Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

ADVANCED SUBSIDIARY GCE

F332/TEST

CHEMISTRY B (SALTERS)

Chemistry of Natural Resources

WEDNESDAY 3 JUNE 2009: Morning
DURATION: 1 hour 45 minutes

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

Candidates answer on the question paper

OCR SUPPLIED MATERIALS:

Data Sheet for Chemistry B (Salters) (inserted)
Advance Notice: 'Origin of the Earth's Atmosphere'
(inserted)

OTHER MATERIALS REQUIRED:

Graph paper
Scientific calculator

READ INSTRUCTIONS OVERLEAF

DC (AC/JG) OV90964 13164/4

INSTRUCTIONS TO CANDIDATES

- **Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes on the first page.**
- **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.**
- **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.**
- **The insert *'Origin of the Earth's Atmosphere'* is provided for use with question 5.**
- **A copy of the *Data Sheet for Chemistry B (Salters)* 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.**

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Answer ALL the questions.

1 Chlorine can be manufactured from sodium chloride solution using electrolysis. The process also produces hydrogen and sodium hydroxide, which themselves have uses.

(a) If an accident occurred during chlorine manufacture, people dealing with the incident would wear breathing apparatus. Explain why this would be necessary.

_____

_____

_____ **[2]**

(b) EQUATION 1.1 represents the overall reaction that occurs in the electrolysis cell.

$$2NaCl(aq) + 2H_2O(l) \longrightarrow H_2(g) + Cl_2(g) + 2NaOH(aq)$$

EQUATION 1.1

(i) Calculate the volume of chlorine gas that would be produced from 100 kg of dissolved sodium chloride.

Assume that 1 mol of gas occupies 24 dm^3 under the conditions of the experiment.

volume = _____ dm^3 [3]

(ii) Explain, using ideas of atom economy, why this electrolysis is a particularly useful industrial process.

_____

_____ **[1]**

(c) The table opposite gives information about three types of electrolysis cell that are used for chlorine production. In some cases, the NaOH(aq) must be slowly evaporated, by heating with steam, to produce the concentration required for further use.

(i) Suggest <u>ONE</u> advantage and <u>ONE</u> disadvantage of the diaphragm cell over the mercury cell.

advantage of diaphragm cell: _____

_____

disadvantage of diaphragm cell: _____

_____ [2]

(ii) Suggest why a company might build a new chlorine manufacturing plant near to an existing plant.

_____

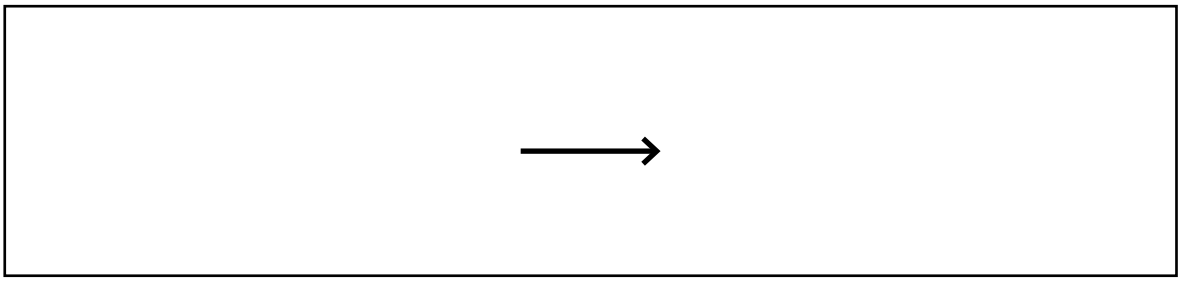
_____ [1]

TABLE 1.1

	mercury cell	diaphragm cell	membrane cell
amount of electricity used	most → least		
mass of steam used [tonnes steam/tonne NaOH (aq)]	none	3	1
purity of products	extremely pure	Cl_2 contains O_2 and must be purified before use	Cl_2 contains some O_2 and may need purifying before use
environmental concerns unique to this method	mercury loss causes environmental damage	none	none

7

(iii) All of the methods shown in TABLE 1.1 involve the conversion of chloride ions to chlorine molecules. Write a half-equation for this reaction.



