



A-Level Chemistry

Alkanes

Question Paper

Time available: 65 minutes

Marks available: 61 marks

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1.

Petrol contains saturated hydrocarbons. Some of the molecules in petrol have the molecular formula C_8H_{18} and are referred to as octanes. These octanes can be obtained from crude oil by fractional distillation and by cracking suitable heavier fractions.

Petrol burns completely in a plentiful supply of air but can undergo incomplete combustion in a car engine.

- (a) State the meaning of both the words *saturated* and *hydrocarbon* as applied to the term *saturated hydrocarbon*.

Name the homologous series to which C_8H_{18} belongs.

(3)

- (b) Outline the essential features of the fractional distillation of crude oil that enable the crude oil to be separated into fractions.

(4)

- (c) C_8H_{18} is obtained by the catalytic cracking of suitable heavy fractions.
State what is meant by the term *cracking* and name the catalyst used in catalytic cracking.

Write an equation to show how one molecule of $C_{14}H_{30}$ is cracked to form one molecule of C_8H_{18} and one molecule of another hydrocarbon.

Explain why oil companies need to crack 'suitable heavy fractions'.

(4)

- (d) Write an equation for the incomplete combustion of C_8H_{18} to form carbon monoxide and water only.

A catalytic converter is used to remove carbon monoxide from the exhaust gases in a car. Identify a catalyst used in the catalytic converter.

Write an equation to show how carbon monoxide is removed in a catalytic converter.

State why the water produced in the exhaust gases may contribute to global warming.

(4)

- (e) When some petrol was accidentally contaminated in 2007, the sensors in the affected cars caused a decrease in the supply of petrol to the engine.

Suggest the effect that the contaminated fuel would have on the performance of the cars.

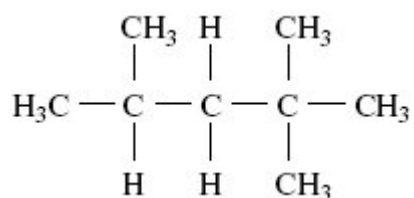
State how the oil company might have recognised the problem before the petrol was sold.

(2)

- (f) The molecular formula C_8H_{18} represents several structural isomers.

State what is meant by the term *structural isomers*.

Name the following structural isomer of C_8H_{18}



(3)

(Total 20 marks)

2.

The fractions obtained from petroleum contain saturated hydrocarbons that belong to the homologous series of alkanes.

(a) Any homologous series can be represented by a general formula.

(i) State **two** other characteristics of homologous series.

Characteristic 1 _____

Characteristic 2 _____

(ii) Name the process which is used to obtain the fractions from petroleum.

(iii) State what is meant by the term *saturated*, as applied to hydrocarbons.

(4)

(b) Decane has the molecular formula $C_{10}H_{22}$

(i) State what is meant by the term *molecular formula*.

(ii) Give the molecular formula of the alkane which contains 14 carbon atoms.

(iii) Write an equation for the incomplete combustion of decane, $C_{10}H_{22}$, to produce carbon and water only.

(3)

(c) When petrol is burned in an internal combustion engine, some nitrogen monoxide, NO , is formed. This pollutant is removed from the exhaust gases by means of a reaction in a catalytic converter.

(i) Write an equation for the reaction between nitrogen and oxygen to form nitrogen monoxide.

(ii) Identify a catalyst used in a catalytic converter.

(iii) Write an equation to show how nitrogen monoxide is removed from the exhaust gases as they pass through a catalytic converter.

(3)

(Total 10 marks)

3.

(a) Crude oil is separated into fractions by fractional distillation. Outline how different fractions are obtained by this process.

(3)

(b) The table below gives details of the supply of, and demand for, some crude oil fractions.

Fractions	Approximate %	
	Typical supply from crude oil	Global demand
Gases	2	4
Petrol and naphtha	16	27
Kerosine	13	8
Gas oil	19	23
Fuel oil and bitumen	50	38

(i) Use the data given above to explain why catalytic cracking of crude oil fractions is commercially important.

(ii) Give the two main types of product obtained by catalytic cracking.

Type 1 _____

Type 2 _____

(4)

(c) Name a catalyst used in catalytic cracking. State the type of mechanism involved and outline the industrial conditions used in the process.

Catalyst _____

Conditions _____

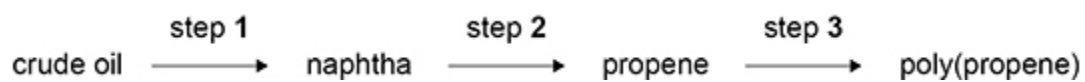
(4)

(Total 11 marks)

4.

This question is about poly(propene).

(a) The three key steps in the manufacture of poly(propene) from crude oil are shown.



Naphtha is a mixture of alkanes with 6 to 12 carbon atoms per molecule.

For each step, name the process and state briefly the purpose of the process that leads to the formation of poly(propene).

Step 1

Name _____

Purpose _____

Step 2

Name _____

Purpose _____

Step 3

Name _____

Purpose _____

(6)

(b) Poly(propene) is not biodegradable because it is unreactive.

Explain why poly(propene) is unreactive.

