THIS IS A NEW SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

CHEMISTRY A

Chains, Energy and Resources

F322

Candidates answer on the Question Paper

OCR Supplied Materials:
- *Data Sheet for Chemistry A* (inserted)

Other Materials Required:
- Scientific calculator

Thursday 14 January 2010
Morning

Duration: 1 hour 45 minutes

OCE/19234

F322

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **100**.
- This document consists of **20** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 Kerosene is used as a fuel for aeroplane engines.

(a) Kerosene is obtained from crude oil.

Name the process used to obtain kerosene from crude oil **and** explain why the process works.

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

(b) Some of the hydrocarbons in kerosene have the formula $C_{10}H_{22}$.

(i) What is the name of the straight chain hydrocarbon with the formula $C_{10}H_{22}$?

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

(ii) Draw the skeletal formula of one branched chain isomer with the formula $C_{10}H_{22}$.

[1]

(iii) Explain why the straight chain isomer of $C_{10}H_{22}$ has a higher boiling point than any of its branched chain structural isomers.

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

(iv) Explain why the straight chain isomer of $C_{10}H_{22}$ is converted by the petroleum industry into its branched chain isomers.

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

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(c) When kerosene burns in an aeroplane engine very little carbon monoxide, CO, is formed but a significant amount of nitrogen monoxide, NO, is formed.

(i) Construct the equation to show the **complete** combustion of $C_{10}H_{22}$.

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

(ii) Suggest, with the aid of an equation, how NO is formed within an aeroplane engine.

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

(d) NO is a radical and contributes towards ozone depletion in the stratosphere.

(i) What is a *radical*?

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

(ii) One of the processes leading to the breakdown of ozone in the stratosphere can be represented by the following two equations.

$$NO(g) + O_3(g) \rightarrow NO_2(g) + O_2(g)$$

$$NO_2(g) + O(g) \rightarrow NO(g) + O_2(g)$$

What is the role of the NO in this process?

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

(iii) Ozone in the stratosphere is broken down to make O_2 and O.

Describe and explain how the concentration of ozone in the stratosphere is maintained.

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

(iv) Why is it important to life on the Earth's surface that the concentration of ozone in the stratosphere is maintained?

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

[Total: 15]

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2 Dilute aqueous hydrogen peroxide, $H_2O_2(aq)$, is used to sterilise contact lenses.

(a) Dilute $H_2O_2(aq)$ slowly decomposes at room temperature to produce oxygen and water.

The decomposition of $H_2O_2(aq)$ can be made faster by:

- increasing the concentration of the $H_2O_2(aq)$,
- adding a small amount of manganese(IV) oxide catalyst,
- heating the solution to 60 °C.

(i) Construct the equation for the decomposition of H_2O_2.

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

(ii) Explain why increasing the concentration of $H_2O_2(aq)$ increases the rate of decomposition.

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

(iii) Explain how the catalyst can increase the rate of decomposition of $H_2O_2(aq)$.

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

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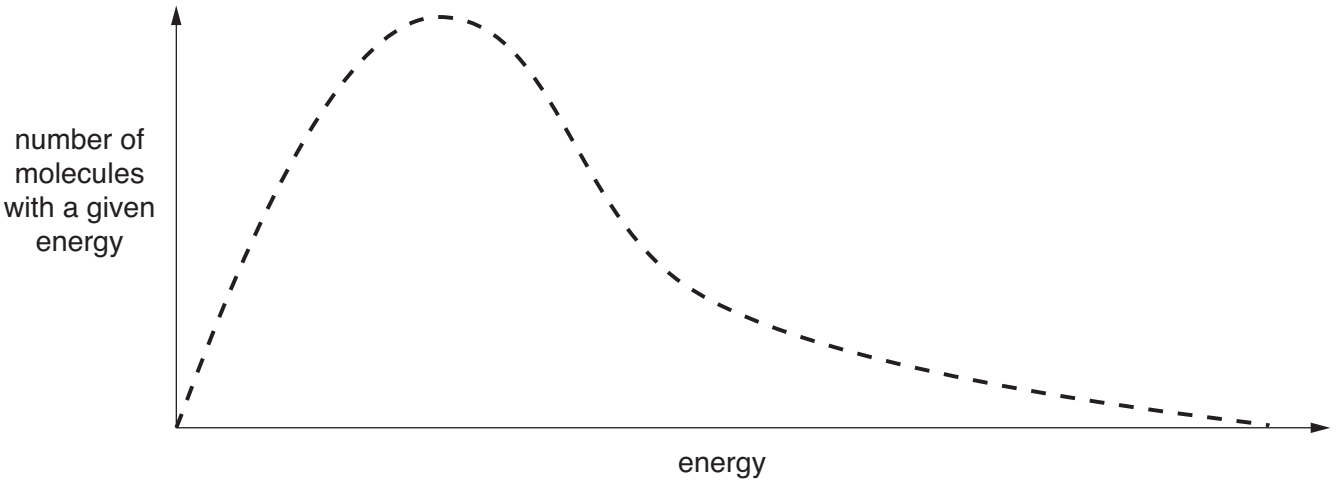
(iv) Explain why increasing the temperature of $H_2O_2(aq)$ increases the rate of decomposition.

