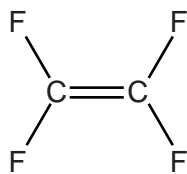
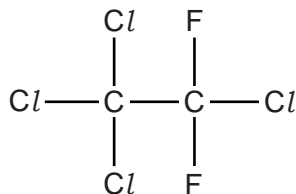


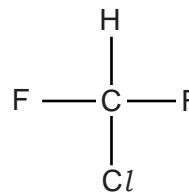
1 This question is about the compounds shown below.



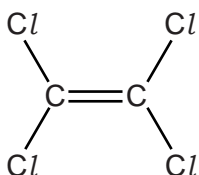
B



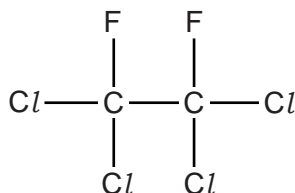
C



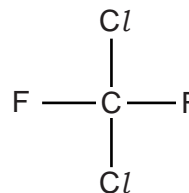
D



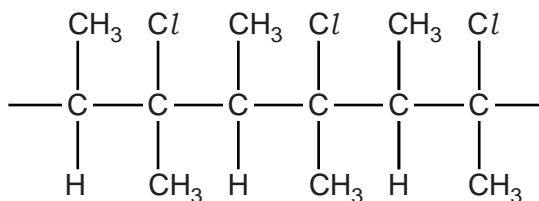
E



F



G



H

(a) Which compound, **B** to **H**, could be used to make the polymer PTFE?

..... [1]

(b) Polymer **H** can be disposed of by combustion. One environmental problem is the production of toxic gases, such as CO.

(i) Draw the structure of the monomer needed to produce polymer **H**.

[1]

(ii) Give the formula of an acidic toxic gas that could form during combustion of polymer **H**.

..... [1]

(c) Compound **G** was once used as a propellant in aerosols. Compound **G** has been linked with depletion of the ozone layer in the stratosphere.

(i) State **two** properties that made compound **G** suitable for use as an aerosol.

1

2 [1]

(ii) Explain the following statements, using equations where appropriate.

- Life on Earth benefits from the presence of an ozone layer.
- The concentration of ozone is maintained in the ozone layer.
- Compound **G** produces radicals which catalyse the breakdown of ozone.

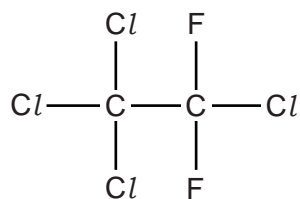
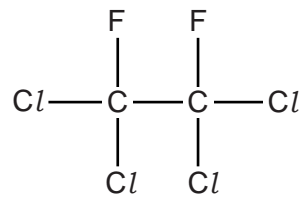
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..... [5]

(iii) Alternative 'ozone-friendly' compounds are now used as propellants instead of compound **G**.

Which compound, **B** to **H**, might be suitable as an 'ozone-friendly' propellant?

..... [1]

(d) Compounds **C** and **F** can be analysed to obtain infrared and mass spectra.

**C****F**

(i) What happens to molecules when infrared radiation is absorbed?

..... [1]

(ii) Suggest the molecular formulae of **two** ions responsible for peaks in the mass spectrum of **C** that are **not** in the mass spectrum of **F**.

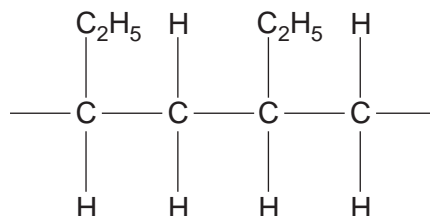
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..... [2]

[Total: 13]

2 Plastics contain polymer molecules. The disposal of waste plastics is causing many environmental problems. In the middle of the Pacific Ocean, there is a huge area of sea water contaminated with very small pieces of plastic waste. In some parts of the Pacific Ocean, there are as many as one third of a million of small pieces of plastic waste per square kilometre of ocean.

(a) A short section of one of the polymers found in the Pacific Ocean is shown below.



