

Name of the Student: _____

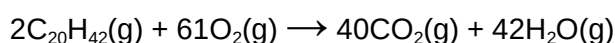
Max. Marks : 18 Marks

Time : 18 Minutes

Q1.

- (a) Alite must be made at temperatures above 1250 °C. This means that Portland cement manufacture is a very energy-intensive process.

In the 1950s, heavy fuel oil was used. A typical heavy fuel oil contains compounds with the molecular formula $C_{20}H_{42}$. This kind of fuel requires pre-heating before it can be burned. The equation for the complete combustion of $C_{20}H_{42}$ is



- (i) Suggest why combustion of the fuel oil is likely to be incomplete.

(1)

- (ii) The large volume of exhaust gases can cause dust to be blown out of the kiln. The amount of dust can be decreased by passing the exhaust gases through electrostatic precipitators. These can produce sparks because of the high voltage.

Identify a gas that may be present because of incomplete combustion. Suggest why the use of electrostatic precipitators could be a hazard if this gas were present.

Identity of gas _____

Reason _____

(2)

- (iii) Cold air is blown over the alite at the end of the process so that it is cooled as quickly as possible.

Suggest how the resulting air can be used to improve the economy of the whole process.

(1)

- (b) Cement kilns were once one of the largest contributors to global pollution by nitrogen oxides.

- (i) State how nitrogen oxides could be formed during the manufacture of Portland cement.

(1)

- (ii) Sulfur dioxide is formed by the oxidation of sulfur compounds in the fuel used to heat the kiln. Sulfur dioxide can be removed by the minerals in the kiln. Suggest why a kiln with a very fast air flow is likely to emit more sulfur dioxide than one with a slower air flow but otherwise operating under the same conditions.

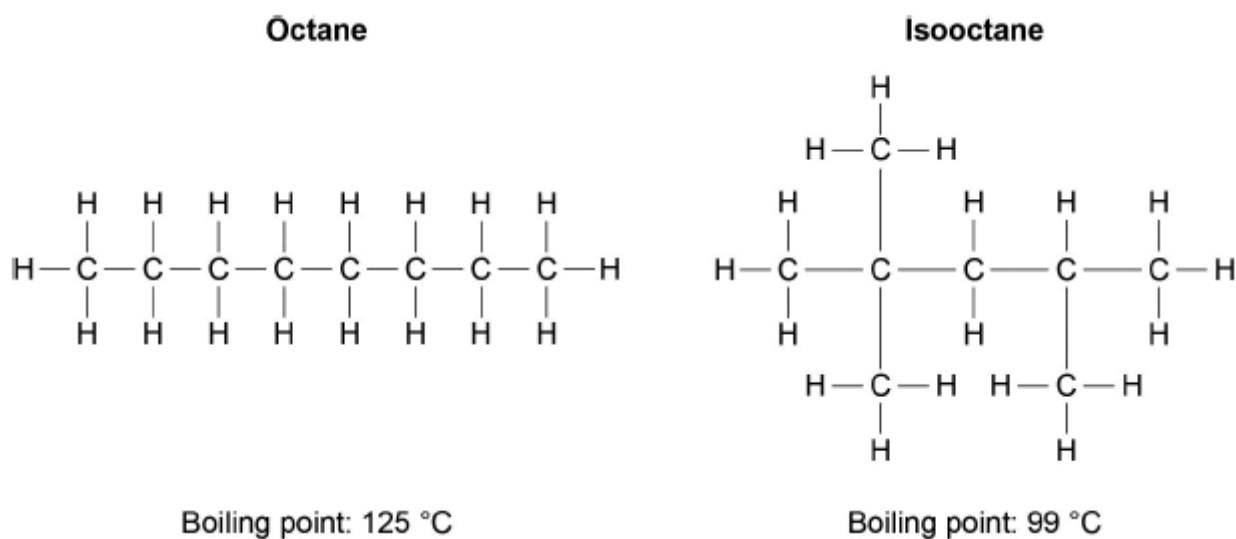
(1)

(Total 6 marks)

Q2.

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)

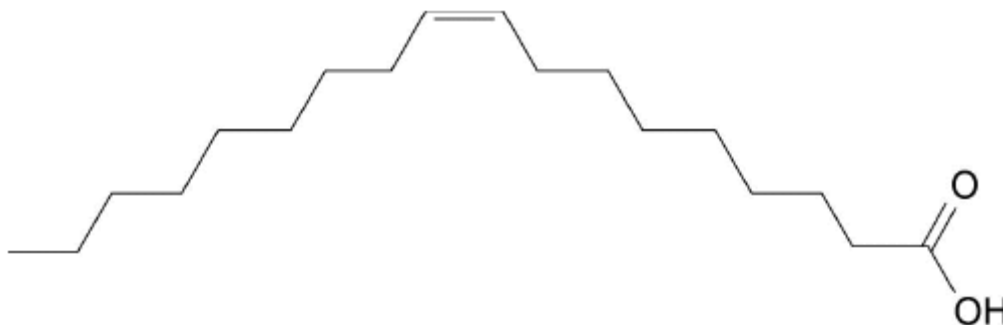
- (f) Platinum, palladium and rhodium are metals used inside catalytic converters. A very thin layer of the metals is used on a honeycomb ceramic support.

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)