

Q1. 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.

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

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(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'.

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- (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.

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- (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.

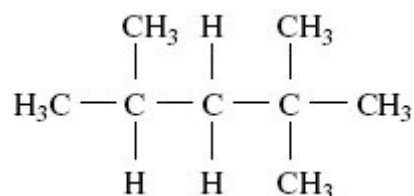
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(2)

(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}



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(Total 20 marks)

Q2. (a) Crude oil is separated into fractions by fractional distillation. Outline how

different fractions are obtained by this process.

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(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.

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(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)

- Q3.** (a) Gas oil (diesel), kerosine (paraffin), mineral oil (lubricating oil) and petrol (gasoline) are four of the five fractions obtained by the fractional distillation of crude oil within the temperature range 40–400 °C.

Identify the missing fraction and state the order in which the five fractions are removed as the fractionating column is ascended. Give **two** reasons why the fractions collect at different levels in the fractionating column.

(4)

- (b) Thermal cracking of large hydrocarbon molecules is used to produce alkenes. State the type of mechanism involved in this process. Write an equation for the thermal cracking of $C_{21}H_{44}$ in which ethene and propene are produced in a 3:2 molar ratio together with one other product.

(3)

- (c) Write equations, where appropriate, to illustrate your answers to the questions below.

(i) Explain why it is desirable that none of the sulphur-containing impurities naturally found in crude oil are present in petroleum fractions.

(ii) The pollutant gas NO is found in the exhaust gases from petrol engines. Explain why NO is formed in petrol engines but is not readily formed when petrol burns in the open air.

- (iii) The pollutant gas CO is also found in the exhaust gases from petrol engines. Explain how CO and NO are removed from the exhaust gases and why the removal of each of them is desirable.

(10)
(Total 17 marks)

Q4. 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

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Characteristic 2

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

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

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

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

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

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

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(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.

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

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

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(3)

(Total 10 marks)