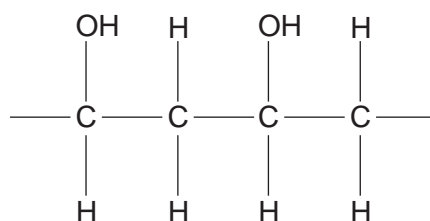
(i) Name and draw the structure of the monomer used to produce this polymer.

name of monomer:

structure:

[2]

(ii) The short section of poly(ethenol) is shown below.



Large quantities of poly(ethene) and poly(ethenol) are disposed of each year.

Poly(ethene) is found as a waste plastic in the Pacific Ocean but poly(ethenol) is not because it slowly dissolves in water.

Suggest why poly(ethenol) dissolves in water.

.....

(b) One way of disposing of poly(chloroethene) is incineration.

This process can cause environmental damage. Incineration produces a mixture of carbon dioxide, carbon monoxide and hydrogen chloride.

Carbon dioxide can cause climate change because it is a greenhouse gas.

- Describe examples of environmental damage that may result from carbon monoxide and hydrogen chloride.
- Outline the methods developed by chemists to reduce environmental damage caused by incineration.

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..... [4]

(c) Explain why it is important to establish international cooperation to reduce the pollution levels of waste plastics.

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..... [2]

[Total: 10]

3 There is much international concern that an increase in atmospheric concentrations of carbon dioxide and methane may lead to global warming and climate change.

(a) Carbon dioxide and methane are both greenhouse gases.

(i) What type of radiation is absorbed by methane molecules and what effect does this radiation have on these molecules?

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

(ii) Some scientists are more concerned about carbon dioxide as a greenhouse gas than methane.

Suggest why.

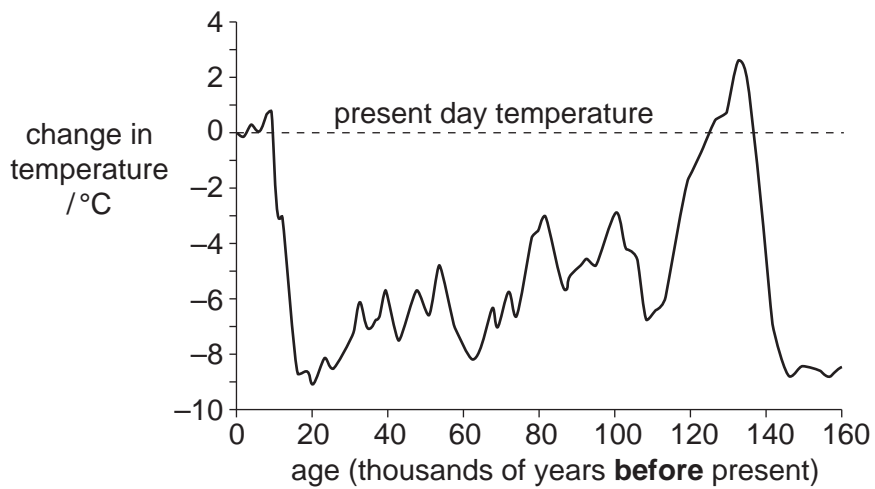
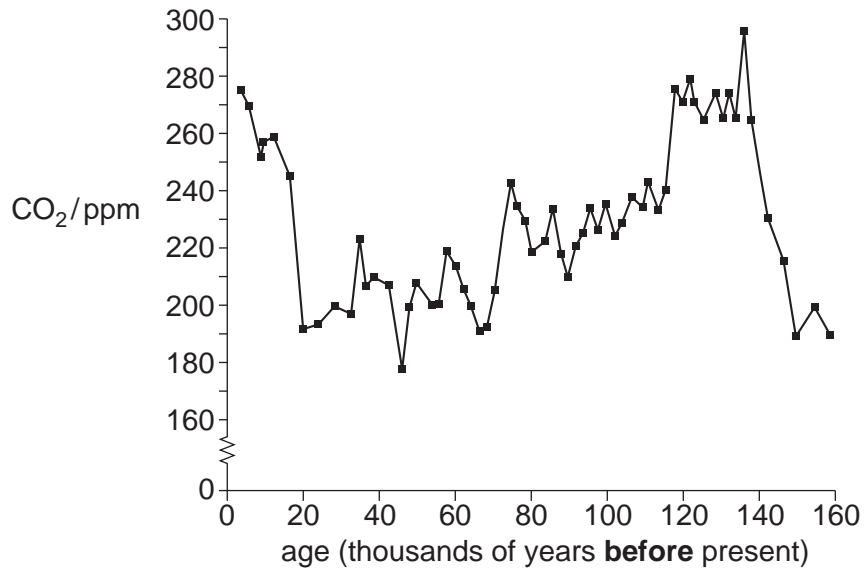
.....
..... [1]

