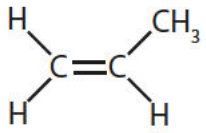
1 The structure of a molecule of propene is



(a) Propene is an unsaturated hydrocarbon.

(i) Explain what is meant by **unsaturated hydrocarbon**.

(3)

(ii) Complete the sentence by putting a cross (☒) in the box next to your answer.

Propene can be made by using heat to decompose large alkane molecules into smaller, more useful molecules.

This process is known as

(1)

☒ **A** combustion

☒ **B** cracking

☒ **C** fractional distillation

☒ **D** polymerisation

(iii) Describe what is seen when a sample of propene is shaken with bromine water.

(2)

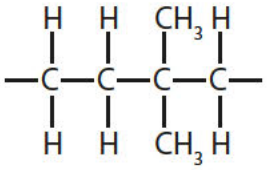
(b) Molecules of propene can be combined to form a molecule of poly(propene).

(i) Which of these shows part of the structure of a molecule of poly(propene)?

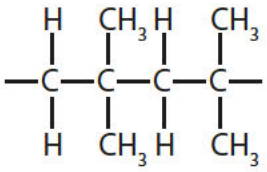
Put a cross (☒) in the box next to your answer.

(1)

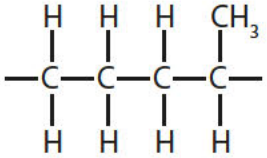
☐ **A**



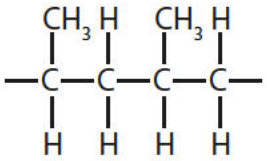
☐ **B**



☐ **C**



☐ **D**



(ii) Ropes used on boats are often made from poly(propene).



State a property of poly(propene) that makes it suitable for use as ropes on boats.

(1)

.....

(iii) e a problem caused by the disposal of poly(propene) ropes in landfill sites.

(1)

.....

.....

.....

(Total for Question 1 = 9 marks)

2 (a) Propene is a gaseous hydrocarbon.

Draw the structure of a molecule of propene, showing all bonds.

(2)

(b) Nitrogen reacts with hydrogen to form ammonia.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(i) Calculate the minimum volume of nitrogen, in dm^3, required to react completely with 1000 dm^3 of hydrogen.

All volumes are measured at the same temperature and pressure.

Put a cross (☒) in the box next to your answer.

(1)

☐ **A** 333 dm^3

☐ **B** 1000 dm^3

☐ **C** 3000 dm^3

☐ **D** 4666 dm^3

(ii) The minimum volumes of nitrogen and hydrogen that must react completely to form 5000 dm^3 of ammonia are calculated.

These volumes are mixed and left, under appropriate conditions, until the reaction reaches equilibrium.

Explain which gas or gases will be present when equilibrium is reached.

(2)

.....

.....

.....

.....

(iii) The Haber process is carried out under a pressure of about 200 atm.

Explain the effect on the **equilibrium yield** of ammonia, if the process is carried out at a pressure higher than 200 atm.

(2)

.....

.....

.....

.....

(iv) Explain the effect on the **rate of attainment of equilibrium**, if the process is carried out at a pressure higher than 200 atm.

(3)

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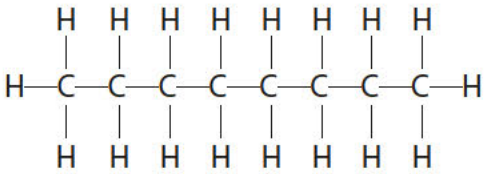
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(Total for Question 2 = 10 marks)

3 (a) Petrol is obtained by the fractional distillation of crude oil.

One substance present in petrol is octane, C_8H_{18}.

The structure of a molecule of octane is shown.



(i) Octane is a saturated hydrocarbon.

Explain what is meant by **saturated hydrocarbon**.

(3)

(ii) Octane is mixed with bromine water and shaken.

Complete the sentence by putting a cross (☒) in the box next to your answer.

On shaking, the colour of the mixture

(1)

☒ **A** remains orange

☒ **B** remains colourless

☒ **C** changes from clear to orange

☒ **D** changes from orange to colourless

(b) In the oil industry some fuel oil fraction is converted into petrol.

This is done by heating the fuel oil fraction to thermally decompose it and produce smaller molecules.

(i) State the name given to this process.

(1)

.....

(ii) Give **two** reasons why it is necessary to carry out this process to make more petrol.

(2)

reason 1 .....

.....

reason 2 .....

.....

(c) Methane can be burned in excess oxygen to form carbon dioxide and water.

Write the balanced equation for this reaction.

(3)

.....

(Total for Question 3 = 10 marks)

4 (a) Margarine is made by hydrogenation of a liquid oil.

Complete the sentence by putting a cross (☒) in the box next to your answer.

In hydrogenation of a liquid oil

(1)

- ☐ **A** hydrogen is removed from the liquid oil
- ☐ **B** the liquid oil reacts with steam
- ☐ **C** double bonds are formed
- ☐ **D** the liquid oil is changed into a solid

(b) Soaps are made by boiling oils with concentrated solutions of alkalis.

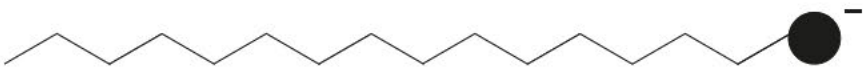
(i) Which of the following would be a suitable alkali to use in the production of soaps?

Put a cross (☒) in the box next to your answer.

(1)

- ☐ **A** sodium chloride
- ☐ **B** sodium hydroxide
- ☐ **C** sodium nitrate
- ☐ **D** sodium sulfate

(ii) The diagram shows a soap anion.



Explain how soap anions remove grease marks from clothes during washing with water.

(2)

.....

.....

.....

.....

.....

(c) Esters are made by reacting alcohols with carboxylic acids.

(i) Give the name of the carboxylic acid that has three carbon atoms in each molecule.

(1)

.....

(ii) When ethanoic acid, CH_3COOH, reacts with ethanol, C_2H_5OH, ethyl ethanoate is one of the products formed.

Write the balanced equation for the reaction.

(2)

.....

(d) Polyesters are used to make plastic bottles.

State another use of polyesters.

(1)

.....

(Total for Question 4 = 8 marks)

5 (a) Which of these is the formula of a molecule of a hydrocarbon?

Put a cross (☒) in the box next to your answer.

(1)

- ☐ **A** CH_3COOCH_3
- ☐ **B** CH_3CH_2Cl
- ☐ **C** CH_3CH_3
- ☐ **D** CH_3COOH

(b) The formula of a molecule of propene is C_3H_6.

Draw the structure of a molecule of propene, showing all covalent bonds.

(2)

(c) Methane burns in oxygen to form carbon dioxide and water.
Write the balanced equation for this reaction.

(3)

*(d) Natural gas is mainly methane.
A gas with similar composition, known as bio-methane, can be produced from plants grown specifically for this purpose.

Describe the advantages and disadvantages of using bio-methane rather than natural gas as a source of energy.

(6)

(Total for Question 5 = 12 marks)