Introduction to Polymers

2008
29 minutes

Teacher Notes:
Jodie Ashby
B.Sc.,B.Ed.

Program Synopsis

This program looks at polymers all around us and investigates both synthetic and naturally occurring polymers. Students will see how a monomer is transformed into a polymer. A chapter is dedicated to thermosetting and thermoplastic polymers, as well as addition polymerisation and condensation polymerisation. The problems with plastics are explored, as is the discovery by Charles Goodyear of the process of vulcanisation.

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Introduction

This program introduces senior students to a range of monomers and their associated polymers. Innovative graphics enable students to gain a sound understanding of both addition and condensation polymerisation. Properties of thermosetting and thermoplastic polymers are investigated, as well as the bonding that occurs both within and between molecules. The program explores elastomers and the process of vulcanisation, and the future of plastics, including the issues of biodegradability and use of renewable resources.

Program Rationale

This program will reinforce the theory covered in the classroom on polymers. The graphics in the program are essential for visual learners in their understanding of both addition and condensation polymerisation. This program aims to provide teachers and students with a comprehensive overview of the chemistry of polymers and identifies polymers that are all around us.

Program Timeline

00:00:00	Introduction
00:00:59	Chapter 1 Monomers to polymers
00:03:46	Chapter 2 Thermosetting or thermoplastic
00:09:17	Chapter 3 Addition or polymerisation
00:13:08	Chapter 4 Condensation polymerisation
00:19:15	Chapter 5 Vulcanisation
00:22:57	Chapter 6 Problems with plastics
00:26:46	Conclusion
00:27:32	Credits
00:28:17	End of program

Useful Resources

Books and Other Print Resources

- Key Chemistry. Investigating Chemistry in the Contemporary World. Alan Smith and Christopher Dwyer. Book 1: Materials and Everyday Life
- Heinemann Chemistry One

Program Worksheet

Before the Program

1. Using the internet provide a 300 word report on Charles Goodyear and his contribution to the process of vulcanisation.

2. Using a chemical modelling kit construct three models of ethene. Then explain how these monomers undergo addition polymerisation to form polyethene and make the model.

3. Carbon is the main base element in polymers. In small groups discuss whether or not you think any other element could be a base element for monomers. Use your knowledge of the periodic table and bonding to justify your answer.

During the Program

1. The word *polymer* means: _____

2. What is the base element in polymers?

   _____

3. Name three naturally occurring polymers.

   _____

   _____

   _____

4. What happens to a thermoplastic polymer when it is heated?

   _____

5. If we apply a small amount of heat to a thermosetting polymer nothing happens, but what happens if a higher temperature is applied?

   _____

   _____

6. Both thermosetting and thermoplastic polymers have strong covalent bonds within the polymer chains. What is the difference in bonding between the chains?

   _____

   _____

7. When a thermosetting polymer chars what is the black residue that is left behind?

   _____

8. What do LDPE and HDPE stand for?

   _____

   _____

9. Explain the difference between LDPE and HDPE in terms of the branching between the chains.

   _____

   _____

   _____

   _____

10. In addition polymerisation an unsaturated monomer is necessary for the polymerisation to occur. Why?

_____

_____

11. Draw monomers for the following and provide one example of its use as a polymer:

    a) Polypropene

    b) Polyvinyl chloride (PVC)

    c) Polytetrafluoroethene (Teflon)

12. Polymers made from two or more monomers are called? _____

13. What type of polymerisation do co-polymers undergo?

_____

14. What by-products often occur from condensation polymerisation?

_____

15. When rubber was first discovered what were two of its initial problems?

_____

_____

16. What process did Charles Goodyear develop?

_____

17. How is rubber affected with the addition of sulphur?

_____

_____

_____

18. Currently many plastics are made from non-renewable resources, what are some of the changes that will influence plastics in the future?

_____

_____

After the Program

1. Complete the following table:

	Thermosetting	**Thermoplastic**
Type of bonding within the polymer		
Type of bonding between polymer chains		
Reaction upon addition of heat		
Examples		

2. Show the addition polymerisation of the following:

   a) Polypropene

   b) Polyvinyl chloride

3. Polystyrene is another common polymer. Complete the following:

   a) Draw a diagram of polystyrene.

   b) Draw a diagram of polystyrene.

   c) What are three uses of polystyrene?