As part of your answer, you should add a second curve and any necessary labels to the Boltzmann distribution of molecular kinetic energies shown below.



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

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(b) (i) In the past, hydrogen peroxide was manufactured by reacting barium peroxide, BaO_2, with ice-cold dilute sulfuric acid.

$$BaO_2(s) + H_2SO_4(aq) \longrightarrow BaSO_4(s) + H_2O_2(aq)$$

This method required the disposal of poisonous barium compounds.

Calculate the atom economy for this manufacture of hydrogen peroxide from BaO_2. Use the table of relative formula masses given below.

compound	relative formula mass
BaO_2	169.3
H_2SO_4	98.1
$BaSO_4$	233.4
H_2O_2	34.0

atom economy = ... % **[2]**

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(ii) Nowadays, hydrogen peroxide is manufactured using hydrogen gas, oxygen from the air and a substance called anthraquinone.

stage 1 H_2 + anthraquinone $\longrightarrow$ anthraquinol

stage 2 O_2 + anthraquinol $\longrightarrow$ H_2O_2 + anthraquinone

Compare the manufacture of H_2O_2 from hydrogen and oxygen with the manufacture from barium peroxide described in **b(i)**.

Explain the advantages of the manufacture of H_2O_2 from hydrogen and oxygen.

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

(c) Some reactions of H_2O_2 are exothermic.

Use ideas about the enthalpy changes that take place during bond breaking and bond making to explain why some reactions are exothermic.

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

[Total: 15]

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3 Glucose, $C_6H_{12}O_6$, can be completely combusted to give carbon dioxide and water.

$$C_6H_{12}O_6(s) + 6O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(l)$$

(a) In the body, the conversion of glucose into carbon dioxide and water takes place in a number of stages catalysed by enzymes.

What name is given to this oxidation process in the body?

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

(b) A student carries out an experiment to determine the enthalpy change of combustion of glucose.

In the experiment, 0.831 g of glucose is burned. The energy released is used to heat 100 cm^3 of water from 23.7 °C to 41.0 °C.

(i) Calculate the energy released, in kJ, during combustion of 0.831 g glucose.

The specific heat capacity of water = 4.18 $J\,g^{-1}\,K^{-1}$.
Density of water = 1.00 $g\,cm^{-3}$.

energy = ... kJ **[2]**

(ii) Calculate the amount, in moles, of glucose that is burned.

amount = ... mol **[2]**

(iii) Calculate the enthalpy change of combustion of glucose.
Give your answer to **three** significant figures.

ΔH_c = ... kJ mol^{-1} **[2]**

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(c) The standard enthalpy change of combustion of glucose can also be determined indirectly.

Calculate the standard enthalpy change of combustion of glucose using the standard enthalpy changes of formation below.

substance	$\Delta H_f^{\ominus}$ / kJ mol^{-1}
$C_6H_{12}O_6(s)$	–1250
$CO_2(g)$	–394
$H_2O(l)$	–286

$$C_6H_{12}O_6(s) + 6O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(l)$$

–1

answer = ... kJ mol^{-1} **[3]**

(d) Suggest **two** reasons why standard enthalpy changes of combustion determined experimentally are less exothermic than the calculated theoretical values.

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

[Total: 12]

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4 A reaction mechanism shows the individual steps that take place during a reaction.

(a) Methane reacts with bromine in the presence of ultraviolet radiation to form several products. Two of these products are bromomethane and hydrogen bromide.

(i) Write an equation for the reaction between methane and bromine to make bromomethane and hydrogen bromide.

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

(ii) Name one other bromine-containing organic product which is formed when methane reacts with bromine.

