that would cause complete and incomplete combustion to occur
- name the products that are formed under the different conditions
- describe the appearance of the flames, and link this to any relevant products formed
- explain the effects of the products of incomplete combustion of butane on the environment.

(b) Other alkanes and alkenes can also be used as fuels.

(i) Complete the following equations:
A word equation to show pentane undergoing complete combustion.
pentane + oxygen →
A balanced symbol equation to show ethene undergoing complete combustion. $C_2H_4 + O_2$ →

(ii) Write balanced symbol equations for the following combustion reactions:
Propane forming water, carbon dioxide, and carbon monoxide.
Butane forming water and carbon monoxide.

2019:3

(c) The following table shows selected data for the compounds methanol, ethanol, and propene. Compare and contrast the data in the table, with reference to the type of organic compound and your knowledge of the structure and chemical properties of the compounds.

Compound	Solubility in water	Number of molecules of water produced per molecule of compound during complete combustion
methanol	soluble	2
ethanol	soluble	3
propene	insoluble	3

In your answer, you should explain how you used the information in the table to compare and contrast the solubility and combustion reactions of the compounds.

2018:2

(a) Fuels such as butane react with oxygen to release energy.

(i) Draw the structural formula of butane.

(ii) When butane reacts with oxygen, water vapour is produced, as well as carbon dioxide, carbon monoxide, and/or carbon particles (soot), depending on the conditions.
Explain under what conditions these various products are produced.
In your answer, you should state the type of reaction(s) occurring and give balanced symbol equations for the reaction(s).

(b) A variety of fuels can be used in car engines. The table below shows some properties of two of these fuels.

Fuel	Content	Flashpoint* / °C	Energy released/kJ L^{-1}
Ethanol	C_2H_5OH	16.6	29700
Petrol	mixture of hydrocarbons	–43	35000

* Flashpoint is the lowest temperature at which the vapours of the fuel will ignite.

Evaluate the feasibility of replacing petrol with ethanol as a fuel for use in cars.
In your answer, you should:
- refer to relevant data from the table above
- consider the combustion reactions of each fuel
- include the effects of each fuel on human health and on the environment.

2017:1

(c) The boiling point for ethene is –104°C and propene is –48°C.
Why does propene have a higher boiling point than ethene? Explain your answer.

2017:3

(c) Both heptane and methanol can be used as fuels and can undergo both complete and incomplete combustion. Analyse the combustion reactions of the two fuels – heptane and methanol.

In your answer, you should include:
- a description of the observations that would be made for both complete and incomplete combustion of EITHER heptane OR methanol
- an explanation of the effect on human health for TWO combustion products from the incomplete combustion of EITHER heptane OR methanol
- an explanation of the advantages of using methanol as a fuel compared to heptane
- a balanced symbol equation for the complete combustion of each fuel.

2016:1

(c) Alkanes can be used as fuels. Compare and contrast: the complete combustion of alkanes, which produces carbon dioxide; and the incomplete combustion, which produces carbon monoxide and carbon in addition to carbon dioxide.

In your answer, you should:
- use butane as an example to illustrate your answer
- give an explanation of an effect on the environment for TWO combustion products
- include balanced symbol equations for the reactions occurring, in the labelled boxes below.

2015:1

(c) Camping burners usually have a warning notice instructing people to always use them in a well-ventilated place (plenty of oxygen) otherwise serious injury or death may occur. Elaborate on why this warning is given on camping burners. Use a burner that contains propane as an example.

In your answer, you should:
- state the type of combustion reaction that occurs when there is a shortage of oxygen
- describe the observations that may be seen if there was a shortage of oxygen, and link these to the reaction occurring

Answers are here: https://www.nzqa.govt.nz/ncea/assessment/search.do?query=Chemistry&view=reports&level=01

- explain two effects that the combustion products can have on human health when there is a shortage of oxygen
- write a word equation and a balanced symbol equation for the reaction occurring.