(b) Describe ways that research chemists are trying to minimise climate change resulting from global warming caused by the release of greenhouse gases.

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..... [5]

- (c) Research scientists working in the Antarctic have measured the concentration of carbon dioxide in the ice. This study has allowed the scientists to estimate the atmospheric concentration of carbon dioxide over many thousands of years.

The graphs below show these atmospheric concentrations and the corresponding average surface temperature.



Do the graphs provide reliable evidence that an increase in atmospheric carbon dioxide concentration will result in global warming?

Explain your answer.

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..... [2]

[Total: 10]

4 Chloroethene, CH_2CHCl , can be polymerised to form poly(chloroethene).

(a) Write an equation, using displayed formulae, to show the formation of this polymer.

[2]

(b) Incineration of plastics containing poly(chloroethene) produces waste gases that can damage the environment.

Incineration carried out in the presence of oxygen produces carbon dioxide, carbon monoxide and hydrogen chloride as waste gases and one other non-toxic product.

(i) Write an equation for the incineration of the monomer, chloroethene, with oxygen.

[1]

(ii) Chemists have developed ways of removing hydrogen chloride from these waste gases. Sodium hydrogencarbonate, $\text{NaHCO}_3(\text{s})$, is frequently used in industry for this purpose.

Explain how sodium hydrogencarbonate removes hydrogen chloride.

..... [1]

(c) Carbon dioxide is a greenhouse gas that is linked to global warming.

The greenhouse effect of carbon dioxide in the atmosphere is dependent on two factors.

What are these **two** factors?

1

2

[2]

(d) Chemists are trying to minimise climate change as a result of global warming.

One way is to use Carbon Capture and Storage (CCS). One method of CCS is to react the carbon dioxide with metal oxides.

(i) Write an equation to illustrate this method of CCS.

..... [1]

(ii) State one other method of CCS.

.....

..... [1]

[Total: 8]

5 The list shows the structural formulae of some halogenoalkanes.

N	CF_3CFCI_2	R	$\text{CH}_3\text{CH}_2\text{CHClCH}_3$
O	$\text{CH}_3\text{CH}_2\text{Br}$	S	$\text{CH}_3\text{CHBrCH}_2\text{CHICH}_3$
P	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$	T	$(\text{CH}_3)_3\text{CBr}$
Q	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{I}$		

(a) Choose from the list above, the **letter** of the halogenoalkane that is extremely unreactive.

.....

[1]

(b) Halogenoalkanes react with hot $\text{KOH}(\text{aq})$ to make alcohols.

(i) Choose from the list above, the **letter** of the halogenoalkane which reacts with hot $\text{KOH}(\text{aq})$ to form a diol (a molecule with two OH groups).

.....

[1]

(ii) Using the curly arrow model, describe the mechanism of the reaction between $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$ and hot $\text{KOH}(\text{aq})$ to make an alcohol.

Include relevant dipoles and the name of the mechanism.

name of mechanism [4]

(iii) Why is the reaction of **P** with hot $\text{KOH}(\text{aq})$ slower than the reaction of **Q** with hot $\text{KOH}(\text{aq})$?

.....

.....

..... [1]

(c) Write one equation, using structural formulae, to show how but-2-ene can be converted into one of the listed halogenoalkanes, **N**, **O**, **P**, **Q**, **R**, **S** or **T**.

[2]

(d) CFCs were once used as propellants but have now been replaced by biodegradable alternatives.

State **one** type of a biodegradable alternative.

..... [1]

[Total: 10]