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

(iii) The mechanism for this reaction is called radical substitution.

Describe the mechanism for the radical substitution of methane by bromine to make bromomethane.

Use the mechanism to suggest why a small amount of ethane is also formed.

In your answer, you should organise your answer and use the correct technical terms.

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..... **[7]**

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(b) The 'curly arrows' model is used in reaction mechanisms to show the movement of electron pairs during chemical reactions.

Choose a reaction mechanism that you have studied involving the curly arrow model.

Name and describe your chosen reaction mechanism.

In your answer, include:

- an example of the reaction with the chosen mechanism,
- the type of bond fission that occurs,
- relevant dipoles.

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[6]

[Total: 15]

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5 Alkenes are a very useful series of hydrocarbons used widely in synthesis. Alkenes are more reactive than alkanes.

(a) What is the name of the process used to convert long chain alkanes into more useful shorter chain alkenes?

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

(b) Ethene and steam can be converted into ethanol.
The equilibrium is shown below.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \qquad \Delta H = -46 \text{ kJ mol}^{-1}$$

le Chatelier's principle can be used to predict the effect of changing conditions on the position of equilibrium.

(i) Name the catalyst used in this reaction.

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

(ii) State le Chatelier's principle.

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

(iii) Using le Chatelier's principle, predict and explain the conditions that would give the maximum equilibrium yield of ethanol from ethene and steam.

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

(iv) The actual conditions used are 60 atmospheres pressure at 300 °C in the presence of a catalyst. Compare these conditions with your answer to **(iii)** and comment on why these conditions are used.

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

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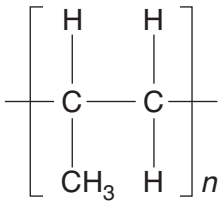
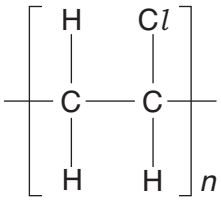
(c) Alkenes are used to make addition polymers.
The repeat unit for an addition polymer is shown below.



What is the name of the monomer used to make this polymer?

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

(d) Poly(chloroethene) has the repeat unit below.



This repeat unit can be written as —CH_2CHCl— .

One way to dispose of poly(chloroethene) is to react it with oxygen at high temperature. This is called incineration.

(i) Complete the following equation that shows the reaction taking place during incineration.

—CH_2CHCl— + ... O_2 → ..... CO_2 + ... H_2O + ... HCl **[1]**

(ii) Research chemists have reduced the environmental impact of incineration by removing the HCl formed from the waste gases.

Suggest a type of reactant that could be used to remove the HCl.

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

(e) The disposal of polymers causes environmental damage.
Research chemists are developing polymers that will reduce this environmental damage and increase sustainability.

Describe **two** ways in which chemists can reduce this environmental damage.

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

[Total: 14]

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6 This question is about the six alcohols below.

butan-2-ol	**ethane-1,2-diol**
2-methylpentan-3-ol	**2-methylpropan-2-ol**
propan-1-ol	**propan-2-ol**

(a) Which alcohol is an example of a tertiary alcohol?

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

(b) Draw the skeletal formula for 2-methylpentan-3-ol.

[1]

(c) Butan-2-ol and 2-methylpropan-2-ol are structural isomers.

(i) What is meant by the term *structural isomer*?

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

(ii) Draw another structural isomer of these two alcohols.

[1]

(d) Ethane-1,2-diol can be dissolved in water to act as an anti-freeze in car radiators.

Explain why ethane-1,2-diol is very soluble in water.

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

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(e) Ethane-1,2-diol is heated under reflux with ethanoic acid and a small amount of H_2SO_4 catalyst. Compound **A** is formed with molecular formula $C_6H_{10}O_4$.

Draw the structure of compound **A**.

[2]

(f) Butan-2-ol is heated with H_2SO_4 catalyst.

- A mixture of **three** alkenes forms, **B**, **C** and **D**.
- The alkenes **B** and **C** are stereoisomers.

(i) Draw the structures of the two stereoisomers **B** and **C**.

[2]

(ii) What type of stereoisomerism is shown by **B** and **C**?

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

(iii) Draw the structure of the other alkene, **D**, that is formed in this reaction.

