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

THURSDAY 14 JANUARY 2010: 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: 'Treating the Public Water Supply' **(inserted)**

OTHER MATERIALS REQUIRED:

Scientific Calculator

READ INSTRUCTIONS OVERLEAF

DC (LEO/SW) MEP10044 22935/3

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 *'Treating the Public Water Supply'* 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 Natural processes in the air can control the concentrations of some types of atmospheric pollutants. Although carbon monoxide emissions increased in the twentieth century, the percentage of carbon monoxide in the troposphere has remained almost constant.

(a) The increased use of cars in the twentieth century is one reason for the increase in carbon monoxide emissions.

Explain the origin of these carbon monoxide emissions.

_____

_____

_____ **[2]**

(b) Give TWO reasons why carbon monoxide is classed as a polluting gas.

_____

_____

_____ **[2]**

(c) The reaction of carbon monoxide with hydroxyl radicals helps control atmospheric carbon monoxide concentrations. Hydroxyl radicals form by the breakdown of water molecules.

(i) Name the type of bond breaking process that occurs to form hydroxyl radicals from water molecules.

_____ **[1]**

(ii) The bond enthalpy for the O–H bond is +464 kJ mol^{-1}. Calculate the energy, in Joules, needed to break a <u>SINGLE</u> O–H bond.

Avogadro constant, N_A = 6.02 × 10^{23} mol^{-1}

energy = _____ **J [2]**

(iii) Calculate the frequency of radiation that is needed to break a single O-H bond.

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

Planck constant, h = 6.63 x 10^{-34} J Hz^{-1}

frequency = _____ **Hz [3]**

(d) EQUATION 1.1 represents the reaction of hydroxyl radicals with carbon monoxide to produce carbon dioxide.

$$CO + OH \rightarrow CO_2 + H \quad \text{EQUATION 1.1}$$

(i) Explain what is meant by the term *radical*.

_____

_____ **[1]**

(ii) Draw a '*dot-and-cross*' diagram to show that OH is a radical.

[2]

(iii) Classify the reaction represented by EQUATION 1.1 as initiation, propagation or termination. Explain your choice.

_____

_____

_____ **[2]**

(e) The reaction represented by <u>EQUATION 1.1</u> produces carbon dioxide, which is a gas at room temperature. Silicon dioxide, another Group 4 oxide, is a solid at room temperature.

Explain this difference in terms of bonding and structure.

_____

_____

_____

_____

_____

_____ **[3]**

(f) Scientists monitor the composition of the Earth's atmosphere. They have found that the concentration of carbon dioxide in dry, unpolluted tropospheric air has increased from 300 ppm to around 380 ppm between 1900 and the present day.

(i) Taking the present day value to be 380 ppm, calculate the <u>INCREASE</u> in the percentage of carbon dioxide in the air between 1900 and the present day.

increase in carbon dioxide concentration = _____ % [1]

(ii) Carbon dioxide is described as a 'greenhouse gas'. Greenhouse gases absorb infrared radiation in the troposphere.

Explain the source of the infrared radiation absorbed by carbon dioxide and the possible link between increased concentrations of carbon dioxide in the troposphere and global warming.

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

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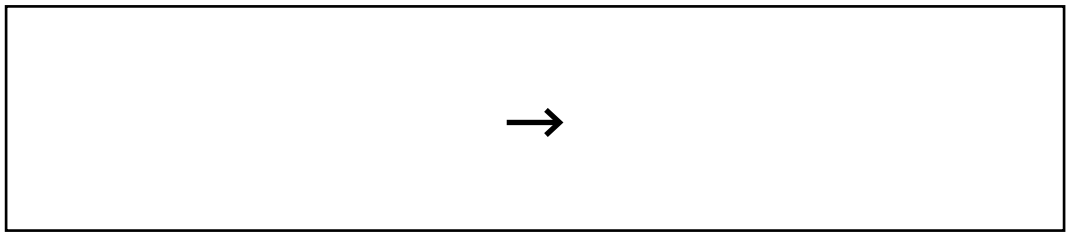
_____ **[6]**

(g) Carbon monoxide is used as a reactant for the production of propanal, CH_3CH_2CHO, from ethene.

(i) Name the homologous series to which propanal belongs.

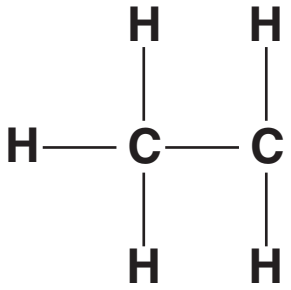
_____ **[1]**

(ii) Suggest the equation for the reaction in which propanal is made from carbon monoxide, ethene and another reagent.



