1 This question is about isomers of C_4H_8.

(a) (i) Alkenes contain a carbon-carbon double bond, which consists of a σ bond and a π bond.

Show, and clearly label, the σ and π bonds on the diagram below.

(2)

C C

*(ii) Explain why the σ bond is stronger than the π bond.

(2)

(b) (i) Draw the structural formula of *E*-but-2-ene.

(1)

(ii) Explain why but-1-ene does not exhibit *E-Z* isomerism.

(1)

(iii) Describe the result of the test for the presence of a C═C bond in *E*-but-2-ene using bromine water. Give the displayed formula of the organic product.

(2)

Test result .....

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Displayed formula of organic product:

(c) Another test for C═C bonds is the reaction with acidified potassium manganate(VII).

Describe the result of this test using **but-1-ene** and give the displayed formula of the organic product.

(2)

Test result .....

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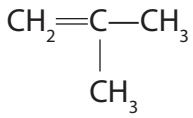
Displayed formula of organic product:

(d) Another isomer of C_4H_8 has the structure shown below.



(i) Name this isomer.

(1)

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(ii) This isomer forms an addition polymer. Show the structure of this polymer by drawing **two** repeat units.

(1)

(e) 'Polybutene' is the name used by cosmetic companies for a mixture of poly(but-1-ene) and poly(but-2-ene).

An American "eco-cosmetics" company says that though 'polybutene' is considered a safe ingredient in lip gloss, it is non-sustainable to use it.

Suggest **one** reason to justify this statement.

(1)

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(Total for Question = 13 marks)

2 (a) Explain how the atoms are held together by the covalent bond in a molecule of hydrogen.

(1)

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(b) Draw the dot and cross diagrams for

(i) methane, CH_4

(1)

(ii) ethene, $CH_2{=}{=}CH_2$

(1)

(iii) nitrogen, N_2

(1)

(iv) the ammonium ion, NH_4^+

(1)

(c) Silicon exists in a giant covalent lattice.

(i) The electrical conductivity of pure silicon is very low. Explain why this is so in terms of the bonding.

(2)

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(ii) Explain the high melting temperature of silicon in terms of the bonding.

(2)

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(Total for Question 9 marks)

3 This question is about the properties of ions and ionic compounds.

(a) Solid calcium carbonate, $CaCO_3$, has a giant ionic structure.

(i) Draw a diagram (using dots or crosses) for a calcium **ion**. Show **ALL** the electrons and the charge on the ion.

(2)

(ii) Complete the electronic configuration for a calcium **ion**.

(1)

$1s^2$

(iii) Would you expect a calcium ion to be bigger, smaller or the same size as a calcium atom? Give TWO reasons to explain your answer.

(2)

(iv) Explain why ionic compounds have relatively high melting temperatures.

(2)

(b) Changes in the concentration of ions in a solution can be estimated by measuring the electrical conductivity of the solution.

(i) Explain why solutions of ions are able to conduct electricity.

(1)

(ii) Suggest why aqueous solutions of calcium chloride, $CaCl_2(aq)$, and barium chloride, $BaCl_2(aq)$, of the same molar concentration, have different electrical conductivities.

(1)

(iii) 1 kg of a solution contains 0.100 mol of calcium ions, Ca^{2+}.

What is the concentration of the calcium ions by mass in parts per million (ppm)?

[Assume the relative atomic mass of calcium is 40.]

(2)

ppm

*(c) Some buildings are made from limestone, which is mainly calcium carbonate. Gases in the atmosphere such as sulfur dioxide, SO_2, and nitrogen dioxide, NO_2, can be responsible for damaging these buildings.

Describe how these gases come to be present in the atmosphere and explain how they can damage a limestone building.

(3)

(d) The lattice energy of calcium chloride, $CaCl_2$, is -2258 kJ mol^{-1} based on an experimental Born-Haber cycle and -2223 kJ mol^{-1} based on theoretical calculations.

Would you expect its bonding to match the ionic model? Justify your answer.

(1)

(Total for Question = 15 marks)