[1]

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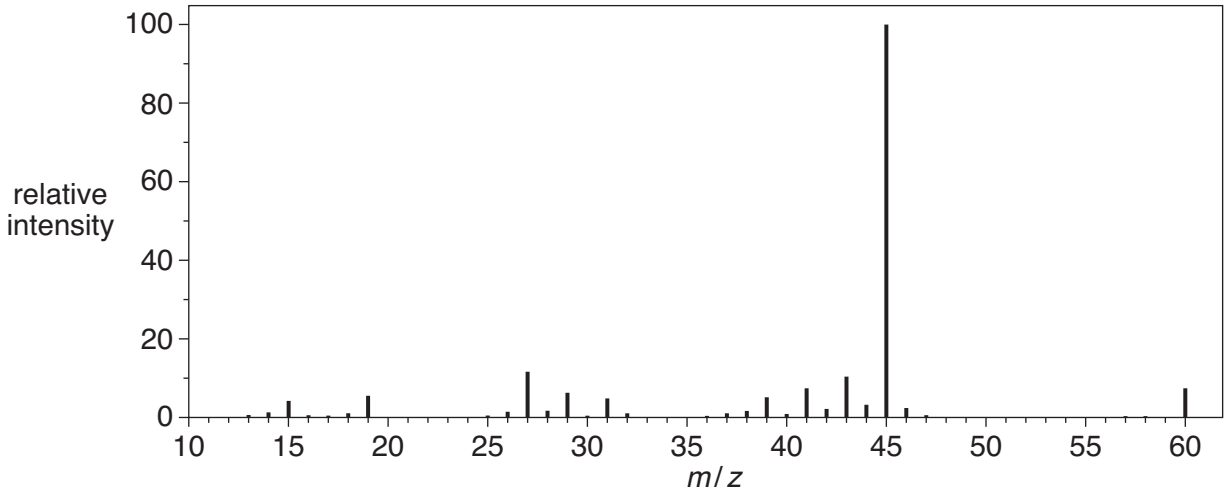
(g) Alcohol **E** is one of the following alcohols.

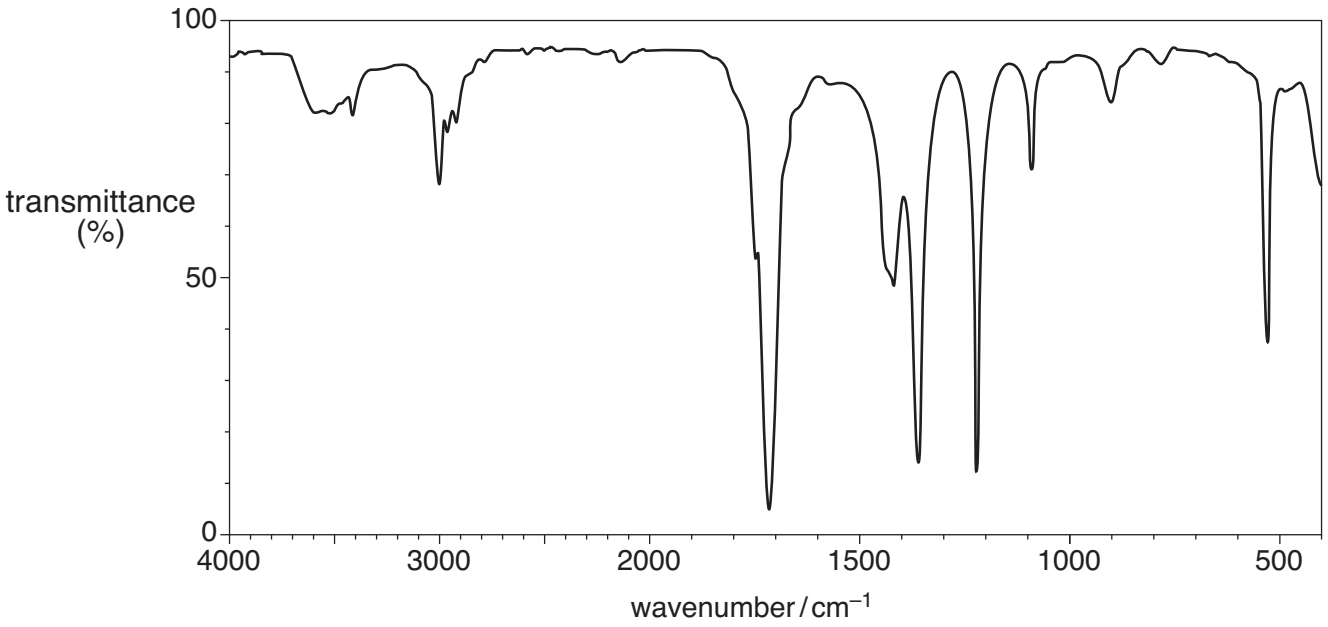
butan-2-ol	**ethane-1,2-diol**
2-methylpentan-3-ol	**2-methylpropan-2-ol**
propan-1-ol	**propan-2-ol**

A student oxidises alcohol **E** by heating under reflux with excess acidified potassium dichromate(VI). An organic product **F** is isolated.