[2]

(iii) Complete the diagram below to show the full structural formula for propanal.



[1]

[Total: 29]

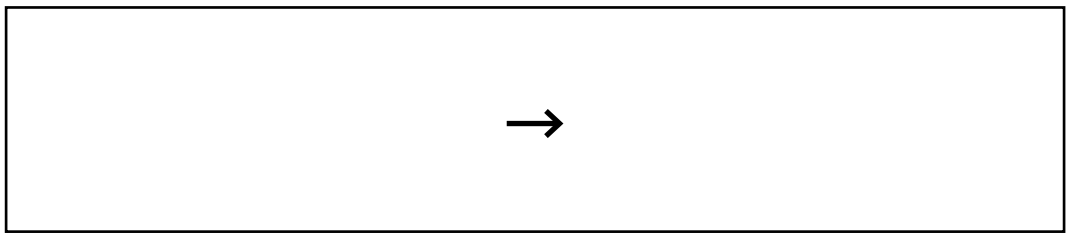
2 Chloromethane, CH_3Cl, and bromomethane, CH_3Br, are naturally occurring. Bromomethane is produced by seaweed in ocean water. It is also manufactured for a variety of agricultural and industrial uses.

(a) Name the homologous series to which bromomethane belongs.

_____ **[1]**

(b) Bromomethane can be manufactured from methanol and hydrogen bromide.

(i) Write the equation for the reaction between methanol and hydrogen bromide.



[2]

(ii) Circle <u>TWO</u> words from the following list that best describe what is happening in the reaction of methanol with hydrogen bromide.

ADDITION ELECTROPHILIC ELIMINATION

NUCLEOPHILIC RADICAL SUBSTITUTION

[2]

(c) Bromomethane reacts with a solution of ammonia when heated in a sealed tube. One product of this reaction is <u>COMPOUND A</u>, which is an organic compound.

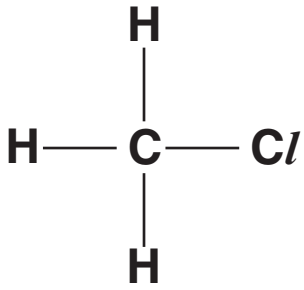
(i) Name the homologous series to which <u>COMPOUND A</u> belongs.

_____ **[1]**

(ii) Write the formula of <u>COMPOUND A</u>.

_____ **[1]**

(d) The C–C*l* bond in chloromethane is slightly polar. On the diagram of the CH_3C*l* molecule shown below, mark the partial charges on the atoms.



[1]

(e) Draw a diagram to represent the three-dimensional <u>SHAPE</u> of a molecule of CH_3Cl and give the bond angle.

Bond angle: _____ ° [2]

(f) Bromomethane and chloromethane are both present in the atmosphere. Explain how chloromethane causes ozone depletion in the stratosphere <u>AND</u> suggest why bromomethane has a lower ozone depleting potential than chloromethane.

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

_____

_____

_____

_____

_____

_____

_____

_____

_____ **[5]**

(g) Scientists working in the 1980s discovered the problem of ozone depletion in the stratosphere when they were studying the Earth's atmosphere over the Antarctic.

The scientists used a new instrument to take a second set of readings for their experiment because they did not think their first results were correct.

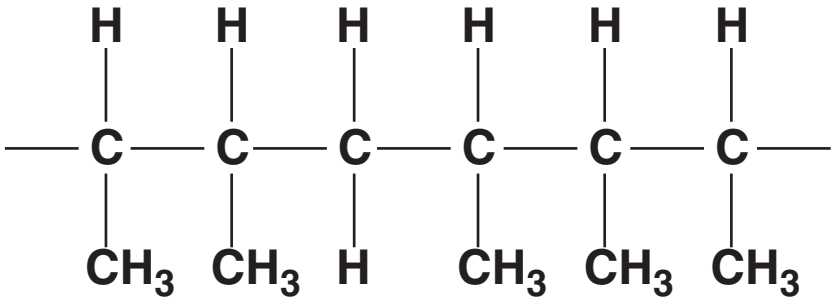
Why did the scientists think their results from the first experiment were incorrect?

_____

_____ **[1]**

[Total: 16]

3 Co-polymers have a variety of uses. The diagram below shows a section of CO-POLYMER A, which is produced from but-2-ene and another alkene monomer.



CO-POLYMER A

(a) (i) Name the TYPE of polymerisation that produces CO-POLYMER A.

_____ **[1]**

(ii) Give the name and full structural formula of the other alkene monomer that is reacted with but-2-ene to produce CO-POLYMER A.

Name: _____

Full structural formula:

[2]

(b) The monomers used to make <u>CO-POLYMER A</u> are both alkenes. Describe a simple chemical test for an alkene.