Suggested Student Responses

During the Program

1. The word polymer means:
   A. Having many parts

2. What is the base element in polymers?
   A. Carbon

3. Name three naturally occurring polymers.
   A. Silk, wool, rubber, cellulose

4. What happens to a thermoplastic polymer when it is heated?
   A. It softens on heating and can be reshaped.

5. If we apply a small amount of heat to a thermosetting polymer nothing happens, but what happens if a higher temperature is applied?
   A. The polymer will start to char, it will not melt.

6. Both thermosetting and thermoplastic polymers have strong covalent bonds within the polymer chains. What is the difference in bonding between the chains?
   A. Thermoplastic polymers have weak dispersion forces between the chains, whilst thermosetting polymers have strong covalent bonds between the chains.

7. When a thermosetting polymer chars what is the black residue that is left behind?
   A. Carbon

8. What do LDPE and HDPE stand for?
   A. LDPE – Low density polyethene, HDPE – High density polyethene

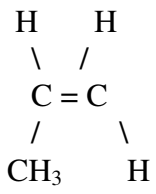
9. Explain the difference between LDPE and HDPE in terms of the branching between the chains. Include a diagram of each.
   A. LDPE has a lot of branching between the chains. The branches are longer and more frequent, and therefore the chains cannot pack together tightly, hence the low density. HDPE does not have a lot of branching between the chains, therefore the chains can pack together tightly, giving a high density.

10. In addition polymerisation an unsaturated monomer is necessary for the polymerisation to occur. Why?
    A. An unsaturated monomer contains a double bond between the carbon atoms. The double bond breaks releasing electrons and allowing new bonds to form between monomers.

11. Draw monomers for the following and provide one example of its use as a polymer:

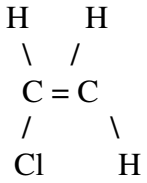
    a) Polypropene

    A. Use: rope, outdoor furniture



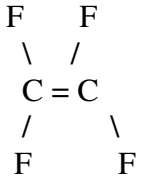
b) Polyvinyl chloride (PVC)

A. Water pipes, rain coats, linoleum floors



c) Polytetrafluoroethene (Teflon)

A. Cookware



12. Polymers made from two or more monomers are called?
    A. Co-polymers.

13. What type of polymerisation do co-polymers undergo?
    A. Condensation polymerisation.

14. What by-products often occur from condensation polymerisation?
    A. Often water, also hydrochloric acid or methanol.

15. When rubber was first discovered what were two of its initial problems?
    A. In cold weather it went very stiff, whilst in hot weather it turned very soft and sticky.

16. What did Charles Goodyear develop?
    A. Vulcanisation.

17. How does the addition of sulfur affect the rubber?
    A. The more sulfur, the more cross links that can occur, therefore stiffening up the rubber. Tyres are an example of a lot of sulfur being added to rubber, whilst rubber bands have had only a small amount of sulfur added.

18. Currently many plastics are made from non-renewable resources, what are some of the changes that will influence plastics in the future?
    A. Plastics will have to be made from renewable resources, and be biodegradable.

After the Program

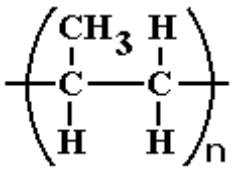
1. Complete the following table:

	Thermosetting	Thermoplastic
Type of bonding within the polymer		
Type of bonding between polymer chains		
Reaction upon addition of heat		
Examples		

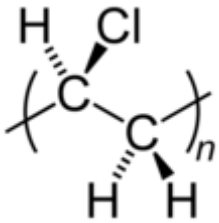
Answer:

	Thermosetting	Thermoplastic
Type of bonding within the polymer	**Covalent bonds**	**Covalent bonds**
Type of bonding between polymer chains	**Strong covalent bonds**	**Weak dispersion forces**
Reaction upon addition of heat	**Char**	**Melt and reshape**
Examples	**PVC pipe, saucepan handles**	**Ice-cream containers**

2. Show the addition polymerisation of the following:
   a. Polypropene

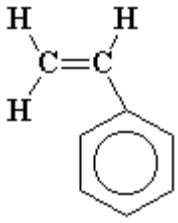


   b. Polyvinyl chloride



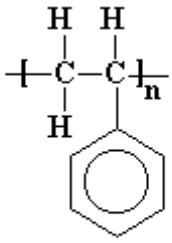
3. Polystyrene is another common polymer. Complete the following:

   a. What is the monomer of polystyrene? Provide a diagram.



styrene monomer

   b. Draw a diagram of polystyrene.



polystyrene

   c. What are three uses of polystyrene?

- yoghurt containers
- cups
- packaging
- hobby kits
- refrigerator doors
- crispers
- shoe heels
- wall tiles