2015:3

(c) Ethanol made from sugar cane can be mixed with petrol to produce a biofuel for cars. Ethanol burns in air with an almost invisible flame, and has some useful advantages as a biofuel compared to some hydrocarbons found in petrol, such as heptane, C_7H_{16}.
Evaluate the use of ethanol in biofuels for cars.

In your answer, you should:
- state the type of combustion reaction that ethanol usually undergoes, and name the products formed
- explain two effects that the combustion products of ethanol can have on the environment
- elaborate on the advantages of using ethanol as a biofuel compared to hydrocarbon fuels, such as those containing heptane
- include a balanced symbol equation for the combustion of ethanol.

2014:4

(c) Methanol and methane are commonly used in fuels. Methanol burns with an almost colourless flame. Methane, if there is a limited supply of oxygen, burns with an orange flame.
Explain the process and effects of complete and incomplete combustion reactions, using methanol and methane as examples.

In your answer:
- describe both types of combustion reactions
- elaborate on ONE effect each of complete AND incomplete combustion can have on EITHER human health OR the environment
- relate your explanation to the combustion of methanol and methane
- write ONE appropriate balanced symbol equation.

2013:1

(c) Compare and contrast the complete combustion of methanol to the incomplete combustion of octane.

In your answer:
- compare and contrast the combustion reactions of both fuels
- compare and contrast the impacts of the combustion products of both fuels on human health or the environment
- write a balanced symbol equation for the complete combustion of methanol.

2012:1

(c) Ethanol burns in air with an almost invisible flame.
State the type of combustion reaction ethanol undergoes and name the products formed.
Write a balanced symbol equation for the reaction of ethanol burning in air.

(d) Identify and evaluate ONE effect that a product of the complete combustion reaction for ethanol would have on the environment.

Polymerisation, Distillation of crude oil & Cracking

2019:2

Polyethene is a polymer made from a raw material that is found in crude oil. The process to make polyethene involves several stages.

(a) One stage is to break down large molecules from crude oil into smaller hydrocarbon molecules.

(i) What is the name of this process, and why is it necessary for the production of polymers?

(ii) Complete the balanced symbol equation to show heptane being broken down into pentane and ethene.

C_7H_{16} →

(iii) Write a balanced symbol equation to show the products formed when $C_{15}H_{32}$ is broken down into the smaller hydrocarbon molecules of octane, ethene, and propene.

(b) The next stage is to use ethene to produce polyethene. How do molecules of ethene form polyethene? In your answer, you should refer to the structures of ethene and polyethene and draw a section of polyethene containing FOUR repeating units.

(c) Polyethene is a type of plastic. Plastics are used to make many different things. Complete the table below, giving two uses of plastics linked to the properties that are important for these uses.

Use	Property/properties that are important for this use

2018:1

(b) (iii) Ethene can by produced by cracking long-chain hydrocarbons such as hexane in crude oil. The ethene can then be used to produce the alcohol, ethanol. Ethanol can also be produced by fermentation. How does the process of producing ethene from hexane (cracking), differ from the process of fermentation to form ethanol?

In your answer, you should include:

- a description of the two processes
- explanations of any conditions required
- balanced symbol equations for any reactions occurring.

2018:3

(a) Polymerisation reactions are used to make the commonly used polymer, polyethene.

(i) What is the name of the monomer unit that polyethene is made from?

(ii) Elaborate on the polymerisation reaction involved in producing polyethene.

In your answer you should:

- refer to the structure of the monomer unit
- state any conditions required for the reaction, and explain why they are needed
- give the structural formula of polyethene.

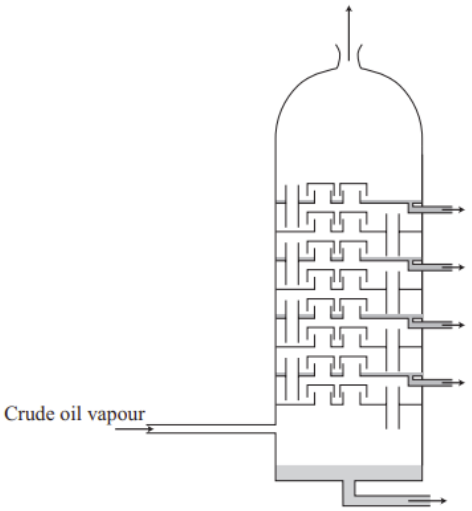
2017:1

(b) Propene is used to make the polymer polypropene. Draw a section of the polymer polypropene with THREE repeating units.