[2]

(iv) Write the electronic configuration, in terms of s and p sub-shells, for a chlorine atom.

_____ **[1]**

(d) Chlorine can be used to produce bromine. The chlorine is passed through a solution, obtained from seawater, which contains bromide ions.

$$Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^- \quad \text{EQUATION 1.2}$$

(i) Give the oxidation states of chlorine in Cl_2 and Cl^-.

Cl_2 _____ Cl^- _____ [2]

(ii) Give the name of the process in which Cl_2 is converted to Cl^- giving an explanation for your choice.

_____

_____ **[2]**

(iii) Explain why the reaction represented by EQUATION 1.2 happens, by reference to the oxidising ability of chlorine and bromine.

_____ **[1]**

(iv) Give a use for the bromine that is produced in EQUATION 1.2.

_____ **[1]**

(e) Explain, in terms of intermolecular bonds, why chlorine is a gas at room temperature and pressure but bromine is a liquid under the same conditions. As part of your answer, you should explain how the intermolecular bonds arise.

In your answer, you should use appropriate technical terms, spelt correctly.

_____

_____

_____

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_____

_____

_____

_____

_____

_____ **[5]**

[Total: 23]

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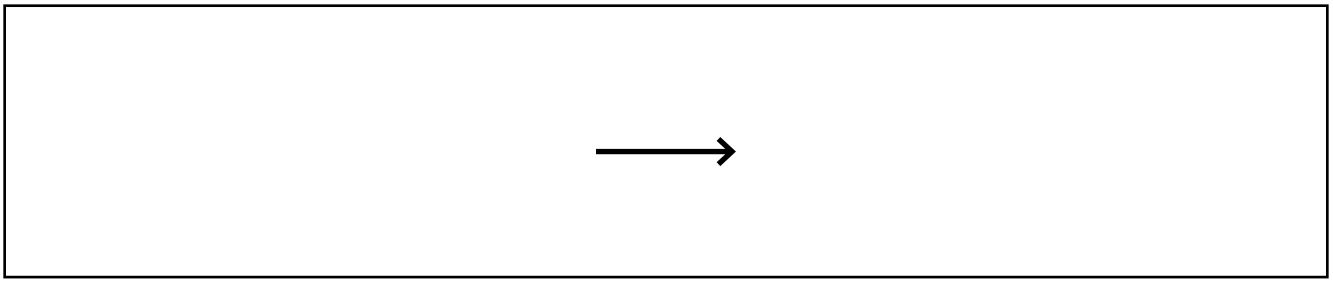
2 Chlorine is present in seawater as chloride ions.

(a) Seawater can be tested, to show it contains chloride ions, by mixing it with a solution containing silver ions.

(i) Give the colour of the silver chloride precipitate that would form.

_____ **[1]**

(ii) Write the ionic equation that describes the precipitation of silver chloride, showing state symbols.



[2]

(iii) The seawater also contains sulfate ions. These react with the silver ions, forming silver sulfate. Give the formula of silver sulfate.

_____ **[1]**

(b) Seawater is slightly alkaline. This is due to the presence of HCO_3^- ions in the water.

$$HCO_3^-(aq) + H^+(aq) \rightleftharpoons CO_2(aq) + H_2O(l)$$

EQUATION 2.1

(i) Use EQUATION 2.1 and le Chatelier's principle to explain what would happen to the concentration of HCO_3^- ions in the seawater if more carbon dioxide were to dissolve in the water.

_____

_____

_____ **[2]**

(ii) The reaction represented by EQUATION 2.1 can reach a position of dynamic equilibrium.

Explain what is meant by the term *dynamic equilibrium*.

_____

_____

_____ **[2]**

(c) Some microorganisms in seawater can convert chloride ions into chlorine-containing molecules, such as chloromethane, CH_3Cl. Chloromethane is then released into the atmosphere.

(i) Explain, in terms of intermolecular bonds, why chloromethane has a lower boiling point than water.

