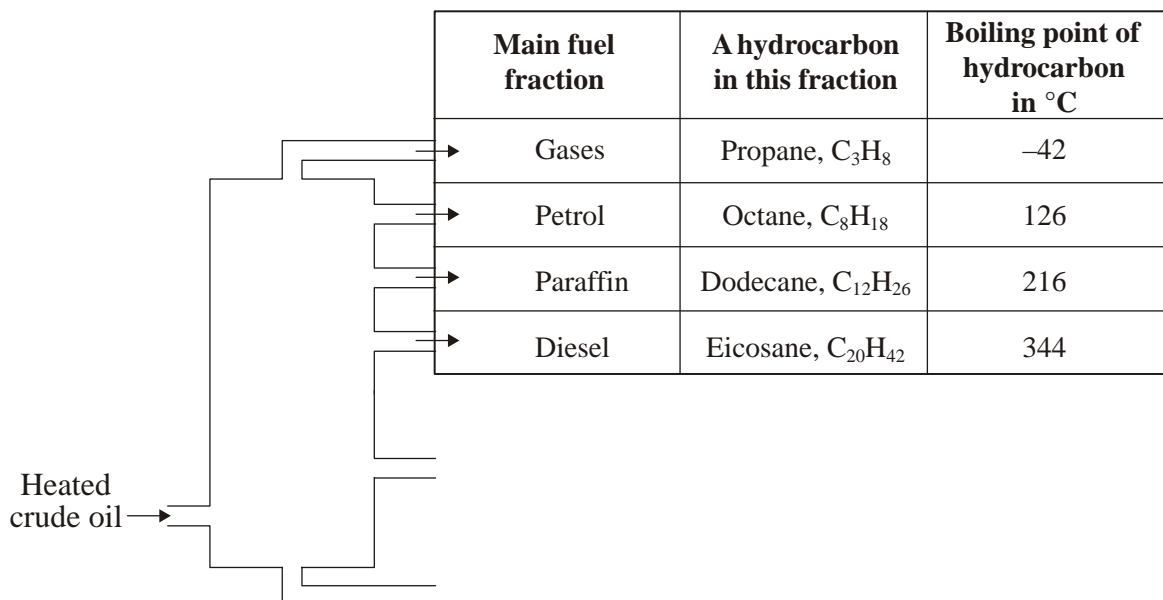


Crude oil, fuels and other useful substances from crude oil

1. Crude oil is a resource from which fuels can be separated.
- (a) The name of the main fuel fractions and one of the hydrocarbons in each fraction are shown in the table.

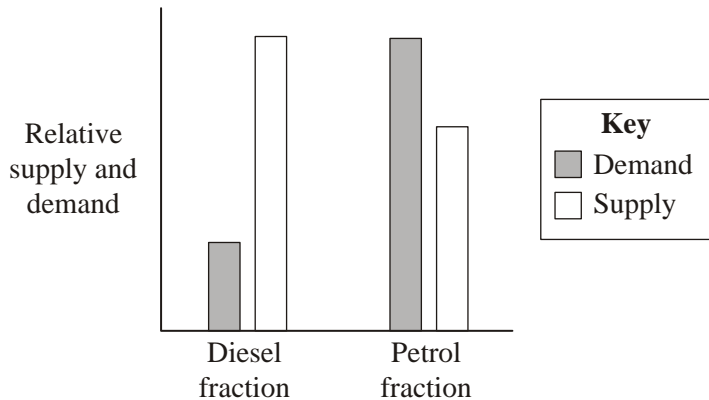


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- (i) How does the number of carbon atoms in a hydrocarbon affect its boiling point?

 (1)
- (ii) Suggest the lowest temperature to which crude oil needs to be heated to vaporize all the hydrocarbons in the table.
 Temperature = °C
 (1)
- (iii) Dodecane boils at 216 °C. At what temperature will dodecane gas condense to liquid?
 Temperature = °C
 (1)

(b) The bar chart shows the relative supply and demand for the petrol and diesel fractions.



(i) How does the relative supply and demand for petrol and diesel fractions cause problems for an oil company?

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(2)

(ii) Suggest **one** way an oil company could solve these problems.