(d) Explain why propene can be used to make polymers, but propane cannot.
In your answer, you should explain the chemical reaction that occurs between propene molecules to form the polymer, polypropene.

2017:2

Crude oil is fractionally distilled in tall towers, like the one shown in the diagram.



(a) (i) Why must crude oil be fractionally distilled before it can be used? Explain your answer.
(ii) Explain why smaller hydrocarbons are collected at the top of the tower.

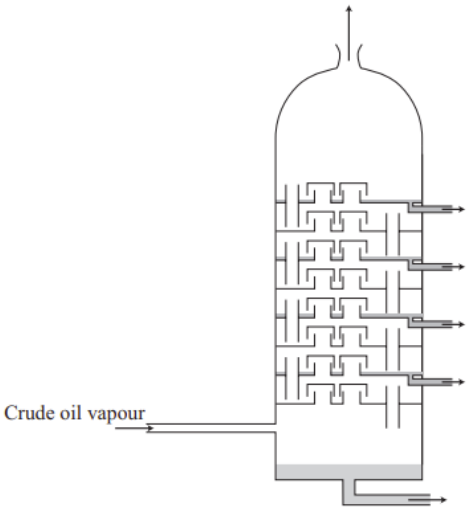
(b) Complete the equation for the cracking of decane, $C_{10}H_{22}$, to produce pentane and two other products.

$C_{10}H_{22} \rightarrow$

(c) Contrast the processes of fractional distillation and cracking. In your answer, you should refer to relevant physical and / or chemical properties of hydrocarbons.

2016:3

Crude oil undergoes fractional distillation in tall towers, like the ones shown in the photograph below. The different fractions produced have many uses.

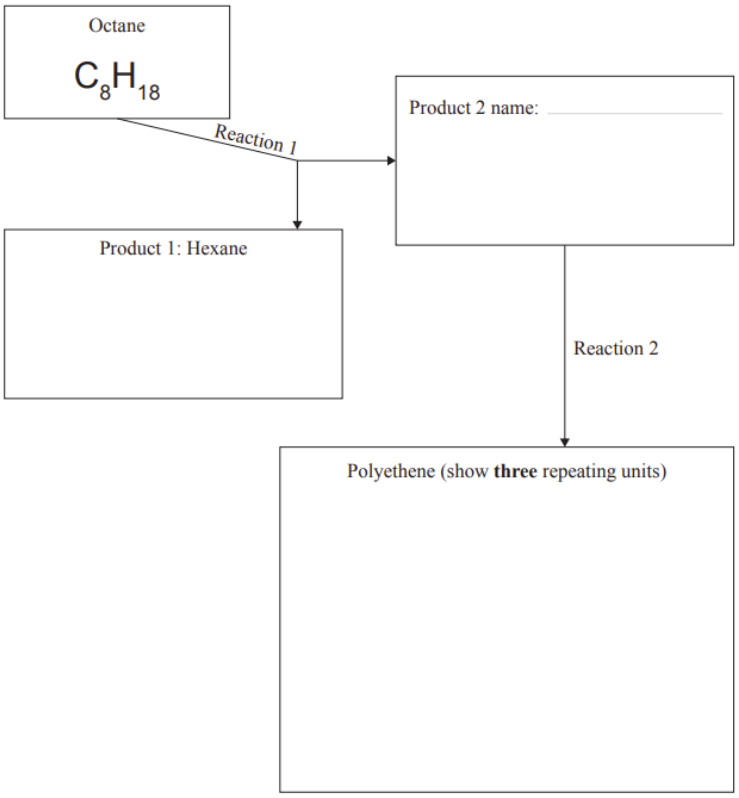


(a) Name TWO of the fractions obtained from a fractional distillation tower, and describe ONE use for each.

