

Name of the Student: _____

Max. Marks : 28 Marks

Time : 28 Minutes

Q1.

Avgas is an aviation fuel used in the internal combustion engines of helicopters.

It consists of a large number of hydrocarbons, including a high proportion of hexane, which can exist as several isomers.

- (a) Draw the skeletal formulae of **two** branched isomers of hexane.

(1)

- (b) State the type of isomerism shown by these branched isomers.

(1)

- (c) Safety signs on the fuselage of the helicopter state that the air inlets to the engine need to be cleaned out regularly.

Write an equation for the combustion of hexane that would happen in the helicopter engine if the air inlets were partially blocked with debris.

(2)

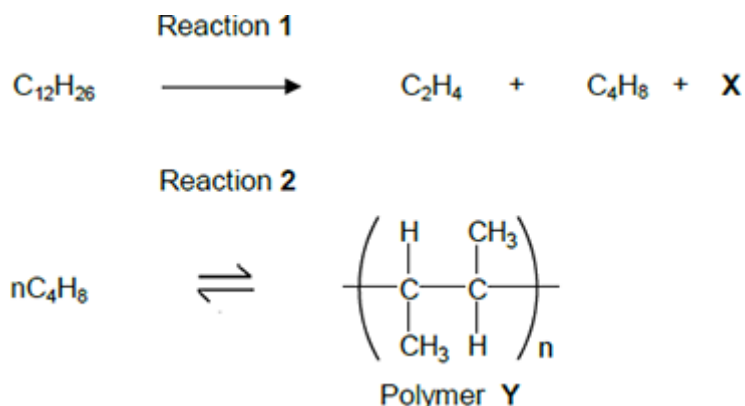
- (d) Suggest how this partial blockage might affect the performance of the helicopter engine.

(1)

(Total 5 marks)

Q2.

Dodecane ($C_{12}H_{26}$) is a hydrocarbon found in the naphtha fraction of crude oil. Dodecane can be used as a starting material to produce a wide variety of useful products. The scheme below shows how one such product, polymer Y, can be produced from dodecane.



- (a) Name the homologous series that both C_2H_4 and C_4H_8 belong to.
Draw a functional group isomer of C_4H_8 that does **not** belong to this homologous series.

Name _____

Functional group isomer

(2)

- (b) Identify compound X.

(1)

- (c) Name polymer Y.

(1)

- (d) Reaction 1 is an example of thermal cracking and is carried out at a temperature of 750°C .

State **one other** reaction condition needed.

(1)

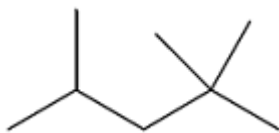
- (e) Reaction 2 is exothermic. A typical compromise temperature of 200°C is used industrially for this reaction.

Explain the effect of a change of temperature on both the position of equilibrium and the rate of reaction, and justify why a compromise temperature is used industrially.

(6)
(Total 11 marks)

Q3.

Isooctane (C_8H_{18}) is the common name for the branched-chain hydrocarbon that burns smoothly in car engines. The skeletal formula of isooctane is shown below.



- (a) Give the IUPAC name for isooctane.

(1)

- (b) Deduce the number of peaks in the ^{13}C NMR spectrum of isooctane.

5 ☐

6 ☐

7 ☐

8 ☐

(1)

- (c) Isooctane can be formed, together with propene and ethene, in a reaction in which one molecule of an alkane that contains 20 carbon atoms is cracked.

Using molecular formulas, write an equation for this reaction.

(1)

- (d) How do the products of the reaction in part (c) show that the reaction is an example of thermal cracking?

(1)

- (e) Deduce the number of monochloro isomers formed by isooctane.
Draw the structure of the monochloro isomer that exists as a pair of optical isomers.

Number of monochloro isomers

Structure

(2)

- (f) An isomer of isooctane reacts with chlorine to form only one monochloro compound.

Draw the **skeletal formula** of this monochloro compound.

(1)

- (g) A sample of a monochlorooctane is obtained from a comet. The chlorine in the monochlorooctane contains the isotopes ^{35}Cl and ^{37}Cl in the ratio 1.5 : 1.0. Calculate the M_r of this monochlorooctane.

$M_r =$ _____

(2)

- (h) Isooctane reacts with an excess of chlorine to form a mixture of chlorinated compounds. One of these compounds contains 24.6% carbon and 2.56% hydrogen by mass. Calculate the molecular formula of this compound.

Molecular formula = _____

(3)

(Total 12 marks)