

IB Chemistry HL - S2.4

From models to materials

Exercises + Practice questions

Official answers appended at the end

Exercise

- Q1.** Use data from Section 9 and Section 17 of the data booklet to classify the bonding in the following materials:
(a) Cl_2O (b) PbCl_2 (c) Al_2O_3 (d) HBr (e) NaBr
- Q2.** Copper(II) oxide can be added to give glass a green or blue colour. Deduce the position of copper oxide in the bonding triangle and describe the nature of its structure and bonding.
- Q3.** Silicon dioxide and aluminium oxide are important minerals in the Earth's crust. Use the bonding triangle to deduce their positions and so determine which has the greater covalent character.

Exercise

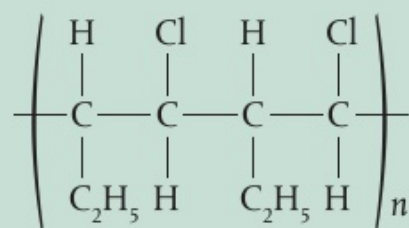
- Q4.** An alloy is a mixture of metal with which of the following?
- A** a second metal or other non-metal material
 - B** a non-metal material only
 - C** a second metal only
 - D** none of the above
- Q5.** Which of the following is not an alloy?
- A** solder **B** silver **C** bronze **D** brass
- Q6.** Explain how alloying can modify the structure and properties of metals.
- Q7.** What is the difference between an alloy and a composite?

Exercise

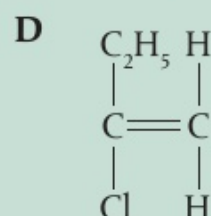
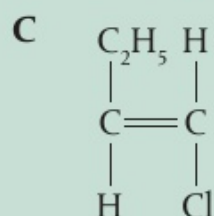
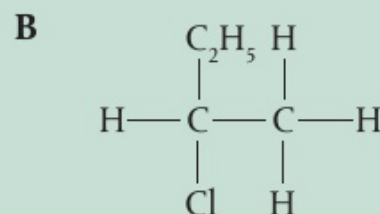
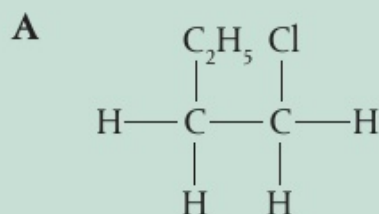
Q8. What do poly(ethene) and ethene have in common?

- A** same molecular formula
- B** same empirical formula
- C** same physical properties
- D** same chemical properties

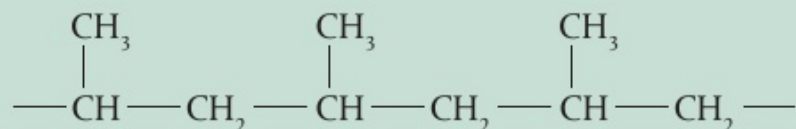
Q9. The repeating unit of a polymer is shown:



Which structure shows the monomer used to make this polymer?



Q10. Part of the structure of a polymer is shown:



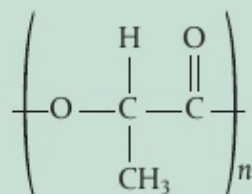
Which is the formula of the monomer used to make this polymer?

- A** C_3H_6 **B** C_6H_{12} **C** C_3H_8 **D** C_6H_{14}

Q11. Distinguish between the terms recyclable, biodegradable and reusable as applied to plastics. What are the advantages and disadvantages of each of these in helping to reduce the environmental impact of plastics? What other ways can we help to reduce the amount of plastic waste accumulating in the oceans?

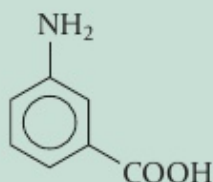
Exercise

- Q12.** Nylon-6,10 is made from the monomers 1,6-diaminohexane and decanedioic acid. Draw the repeating unit of this polymer.
- Q13.** Polylactic acid is a plastic made from fermented plant starch. It has the structure below.



Deduce the structure of the monomer.

- Q14.** Draw the structures of the polymers and any by-products formed from the following pairs of monomers.
- (a) $\text{HO} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{OH} + \text{HO} - \text{CO} - \text{CH}_2 - \text{CH}_2 - \text{CO} - \text{OH}$
- (b) $\text{H}_2\text{N} - \text{CH}_2 - (\text{CH}_2)_4 - \text{CH}_2 - \text{NH}_2 + \text{Cl} - \text{CO} - \text{CH}_2 - \text{CH}_2 - \text{CO} - \text{Cl}$
- Q15.** This compound is a monomer for a condensation polymer.



- (a) Identify the functional groups in the monomer which allow it to act as a monomer.
- (b) Deduce the by-product of the polymerization reaction.
- (c) Deduce the structure of the resulting polymer. You should include at least three monomer units in your answer.
- (d) Kevlar[®] is a polymer produced from monomers which have functional groups in the 1,4 positions of the benzene ring. Explain the strength of the polymer in terms of the orientation of the two functional groups.
- (e) Explain why Kevlar[®] has a lower density than steel.

2. Which of the following **cannot** be deduced from the position of an unknown substance X in the bonding triangle?
- A the chemical formula of X
B the type of bonding in X
C the physical properties of X
D whether X is an element or a compound
3. Which of the following is not an addition polymer?
- A polyester
B polystyrene
C poly(ethene)
D poly(tetrafluoroethene)
4. In the bonding triangle, substance X is found in the top right, substance Y is found in the bottom left and substance Z is found in the bottom right. Answer the following, giving reasons for your answers:
- (a) Which of these substances is likely to be an element? (2)
(b) For substances X and Y, give a physical property you would expect them to have in common. (2)
(c) Which substance will be the most brittle? (2)
(d) Which substance is likely to have the lowest boiling point? (2)
- (Total 8 marks)

5. Use electronegativity values from Section 9 in the data booklet to complete this table for the five substances given.

Substance	χ_{average}	$\Delta\chi$	Position in triangle and type of bonding	Predicted properties	
Sn					(2)
P ₄ O ₁₀					(2)
Cd ₃ Mg					(2)
MgO					(2)
NCl ₃					(2)

(Total 10 marks)

6. Justify why, in terms of atom economy, the polymerization reactions of polypropylene could be considered 'Green Chemistry'. (2)
(Total 2 marks)
7. Alloys of aluminium with nickel are used to make engine parts. With reference to the model of metallic bonding, explain why this alloy is used rather than pure aluminium. (3)
(Total 3 marks)