(b) (i) Why does crude oil need to undergo fractional distillation before it can be used?

(ii) Explain why fractional distillation is carried out in tall towers.
In your answer you should link the process of fractional distillation to the physical properties and chemical structure of the hydrocarbons in crude oil.

(c) Octane can be used to produce the polymer, polyethene. Octane undergoes Reaction 1 to form hexane and Product 2. Product 2 can be used to produce polyethene.
(i) Complete the reaction scheme by filling in the boxes to show all structural formulae, as well as the name for Product 2.



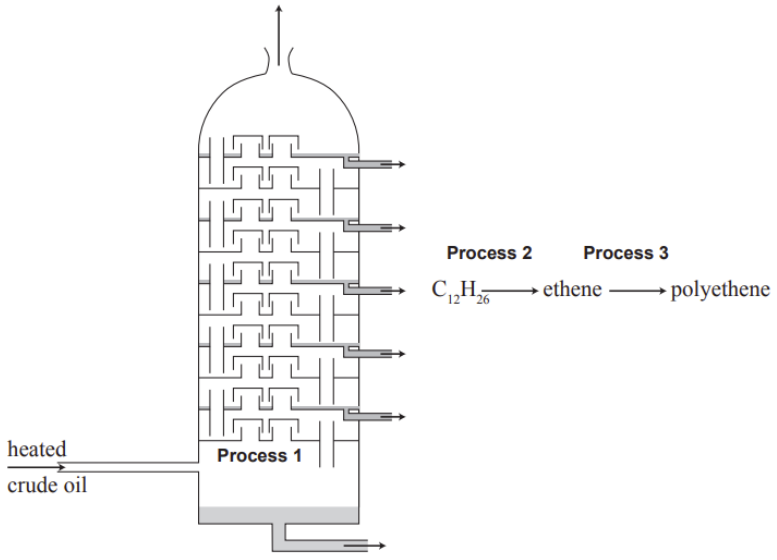
(ii) Elaborate on Reaction 1 and Reaction 2.

In your answer, you should:

- name the types of reactions occurring
- give the conditions required for each reaction
- explain how polyethene can be made from Product 2

2015:2

Crude oil, a mixture of many compounds, undergoes several processes to produce useful products. The diagram below shows three of the **processes** that may be involved.



Answers are here: https://www.nzqa.govt.nz/ncea/assessment/search.do?query=Chemistry&view=reports&level=01

(a) (i) Give the name of each of the processes identified in the diagram above.
(ii) Explain how the structure of ethene allows it to undergo **Process** 3, to form polyethene.

(b) Dodecane, $C_{12}H_{26}$, can be reacted in **Process 2**, to form ethene and octane.
(i) State one condition that is needed during Process 2.
(ii) Complete the following symbol equation for the reaction of dodecane during Process 2. Remember to balance the equation.
$C_{12}H_{26} \rightarrow$

(c) Give a detailed account of **Process 1**, as shown in the diagram.

In your answer, you should:
- explain why **Process 1** is necessary
- elaborate on what occurs during **Process 1**, and link this to the structure and properties of the hydrocarbons in crude oil.
- name two products, other than dodecane, that are formed during **Process 1**.

2014:2

Cracking is a process used to break down the long-chain alkanes found in crude oil, into smaller molecules.

(a) Complete a balanced symbol equation to show how the long-chain alkane decane, $C_{10}H_{22}$, breaks down to form pentane, ethene, and propene.

(b) Explain why some long-chain alkanes need to undergo cracking.

Polymers are very large molecules made up of many small repeating units.