_____

_____ **[1]**

(ii) Draw a diagram showing how two molecules of chloromethane, CH_3Cl, would form one intermolecular bond. Include relevant partial charges.

[2]

(iii) Chloromethane is slightly soluble in water. Give the strongest type of intermolecular bond that could form between molecules of chloromethane and water.

_____ [1]

(iv) In the atmosphere, C–C*l* bonds in chloromethane molecules can be broken when the molecules absorb energy.

The bond enthalpy of the C–C*l* bond is +346 kJ mol^{-1}.

Calculate the minimum energy (in Joules) needed to break a <u>SINGLE</u> C–C*l* bond.

Avogadro constant, $N_A = 6.02 \times 10^{23}$ mol^{-1}

minimum energy = _____ J [2]

(v) Calculate the frequency of radiation that is needed to break one C–C*l* bond.

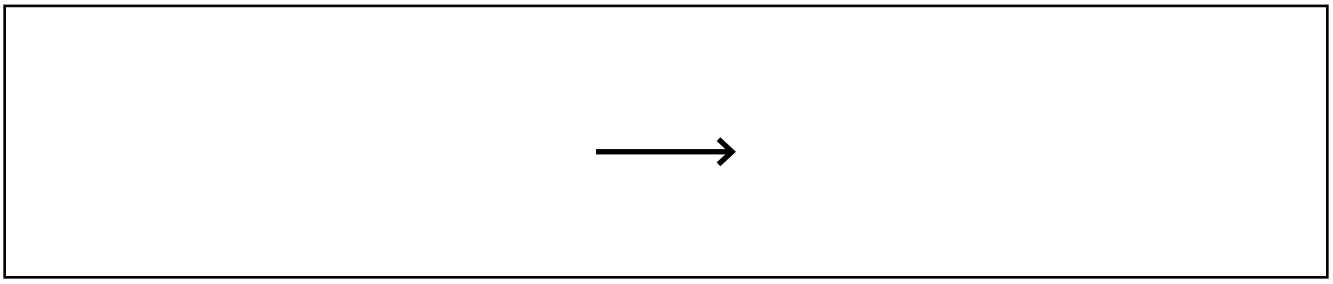
Give your answer to <u>THREE</u> significant figures.

Planck constant, $h = 6.63 \times 10^{-34}$ J Hz^{-1}

frequency = _____ Hz [3]

(d) A student decides to make the halogenoalkane 1-chlorobutane, C_4H_9Cl, by reacting butan-1-ol, C_4H_9OH, with hydrogen chloride.

(i) Write a balanced chemical equation for the reaction.



[1]

(ii) Underline the <u>TWO</u> words that describe the reaction mechanism of butan-1-ol with hydrogen chloride.

ADDITION ELECTROPHILIC ELIMINATION

NUCLEOPHILIC RADICAL SUBSTITUTION

[2]

(iii) The organic product forms as an impure liquid. Describe how the student could remove the acidic impurities from the liquid.

_____

_____

_____ **[1]**

(iv) The student needs to dry the liquid 1-chlorobutane. Name a drying agent she could use.

_____ **[1]**

(v) In the experiment, the student uses 10 g of butan-1-ol, C_4H_9OH, and produces 2.0 g of 1-chlorobutane, C_4H_9Cl.

Calculate the percentage yield of the conversion of butan-1-ol to 1-chlorobutane.

yield = _____ **% [4]**

[Total: 26]

3 In the 1980s, two incidents occurred in Africa as a result of rock slides that disturbed the water in the bottom of a lake. In both cases, large volumes of carbon dioxide gas, originally released by volcanic activity on the lake floor, erupted from the water and suffocated people.

(a) Some gases, including carbon dioxide, enter the Earth's atmosphere as a result of human activities, such as the combustion of fuel in vehicle engines.

(i) Give another industrial activity that acts as a source of atmospheric carbon dioxide.

_____ **[1]**

(ii) Name another gas, that is present in vehicle exhaust fumes, which is a pollutant.

Explain why it is considered to have a polluting effect.