(1)

(c) Scientists are developing new polymers, including some that are biodegradable.

Suggest why it is beneficial for some polymers to be biodegradable.

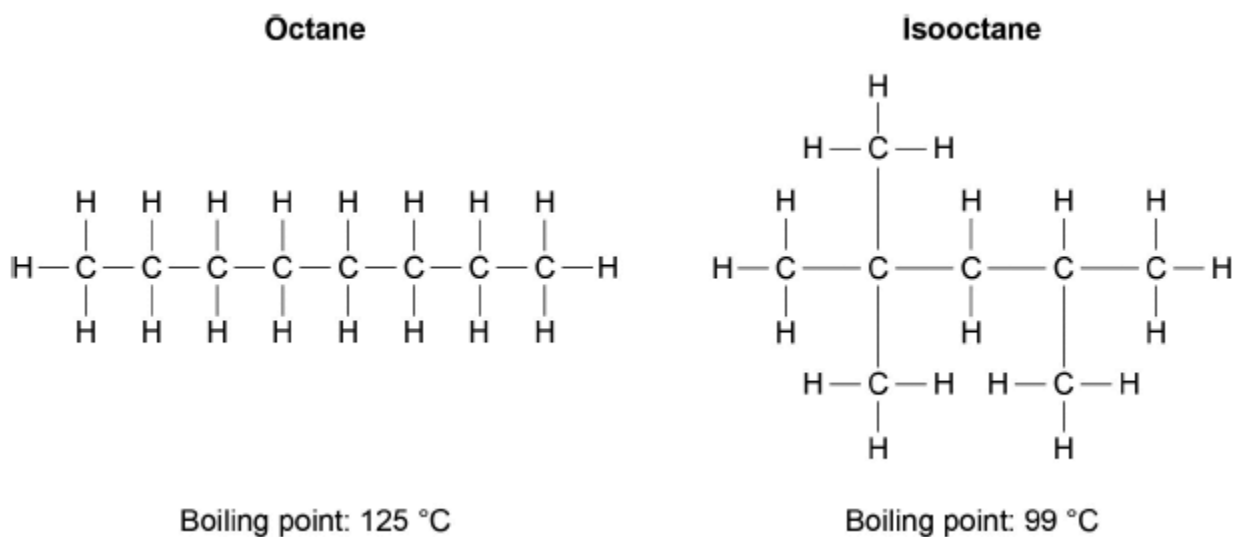
(1)

(Total 8 marks)

5.

Octane and isooctane are structural isomers with the molecular formula C_8H_{18} . The displayed formulas and boiling points of octane and isooctane are shown in **Figure 1**.

Figure 1



(a) Give the IUPAC name for isooctane.

(1)

(b) Octane and isooctane can be separated in the laboratory.

Name a laboratory technique that could be used to separate isooctane from a mixture of octane and isooctane.

Outline how this technique separates isooctane from octane.

Name _____

Outline _____

(3)

(c) Isooctane is added to petrol to increase its octane rating. Some high-performance engines require fuel with a higher octane rating.

Write an equation for the complete combustion of isooctane. Use the molecular formula (C_8H_{18}) of isooctane in your equation.

(1)

(d) Explain, in general terms, how a catalyst works.

(2)

(e) Carbon monoxide is produced when incomplete combustion takes place in engines. Nitrogen monoxide is another pollutant produced in car engines.

Write an equation to show how these pollutants react together in a catalytic converter.

(1)

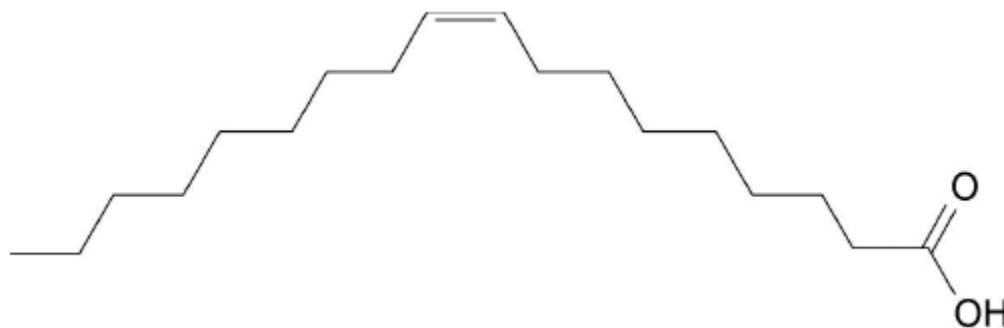
- (f) Platinum, palladium and rhodium are metals used inside catalytic converters. A very thin layer of the metals is used on a honeycomb ceramic support.

Explain why a thin layer is used in this way.

(2)

- (g) Oleic acid ($C_{18}H_{34}O_2$) is a straight-chain fatty acid obtained from plant oils. Isooctane can be made from oleic acid. The skeletal formula of oleic acid is shown in **Figure 2**.

Figure 2



Identify a reagent that could be used in a chemical test to show that oleic acid is unsaturated.

State what would be observed in this test.

Reagent _____

Observation _____

(2)

(Total 12 marks)