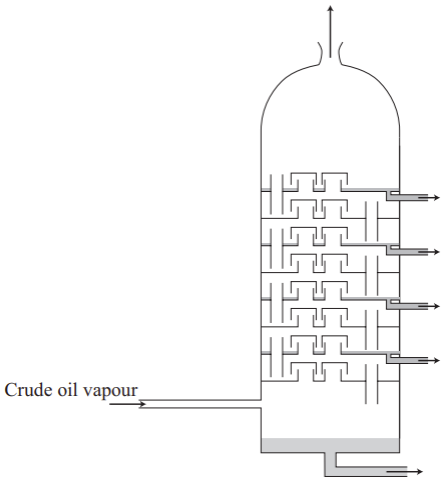
(c) Explain why an alkene such as ethene can be used to make polymers, while an alkane such as ethane cannot. You may draw diagrams as part of your explanation.

(d) Polymers are used in the production of plastics. Plastic pollution is becoming a planet-wide problem, with much of the waste plastic ending up in our oceans. Polyethene (polythene) and polypropene (polypropylene) both float on the ocean's surface, forming part of the large floating islands of plastic waste that form where ocean currents meet.
Explain why the polymers polyethene and polypropene form part of these floating islands of plastic.

In your answer:
- describe the chemical structure and bonding of these polymers
- explain the chemical reactivity of these polymers

2013:2

Crude oil is fractionally distilled in tall towers, like the one shown, to obtain useful products.



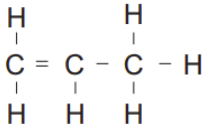
(a) Explain why crude oil must be fractionally distilled before it can be used.

(b) Name TWO of the fractions obtained from the fractional distillation tower, and describe ONE use for each.

(c) Explain why fractional distillation is carried out in towers. You will need to refer to the chemical structure and physical properties of the hydrocarbons that make up crude oil, and the way the fractional distillation tower operates.

2013:3

The chemical structure of propene



(a) Draw THREE repeating units to show the polymer that propene forms.

(b) Explain why alkenes can be used to make polymers, but alkanes cannot.

(c) Polypropene (polypropylene) has many uses that are linked to its chemical and physical properties.
Name TWO uses of polypropene.
Link each use to TWO physical and/or chemical properties of polypropene.

2012:2

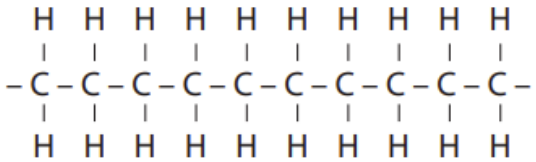
Crude oil is made up of different fractions. Some of these fractions contain large chain hydrocarbons that may not be useful as fuels. Cracking is the process used to produce smaller, more useful hydrocarbons.
Give a detailed account of the process of cracking.

In your answer you should:

- describe the process of cracking, stating the conditions required
- explain why the large chain fractions may not be useful as fuels
- by using hexane as an example, identify the products that would form in cracking, and explain why they form by referring to their chemical structures
- give ONE use for each of the products that form.

2012:4

This is a section of the polymer polyethene (polythene):



(a) Name and draw the monomer used to form polyethene.

(b) This monomer burns with a smoky flame in a limited oxygen supply.
Identify and explain TWO negative effects on human health of the products of this combustion reaction.

(c) Polyethene is available in both a low density (LDPE) and high density (HDPE) form. Some properties of LDPE and HDPE are given in the table below.

	Mass	Solubility in water	Chemical resistance	Flexibility	Polymer chain packing
LDPE (low density polyethene)	light	insoluble	high	more flexible	chains packed loosely together
HDPE (high density polyethene)	light	insoluble	high	less flexible	chains packed closely together

Explain why LDPE is used to make plastic food wrap and HDPE is used to make plastic drink bottles, by analysing the properties provided in the table above.

(d) Explain why polyethene is a non-biodegradable substance.

Alkanes, alkenes, alcohols - physical properties

2019:3

(a) The tables below show the boiling points of some alkanes and alkenes.