_____

_____

_____ **[2]**

(b) Carbon dioxide is described as a 'Greenhouse gas'. Explain how increased concentrations of carbon dioxide in the troposphere could be linked to global warming, saying where the energy comes from originally.

In your answer, you should make it clear how the steps you describe are linked to one another.

_____

_____

_____

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_____

_____ **[6]**

(c) One of the methods being considered for reducing the amount of atmospheric carbon dioxide is to capture it. Carbon dioxide can then be stored by pumping it, under pressure, onto the ocean floor.

(i) Suggest why is it unlikely that carbon dioxide stored under the ocean would escape in the way that occurred in the African lakes.

_____

_____ **[1]**

(ii) Name <u>TWO</u> ways of reducing the amount of carbon dioxide in the atmosphere, other than storing it under the ocean.

_____

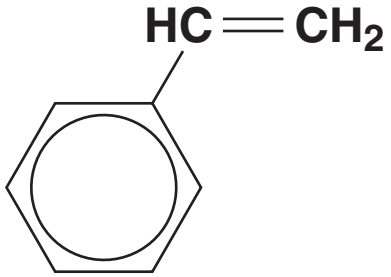
_____

_____

_____ **[2]**

[Total: 12]

4 Poly(phenylethene), commonly known as polystyrene, is used to make packaging. The monomer from which it is produced, phenylethene, is a product of the petrochemical industry.



phenylethene

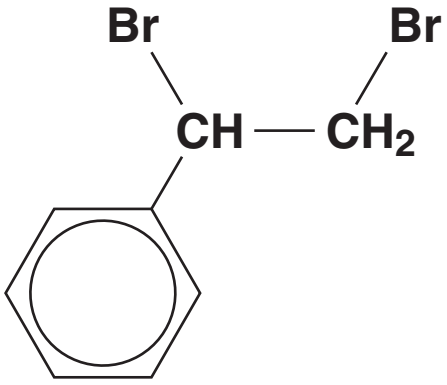
(a) Name the type of polymerisation that occurs when polystyrene is made from phenylethene.

_____ **[1]**

(b) Draw the structure of the repeating unit that forms.

[1]

(c) When this reaction is done in the laboratory, any unreacted phenylethene can be detected by adding a solution of bromine to the reaction mixture. The reaction produces compound A.



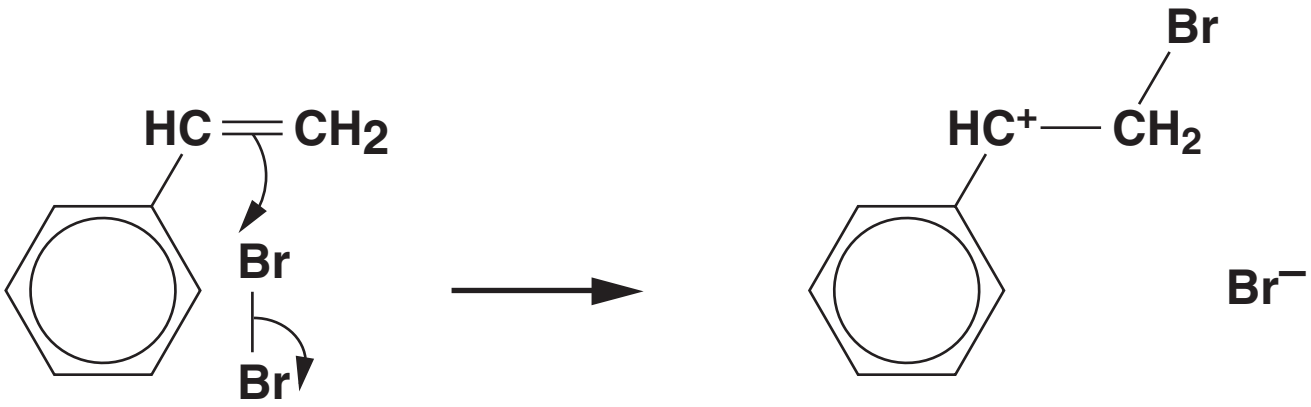
compound A

(i) What colour change would you see when the phenylethene reacts with bromine?