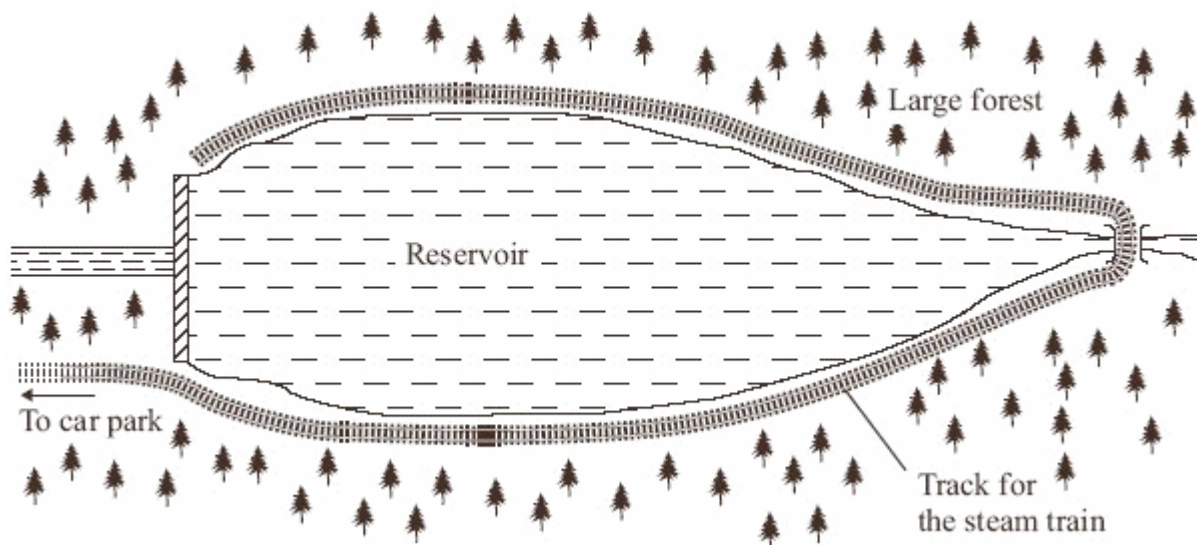
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(1)

(Total 6 marks)

2. A large reservoir is surrounded by trees. Planners need to protect the environment. The distance around the reservoir is many kilometres. There will be only one road access to a car park a few kilometres from the reservoir. From the car park people would be transported to accommodation, activities or places of interest by steam train.



- (a) Coal contains carbon and small amounts of sulfur. The steam train would cause environmental problems if coal were used as the fuel.

Explain why.

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(4)

- (b) The planners have stated that, as a result of using the steam train, there must be no overall increase of carbon dioxide added to the atmosphere. The steam train would be considered as 'carbon neutral' if wood, from the surrounding forest, were used as the fuel.

Suggest why.

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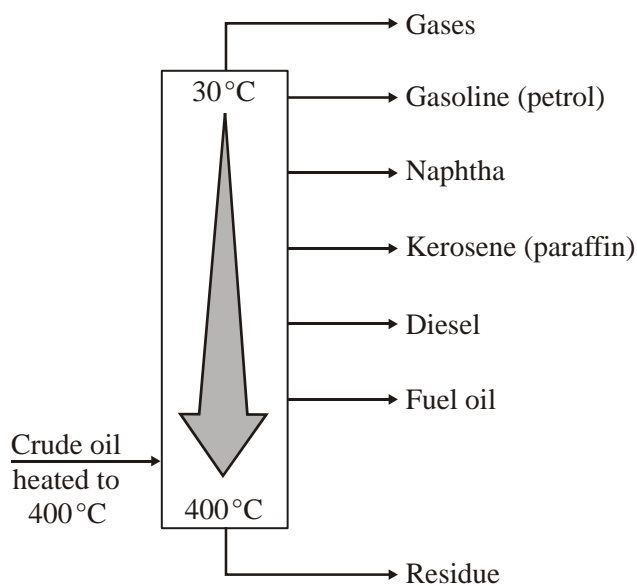
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(3)

(Total 7 marks)

3. Crude oil is the source of many useful materials. Crude oil is separated into fractions by fractional distillation.



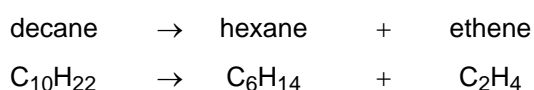
- (a) Describe how the naphtha fraction separates from the other fractions.

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(2)

- (b) The naphtha fraction is often used to make other useful materials.
 This involves the cracking of hydrocarbons in the naphtha fraction.

For example:



- (i) Balance the symbol equation given above.

(1)

- (ii) Describe how cracking is carried out.