(i) aqueous reagent used.

_____ [1]

(ii) colour change seen during the test.

from _____ to _____ [2]

(c) But-2-ene has *E*/*Z* isomers. Draw diagrams of the two isomers and label them as either *<u>E</u>* or *<u>Z</u>*.

[2]

(d) Name the type of intermolecular bond that could form between two chains of CO-POLYMER A.

_____ **[1]**

(e) The uses of polymers and co-polymers are linked to their properties.

(i) Poly(but-2-ene) has been used to make pipes for water supplies. Suggest a property of poly(but-2-ene) that makes it suitable for this use.

_____

_____ **[1]**

(ii) CO-POLYMER A has a low density and is cheap to manufacture. It can be produced as a film that has a high tensile strength. Suggest a use that could be made of this co-polymer film.

_____

_____ **[1]**

[Total: 11]

4 A student decided to make some propene from propan-1-ol.

(a) Propan-1-ol is a liquid at room temperature, whilst propene is a gas. The strongest type of intermolecular bond between propan-1-ol molecules is hydrogen bonding.

(i) Draw a diagram to show the hydrogen bonding between TWO propan-1-ol molecules. Include relevant lone pairs and partial charges in your diagram.

[4]

(ii) Propan-1-ol has a higher boiling point than propene. Explain this in terms of intermolecular bonding.

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

_____

_____

_____

_____

_____ **[4]**

(b) <u>EQUATION 4.1</u> represents the reaction that occurs when propene forms from propan-1-ol.

$$CH_3CH_2CH_2OH(g) \rightleftharpoons CH_3CH{=}CH_2(g) + H_2O(g)$$

$\Delta H = +81\ kJ\ mol^{-1}$ **<u>EQUATION 4.1</u>**

Underline the term below that describes the type of reaction occurring in <u>EQUATION 4.1</u>.

ADDITION ELIMINATION

HYDROLYSIS SUBSTITUTION

[1]

(c) Give the reagents and conditions required for the reaction represented by EQUATION 4.1.

_____

_____

_____ **[3]**

(d) The reaction represented by EQUATION 4.1 can reach a position of dynamic equilibrium. Explain what is meant by the term *dynamic equilibrium*.

_____

_____

_____ **[2]**

(e) Describe and explain the effect of the following changes on the equilibrium amount of propene produced in the reaction represented by EQUATION 4.1.

(i) Increasing the total pressure of the reaction system.

_____

_____

_____ **[2]**

(ii) Carrying out the reaction at a higher temperature.

_____

_____

_____ [2]

(f) Describe and explain what happens to the RATE of the reaction represented by EQUATION 4.1 if the pressure is increased.

_____

_____

_____ [3]

(g) The student used the propene for a range of chemical reactions. Give the structural formula of a product that forms if the student reacts the propene with:

(i) hydrogen bromide

[1]

(ii) hydrogen

[1]

(h) The student carried out the reaction of propene with hydrogen at room temperature and pressure by carefully choosing the catalyst to use. Name the catalyst that would be required under these reaction conditions.

_____ **[1]**

[Total: 24]

5 This question is based on the Advance Notice article '<u>TREATING THE PUBLIC WATER SUPPLY: WHAT IS IN YOUR WATER, AND HOW IS IT MADE SAFE TO DRINK</u>?' which is provided as an insert to this paper.

(a) Suggest what is meant by the term *oxidant* as used in the article. Give an example of an oxidant from the article. Explain your choice in terms of oxidation states.

Definition: _____

_____

_____

Example and explanation: _____

_____

_____

_____ **[4]**

(b) Write the ionic equation for the formation of aluminium hydroxide during the coagulation process using HCO_3^- ions. Include state symbols.

→

[3]

(c) Lime, soda ash and HCO_3^- are involved in water softening. Give the systematic names for lime, soda ash and HCO_3^-.

lime _____

soda ash _____

HCO_3^- _____ **[3]**

(d) The article states that the ion exchange process removes calcium ions from water and replaces them with sodium ions. Suggest why calcium ions displace sodium ions from the ion exchange resin.

_____

_____

_____

_____ **[2]**

(e) 800 cm^3 of hard water, containing calcium ions at a concentration of 0.0020 mol dm^{-3}, are passed through an ion exchanger.

Calculate the mass, in g, of sodium ions that are collected from the process. Assume that the exchange process is 100% efficient.

mass of sodium ions = _____ g [3]

(f) Explain the benefits and disadvantages of using chlorine to treat drinking water. Include references to the transport and storage of chlorine.

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_____ **[5]**

[Total: 20]

END OF QUESTION PAPER