The mass spectrum of the alcohol **E** is shown below.



The infrared spectrum of the organic product **F** is shown below.



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- Name **or** draw the structures of the alcohol **E** and the organic product **F**.
- Write an equation for the reaction of alcohol **E** with acidified potassium dichromate(VI).

Use [O] to represent the oxidising agent, acidified potassium dichromate(VI).

In your answer, you should make clear how each structure fits with the information given above.

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..... **[7]**

[Total: 19]

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7 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?

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

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

Suggest why.

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..... **[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]**

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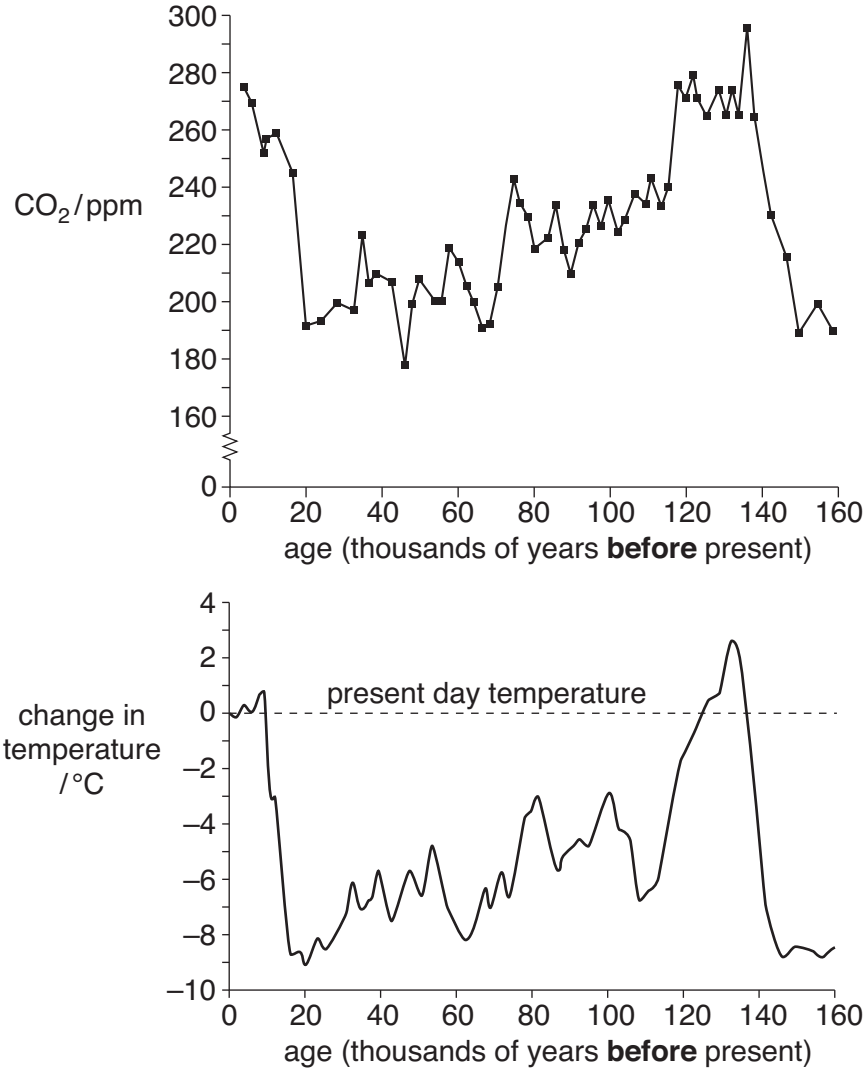
(c) Research scientists working in the Antarctic have measured the concentration of carbon dioxide in the ice. This study has allowed the scientists to estimate the atmospheric concentration of carbon dioxide over many thousands of years.

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]

END OF QUESTION PAPER

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