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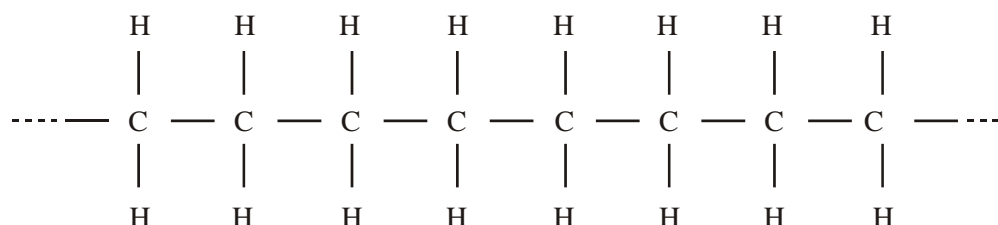
(2)

- (iii) Why does ethene have different chemical properties from decane and hexane?

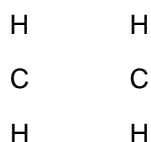
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(2)

- (c) Ethene is used as the starting material for many polymers. The most common polymer is poly(ethene). One hydrocarbon molecule in poly(ethene) will contain thousands of carbon atoms.



Complete the diagram to show the bonds in ethene.



(1)

(d) Read the following information.

Landfill, Incineration, Recycling and Re-use of Poly(ethene)

People could be encouraged to re-use their poly(ethene) bags and containers.

Recycling poly(ethene) saves raw materials and energy needed to make new plastic. When polymers are recycled the plastics must be collected, transported, sorted into different types by hand and washed. This requires the use of fossil fuels and is expensive.

Poly(ethene) can be burnt in an incinerator with other household waste. The heat released could be used to make steam to drive an electric generator. Surplus heat could be used to heat greenhouses used for growing vegetables. Incineration at too low a temperature can produce harmful substances. The residue (ash) has to go to landfill.

Landfill is probably the easiest way to dispose of polymers and it is cheap. Polymers are often mixed in with other household rubbish. Household waste does not get sorted into different materials because it is disposed of in the same hole in the ground. When the hole is eventually full, the waste is covered by a layer of soil to stop it smelling. The waste gets compressed under its own weight. Most polymers, such as poly(ethene), are not biodegradable so will remain in the ground forever.

You are asked to decide which option for the disposal of poly(ethene) will be put forward in your area. You decide that recycling is the best option.

Suggest **one** economic argument and **one** environmental argument that will be made against recycling.

For each argument made, how will you persuade those making the argument to accept your option?

(You must use only one sentence for each argument made against your decision and only one sentence for your response to it.)

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(4)

(Total 12 marks)

4. Known crude oil reserves are being used up rapidly. Crude oil is used to produce many useful fuels, such as petrol. One way to conserve crude oil reserves would be to increase the production of bio-fuels.

(a) Ethanol can be produced for use as a bio-fuel. Cars can be powered by ethanol or ethanol–petrol mixtures.

Sugar cane can be fermented to give a mixture of water (boiling point 100 °C) and ethanol (boiling point 78 °C).

(i) How can ethanol be separated from water?

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(1)

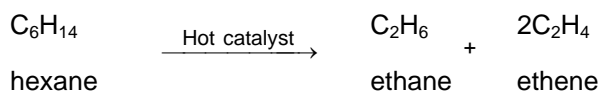
(ii) Ethanol, C₂H₅OH, burns to release heat energy.

Complete the balanced symbol equation by writing in the formulae of the two products.



(2)

(b) The cost of producing a bio-fuel, such as ethanol, by fermentation, is at least three times higher than the production cost of petrol. It costs less to produce ethanol from alkanes. In the production, the vapour of an alkane is passed over a hot catalyst.



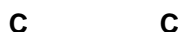
Ethene is then converted into ethanol.

(i) What has happened to the hexane to produce ethene?

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(1)

(ii) Complete the structural formula for ethene, C₂H₄.



(1)

(iii) Name the compound that is added to ethene to produce ethanol, C₂H₅OH.

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(1)

- (c) As explained in parts (a) and (b), ethanol can be made using either sugar or alkanes as the starting material.

Evaluate the advantages and disadvantages of using these two starting materials to produce ethanol.

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(4)
(Total 10 marks)

5. In 1939 Roy Plunkett opened the valve on a new cylinder of tetrafluoroethene gas. No gas came out!



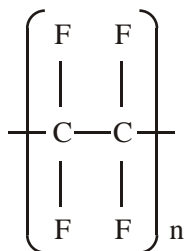
He cut the cylinder open and found that the gas had changed into a white solid. This solid was an addition polymer.

- (a) Give the name of the addition polymer that formed inside the cylinder.

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(1)

(b) The structure of this polymer can be represented by the diagram below.



Draw the structure of the monomer, tetrafluoroethene, from which it is formed.

(2)

(c) Describe how this addition polymer forms from monomers.

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(3)
(Total 6 marks)