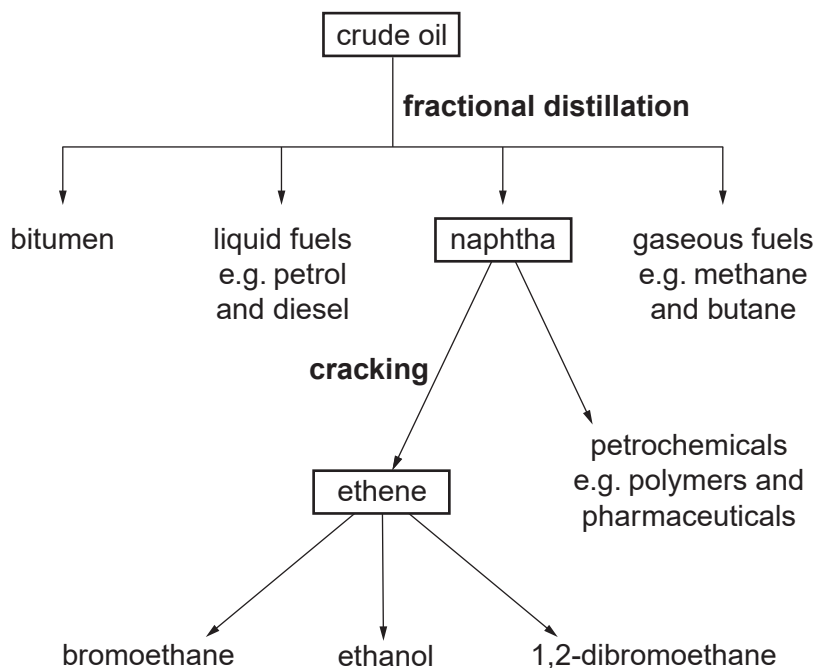


1 Crude oil is a source of many important petrochemicals.

The flow chart shows some of the petrochemicals that can be made and the processes used to make them.



(a) Explain why crude oil can be separated into different fractions.

.....  
..... [1]

(b) Many scientists believe that we should use more fuels such as biodiesel or bio-ethanol rather than petrol and diesel.

Suggest **one** reason why these scientists take this view.

.....  
..... [1]

(c) Cracking converts the alkane dodecane,  $C_{12}H_{26}$ , into more useful short chain alkanes and alkenes.

(i) When  $C_{12}H_{26}$  is cracked, a variety of alkanes and alkenes are formed with different chain lengths.

Explain why a variety of alkanes and alkenes are formed with different chain lengths.

.....  
.....  
..... [1]

(ii) One molecule of  $C_{12}H_{26}$  is cracked to produce one molecule of propane and several molecules of an alkene, **A**.

The mass spectrum of **A** contains peaks with the following  $m/z$  values: 15, 27 and 42. There are no  $m/z$  values above 42.

- Write the formula of the particle responsible for the peak at  $m/z = 27$ .
- Identify, with a reason, alkene **A**.
- Write an equation to show this cracking of  $C_{12}H_{26}$  to form alkene **A**.

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.....  
..... [4]

**(d)** Ethene can be converted into petrochemicals.

- Describe how ethene can be converted into 1,2-dibromoethane, bromoethane and ethanol.
- Name and describe the mechanism for the conversion of ethene into 1,2-dibromoethane using the 'curly arrow' model. Include any relevant dipoles.

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[9]

- (e) Draw and explain the shape of an ethene molecule.  
State the H–C–H bond angle in ethene.

.....  
.....  
.....  
..... [3]

- (f) Addition polymers are made by the polymerisation of alkenes.

*E*-Pent-2-ene can be made into an addition polymer.

- (i) Draw the structure of *E*-pent-2-ene.

[1]

- (ii) Draw the structure of poly(pent-2-ene).  
Include **two** repeat units.

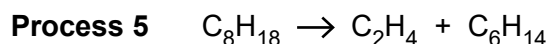
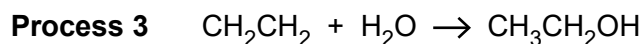
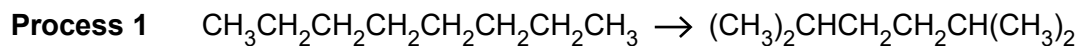
[Total: 21] [1]

2 Atom economy and percentage yield are important factors in deciding the sustainability of a manufacturing process.

(a) Complete the expression below for atom economy.

$$\text{atom economy} = \frac{\text{sum of } \dots\dots\dots}{\text{sum of } \dots\dots\dots} \times 100\% \quad [1]$$

(b) The following five reactions all represent important industrial processes.

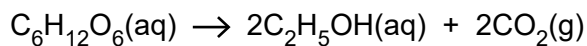


(i) Which process is an example of cracking?  
..... [1]

(ii) Which process makes a structural isomer of the reactant?  
..... [1]

(iii) Which process does **not** have an atom economy of 100%?  
Explain your answer.  
.....  
.....  
.....  
.....  
..... [2]

- (c) The manufacture of ethanol by the fermentation of glucose can be represented by the following equation.