Alkanes

Name	Number of carbons	Boiling point/ °C
Ethane	2	–88
Propane	3	–42
Butane	4	0
Pentane	5	36
Hexane	6	69

Alkenes

Name	Number of carbons	Boiling point/ °C
Ethene	2	–104
Propene	3	–48
Butene	4	–6
Pentene	5	30
Hexene	6	64

(i) What is the relationship between the number of carbon atoms in an alkane molecule and the boiling point of the alkane molecule? You should use information in the table above to explain your answer.

(ii) What does the information in the tables above show about any similarities and differences in the boiling points of alkanes compared to alkenes?

(c) The following table shows selected data for the compounds methanol, ethanol, and propene. Compare and contrast the data in the table, with reference to the type of organic compound and your knowledge of the structure and chemical properties of the compounds.

Compound	Solubility in water	Number of molecules of water produced per molecule of compound during complete combustion
methanol	soluble	2
ethanol	soluble	3
propene	insoluble	3

In your answer, you should explain how you used the information in the table to compare and contrast the solubility and combustion reactions of the compounds.

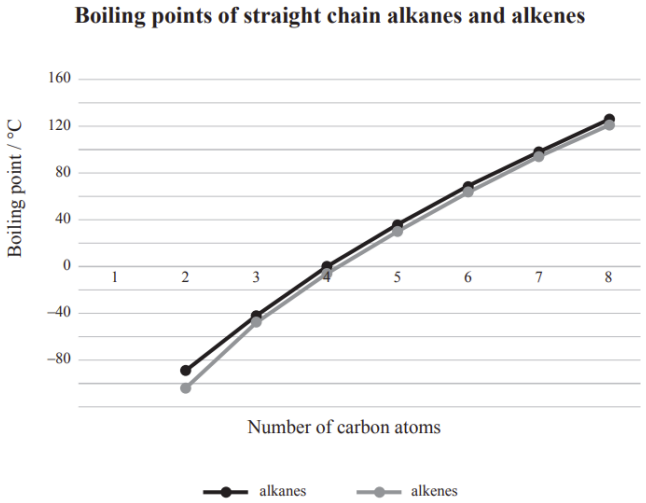
Answers are here: https://www.nzqa.govt.nz/ncea/assessment/search.do?query=Chemistry&view=reports&level=01

2018:1

(a) (ii) Compare and contrast alkanes and alkenes in relation to:

- the structure and bonding of alkanes and alkenes
- trends in their boiling points.

In your answer, you should refer to the graph, and your knowledge of the structure of alkanes and alkenes.



2016:2

(b) (i) The boiling point for methanol is 65ºC and ethanol is 78ºC. Why does ethanol have a higher boiling point than methanol?

(ii) Why are both methanol and ethanol soluble in water?

2015:1

(b) Butane and propane are both used as fuel in camping burners. Propane has a boiling point of – 42°C.

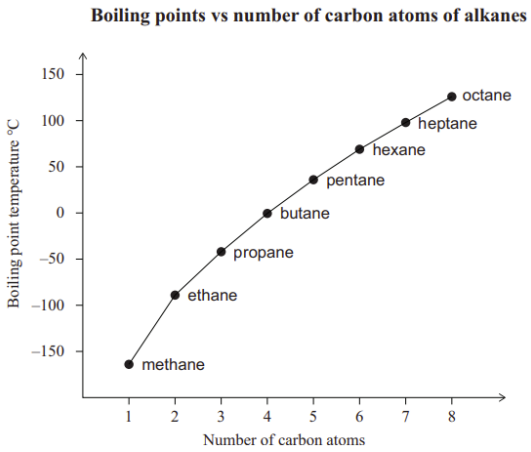
(i) What state would propane be at room temperature (18°C)?

(ii) State whether the boiling point of butane will be higher or lower than propane. Give a reason for your answer using your knowledge of the structure and properties of alkanes.

2014:3

(a) Define the term 'boiling point'.

The boiling points of some alkanes are shown in the graph.



(b) Analyse the trend in boiling points of the first eight alkanes, as shown in the graph above. In your answer:

- describe the trend
- explain why this trend occurs.