_____

_____ **[2]**

(ii) The first step in the mechanism for this reaction is shown below.

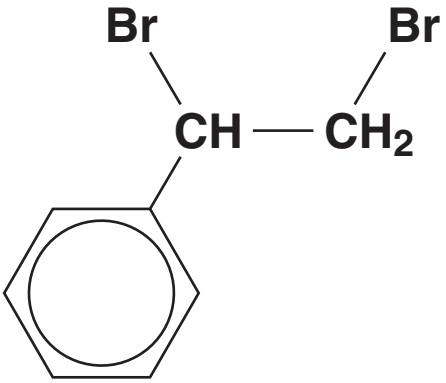


intermediate 1

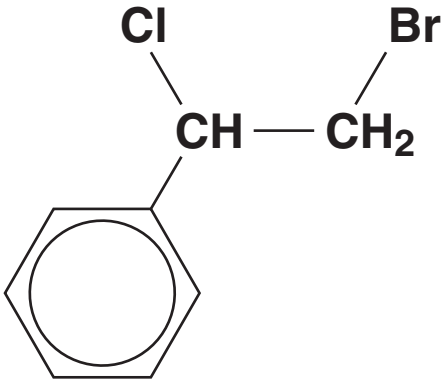
What name is given to the <u>TYPE</u> of organic intermediate, such as <u>INTERMEDIATE 1</u>, formed in the reaction?

_____ **[1]**

(iii) If an aqueous mixture of bromine and potassium chloride is added to phenylethene, some <u>COMPOUND</u> <u>B</u> is produced, as well as <u>COMPOUND</u> <u>A</u>.



compound A



compound B

Use the mechanism shown in (ii) to explain why both these compounds are formed.

_____

_____

_____

_____ **[3]**

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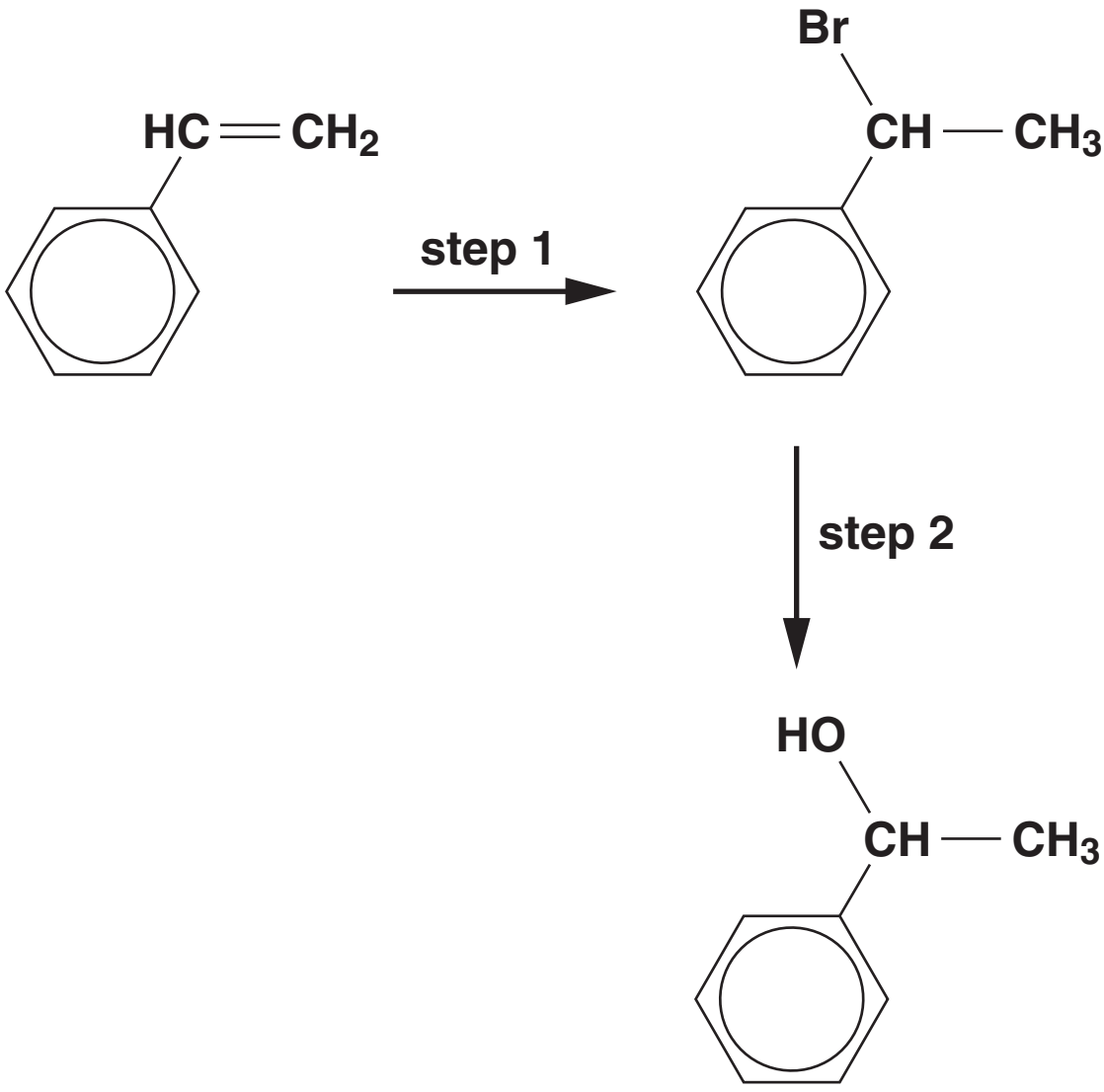
(d) 1-Phenylethanol, a compound that is used for making perfumes, can be prepared in the laboratory from phenylethene in two steps.