The atom economy is 51.1% and the percentage yield is 88.6%.

- (i) Suggest **two** reasons why it is a good idea to find uses for the carbon dioxide produced.

.....  
.....  
.....  
.....  
..... [2]

- (ii) Some scientists believe that it is more important to have a high percentage yield in fermentation but others think that a high atom economy is more important.

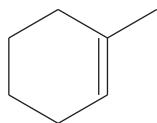
Is it more important to have high percentage yield or a high atom economy in fermentation?

Explain your answer.

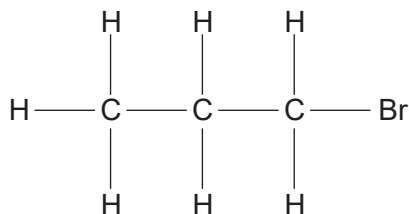
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..... [2]

[Total: 9]

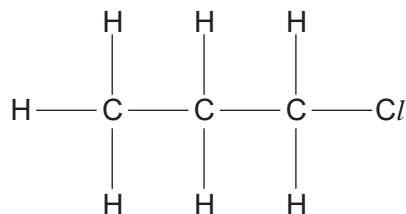
3 This question is about the following organic compounds.



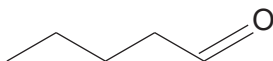
**A**



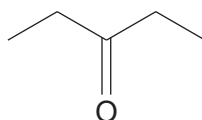
**B**



**C**



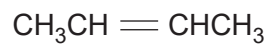
**D**



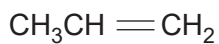
**E**



**F**



**G**



**H**

You will have to refer to these compounds throughout the question.

(a) Explain why compound **A** is a hydrocarbon.

.....  
..... [1]

(b) Which compound is a saturated hydrocarbon?

..... [1]

(c) What is the molecular formula for compound **E**?

..... [1]

(d) Which compounds are structural isomers of one another?

..... [1]

(e) In compound **G**, there are different shapes around different carbon atoms.

(i) State and explain the shape around carbon atom number **1** in compound **G**.

.....  
.....  
.....  
..... [2]

(ii) State the shape around carbon atom number **2** in compound **G**.

..... [1]

(f) (i) Which compound shows *E/Z* isomerism?

..... [1]

(ii) Explain why some molecules show *E/Z* isomerism.

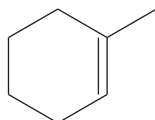
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.....  
..... [2]







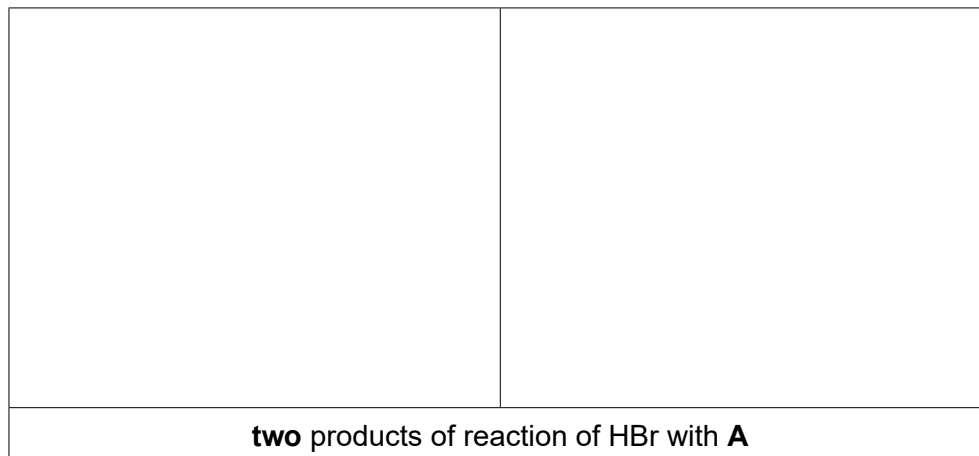
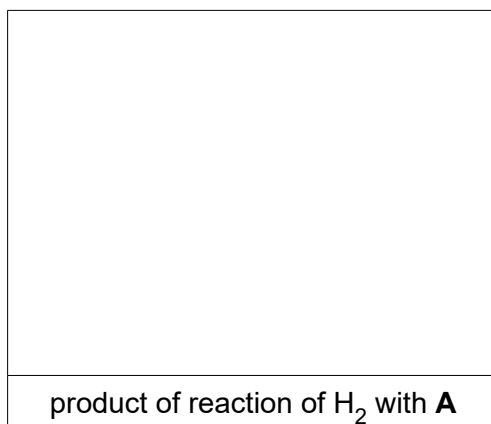
(h) Compound **A** is 1-methylcyclohex-1-ene.



**A**

Compound **A** reacts with  $\text{H}_2$  to give one product and with  $\text{HBr}$  to give two products.

Draw the structures of the products of these reactions.



[3]

[Total: 23]