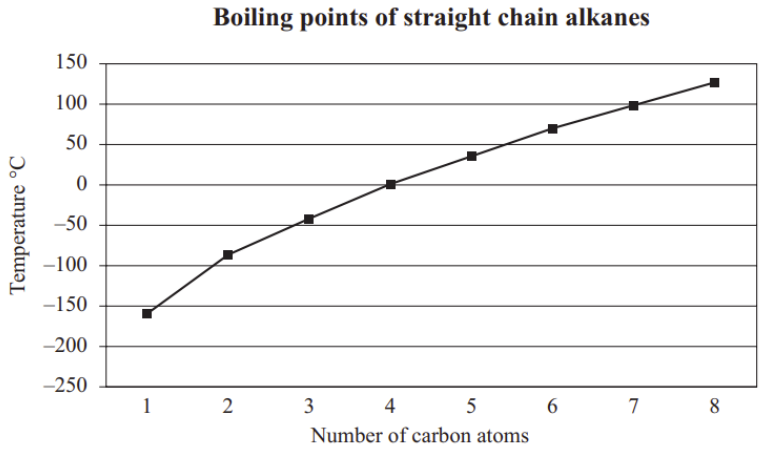
(c) Ethanol is soluble in water, ethane is not. Ethane has a much lower boiling point than ethanol. Compare and contrast the chemical structures and bonding of ethane and ethanol to explain the difference in these physical properties.

In your answer:

- describe the structures and chemical bonding of ethane and ethanol
- link the chemical bonding and structure to each of the physical properties – solubility in water and boiling point – for both ethane and ethanol.

Answers are here: https://www.nzqa.govt.nz/ncea/assessment/search.do?query=Chemistry&view=reports&level=01

2012:3



(a) Name and draw the structural formulae of the alkanes with 3 and 7 carbon atoms,

(b) Identify and explain the trend of boiling points for the alkanes shown in the graph above.

(c) In October 2011 a ship, the Rena, grounded on a reef near Tauranga Harbour, causing oil to be spilled into the ocean. It was observed that the oil formed a layer on top of the water, and that it lasted for a long time.
Give an explanation for both observations by referring to the properties of oil.

Naming and Structural formula

2019:3
(b) (i) Draw the structural formulae of methane and methanol.

2018:1
(a) Both ethane and ethene are classified as hydrocarbons.
(i) Draw the structural formulae of ethane and ethene in the boxes below:

(b) Ethanol is not classified as a hydrocarbon.
(i) Draw the structural formula of ethanol.
(ii) Why is ethanol not classified as a hydrocarbon?

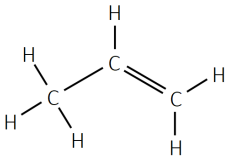
2018:2
(d) Fuels such as butane react with oxygen to release energy.
(i) Draw the structural formula of butane.

2017:1
(a) Draw the structural formulae of propane and propene.

2017:3
(a) (i) Draw the structural formulae of heptane and methanol.
(ii) Explain why heptane is classified as a hydrocarbon, while methanol is not.

2016:1
(a) Draw the structural formulae of propane and propene.
(b) (i) What is the type of bonding present in a molecule of propane? Give a reason for your answer.
(ii) How does the structure of propene differ to propane?

2016:2
(a) Draw the structural formulae of methanol and ethanol.

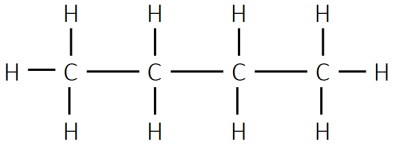
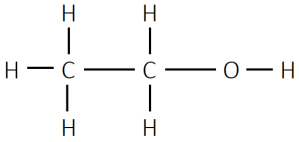
2015:1
(a) Name or draw the structure of each organic compound.
- Methane
- Hexane
- 

2015:3
Alcohols, such as ethanol, are carbon compounds, but are not hydrocarbons like alkanes and alkenes.
(a) (i) Draw the structural formula of ethanol.
(ii) Explain why alcohols are not hydrocarbons, but alkanes and alkenes are.