1-phenylethanol

(i) Give the reagent that you would use for <u>STEP 1</u>.

_____ **[1]**

(ii) The reaction occurring in <u>STEP 1</u> involves attack by an electrophile.

Explain what is meant by the term *electrophile* and how the electrophile attacks the alkene.

_____

_____

_____ **[2]**

(iii) On an industrial scale, phenylethene is more likely to be converted to 1-phenylethanol using a one step process.

Suggest the reagents and conditions that could be used to achieve this.

_____

_____

_____ **[3]**

(e) 1-Phenylethanol is an example of a secondary alcohol.

(i) Explain why the alcohol group is classified as secondary.

_____

_____ **[1]**

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(ii) Another secondary alcohol, propan-2-ol, $(CH_3)_2CHOH$, can be oxidised by heating with acidified potassium dichromate solution. The infrared spectrum opposite is that of the product obtained from the oxidation of propan-2-ol.

Explain how this spectrum shows that the oxidation was successful.

_____

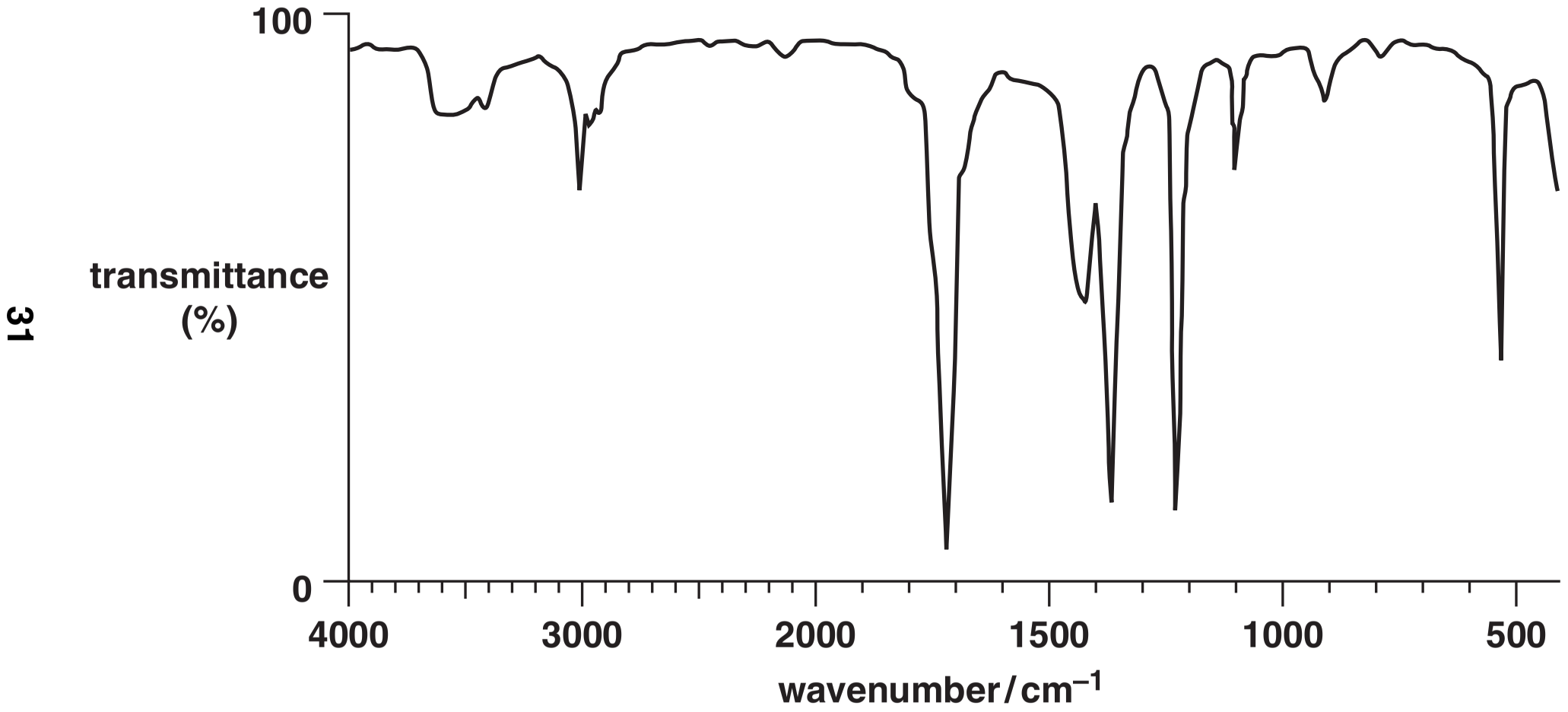
_____

_____

_____

_____ **[4]**

[Total: 19]


100
transmittance
(%)
0
4000
3000
2000
1500
1000
500
wavenumber / cm−1

5 This question is based on the Advance Notice article *'Origin of the Earth's atmosphere'* which is provided as an insert to this paper.

(a) Explain what is meant by the term *photochemical dissociation*. Give an example from the Advance Notice article in your answer.

meaning: _____

_____

_____

example: _____

_____

_____ **[3]**

(b) Explain, using equations, how ozone formed in the Earth's atmosphere. Describe how it shields '...the Earth's surface from UV...'.

In this question, you should make it clear how the steps you describe are linked to one another.

_____

_____

_____

_____

_____

_____

_____

_____ **[6]**

(c) Use data from TABLE 1 in the Advance Notice article to answer this question.

Calculate how many molecules of oxygen there are per molecule of methane in dry tropospheric air, under the same conditions of temperature and pressure.

molecules of oxygen per molecule of methane = _____ [2]

(d) Suggest why FeS_2 is NOT found on the Earth's surface today. Include an equation in your answer.

_____

_____

_____

_____ **[3]**

(e) Describe and explain the way in which the temperature of the atmosphere changes on going from the surface of the Earth to the top of the stratosphere.

_____

_____

_____

_____

_____

_____ **[4]**

(f) Explain why reactions between atoms may occur more quickly at the top of the troposphere than in the middle of the stratosphere, even though the temperature at these points is the same.

_____

_____

_____ **[2]**

[Total: 20]

END OF QUESTION PAPER