Answers are here: https://www.nzqa.govt.nz/ncea/assessment/search.do?query=Chemistry&view=reports&level=01

2014:1

(a) Name or draw the structure of each organic compound.

- 
- Heptane
- Propene
- 

Alkanes and alkenes are organic compounds made up of carbon and hydrogen atoms.

(b) Name the type of bonding that occurs between the atoms in these organic compounds. Explain your answer.

(c) Explain how the chemical bonding in alkanes and alkenes affects the way they are used. In your answer:

- give the general formulae of alkanes and alkenes
- describe the similarities and differences in chemical bonding
- identify ONE common use for each of alkanes and alkenes
- link the chemical bonding to the property or properties of each type of compound that makes them suitable for the identified use.

2014:4

In New Zealand methanol is produced from natural gas, methane, extracted from the Taranaki gas fields.

(a) Draw the chemical structures for methane and for methanol.

2013:1

(a) Draw the structural formula of methanol.

(b) (i) Identify the type of bonding within a molecule of methanol.

(ii) Give a reason for your choice.

2013:4

(a) Draw the chemical structures for ethane and for ethanol.

(b) Analyse the differences between ethane and ethanol by considering the similarities and differences of their chemical structures and their physical properties.
In your answer include, for both ethane and ethanol:

- their state at room temperature
- their relative melting and boiling points
- their solubility in water.

Production of Ethanol & Methanol from Methane

2019:3

(b) (ii) Explain how methanol is produced from methane.

In your answer, you should:
- write relevant balanced symbol equations
- describe any conditions needed.

2016:2

(c) How does the industrial preparation of methanol from natural gas differ from the process of fermentation to form ethanol?

In your answer, you should include:
- a description of the two processes
- explanations of any conditions required
- balanced symbol equations for any reactions occurring.

2015:3

(b) One method of producing ethanol is by fermentation. Explain how ethanol is produced by fermentation.

In your answer, you should:
- complete the following word equation and balanced symbol equation
- identify and elaborate on any conditions required for fermentation to occur.

Word equation: glucose →
Balanced symbol equation: $C_6H_{12}O_6$ →

2014:4

In New Zealand methanol is produced from natural gas, methane, extracted from the Taranaki gas fields.

(a) Draw the chemical structures for methane and for methanol.

(b) Write balanced symbol equations for both of the reactions involved in the production of methanol from methane.
(i) Reaction 1: Methane and steam are reacted using a nickel catalyst, Ni, and a strong heat source, to form carbon monoxide gas and hydrogen gas.
(ii) Reaction 2: Carbon monoxide gas and hydrogen gas are reacted at 250oC using a copper-zinc catalyst, Cu-Zn, to form methanol.

2013:4

(c) Fermentation is one method that can be used to produce ethanol. Elaborate on how fermentation is used to produce ethanol.

In your answer include:
- an explanation of the materials used and the products obtained
- the conditions required for fermentation to occur
- a balanced symbol equation.

2012:1

Ethanol can be produced by the fermentation of glucose.

(a) Draw the structural formula of ethanol.

(b) Outline the fermentation process that produces ethanol from glucose ($C_6H_{12}O_6$). Include the conditions required for this process to occur, and a balanced symbol equation

Identification

2018:3

(b) The following table shows selected data for three compounds, A, B, and C.

Compound	Solubility in water	Number of molecules of CO_2 produced per molecule of compound during complete combustion
A	Soluble	2
B	Insoluble	3
C	Insoluble	2

It is known that the compounds are: ethane, ethanol, and propane.

Use the information in the table to identify each of the compounds listed above.

Explain how you used the structure and properties of these compounds to distinguish between them.

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(b) Heptane and methanol are both colourless liquids at room temperature (25°C).
How could water be used to distinguish between separate samples of heptane and methanol?
In your answer, you should include any observations that would be made, and explain the physical properties of BOTH compounds that allow this identification.

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(a) (iii) Describe how a sample of ethanol could be distinguished from a sample of octane using only water. Explain how the physical properties of the compounds allow them to be identified in this way.