Information Sheet for Teachers: Walter Lincoln Hawkins (1911- 1992)

This information sheet is designed for teachers only.

Walter Lincoln Hawkins was an African American scientist who is known for his contributions to polymer chemistry. He was the first African American to start working at Bell Laboratories, New Jersey. Previously, telephone cables were easily oxidised because scientists used lightweight plastics like polyethene. Walter Lincoln Hawkins researched polymers that were more stable in the environment and discovered cheaper and safer plastic sheath cables that made telecommunications easier and more universal. Walter Lincoln Hawkins' plastic polymer contained chemical additives composed of carbon and antioxidants.

In the KS5 chemistry national curriculum, students' study 'reactions classified as… addition polymerisation and condensation polymerisation'. This aspect of the curriculum has a direct link to Walter Lincoln Hawkins' work on polymers and him being able to develop a polymer that is more suited for cables. The curriculum also includes the topic of oxidation: 'the existence of more than one oxidation state for each element in its compounds.' As Walter Lincoln Hawkins worked on developing a polymer that was not easily oxidised, unlike the polymer used before, it can show the link between oxidation chemistry and his research, along with its implications.

Walter Lincoln Hawkins' work shows a clear link to the national curriculum and his contributions can be incorporated without difficulty.

Walter Lincoln Hawkins

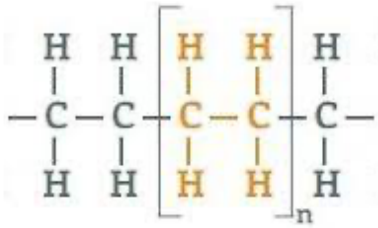
Picture credit: Same Passage

Walter Lincoln Hawkins was born in Washington, D.C. in 1911. He was an African American who had a fond interest in mathematics and science. He had to face several obstacles in his life due to his race. As a young child, he was orphaned and was raised by his sister.

After completing a first degree in chemical engineering, he went on to earn a master's in chemistry from Howard University, also in the States, and then a Doctorate in Chemistry in 1938 at McGill University in Montreal, Canada, with a focus on cellulose (lignin) chemistry.

After completing his studies, Walter Lincoln Hawkins worked on developing substitutes for rubber during World War ll. He was then recruited by AT&T Bell Laboratories, where he researched plastic and polymers and was the first African American to work in a technical position for Bell Laboratories.

Previously, the cables were made of polyethene which would become brittle once oxidised. During his time at Bell Laboratories, he worked on improving the telephone cable sheath. The coating of the sheath was made of polyethene that was toxic, expensive and was not resistant to harsh weather conditions. Walter Lincoln Hawkins developed a much cheaper and safer alternative. His polymer contained carbon and antioxidants. This discovery improved the quality of telephone cables and ultimately led to their incorporation into the universal telephone service.



Polyethylene.
Picture credit: Omnexus

In addition to these accomplishments, Walter Lincoln Hawkins became a role model and an inspiration for students from minority ethnic groups. He mentored younger aspiring chemists by becoming the first chairman of the American Chemical Society's project of Summer Educational Experience for the Economically Disadvantaged (SEED). In his career, he published fifty papers, three books and earned 147 patents. To celebrate his achievements, he received the honour of having the Medal of Technology and Innovation from President George H. W. Bush.

Walter Lincoln Hawkins' work not only created a huge impact on telephone communications, but also in supporting other minorities in achieving their dreams in chemistry.

References:

https://lemelson.mit.edu/resources/w-hawkins

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Walter Lincoln Hawkins

PIONEER OF POLYMER CHEMISTRY

ABOUT

Walter Lincoln Hawkins was born in Washington, D.C. in 1911. As an African American with a fond interest in maths and science, he had to face several obstacles throughout his life. After completing his PhD, he went on to work for Bell Laboratories. He was able to design a new polymer that made telephone cables much safer, which improved telecommunications globally.

Did you know?

Walter Lincoln Hawkins was the first African American to work in a technical position at Bell Laboratories.

He became a role model and inspiration for younger minority students and created a summer research programme at his company to support women and ethnic minorities.

He received a Medal of Technology and Innovation from President George H. W. Bush.

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Oxidation Activity (easy)

Calculate the oxidation state of oxygen in the following compounds:

1. O_2 ___________
2. CO_2 ___________
3. SO_3 ___________
4. PbO_2 ___________
5. H_2O_2 ___________

Calculate the oxidation state of nitrogen in the following compounds:

1. N_2O_3 ___________
2. NO_2^- ___________
3. Mg_3N_2 ___________
4. NH_3 ___________
5. HNO_3 ___________

Calculate the oxidation state of carbon in the following compounds:

1. C ___________
2. CO_2 ___________
3. CH_4 ___________
4. CO ___________
5. $H_2C_2O_4$ ___________

Walter Lincoln Hawkins (1911-1992) was the first African American to work at Bell Laboratories. Early telephone cables oxidised easily. Walter Lincoln Hawkins discovered a polymer that could withstand the environment. This had a huge impact on telecommunications, as it led to the universal telephone service.

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Calculate the oxidation state of oxygen in the following compounds:

1. O_2 = 0
2. CO_2 = -2
3. SO_3 = -2
4. PbO_2 = -2
5. H_2O_2 = -1

Calculate the oxidation state of nitrogen in the following compounds:

1. N_2O_3 = +3
2. NO_2^- = +4
3. Mg_3N_2 = -3
4. NH_3 = -3
5. HNO_3 = +5

Calculate the oxidation state of carbon in the following compounds:

1. C = 0
2. CO_2 = +4
3. CH_4 = -4
4. CO = +2
5. $H_2C_2O_4$ = +3

Redox Activity (medium)

Are the following reactions Oxidation or Reduction? (Hint: Think about OILRIG)

1. $Na \rightarrow Na^{+} + e^{-}$
2. $Br_2 + 2\ e^{-} \rightarrow 2\ Br^{-}$
3. $Fe^{3+} + e^{-} \rightarrow Fe^{2+}$
4. $Ca \rightarrow Ca^{2+} + 2\ e^{-}$
5. $2\ Cl^{-} \rightarrow Cl_2 + 2\ e^{-}$
6. $O_2 + 4\ e^{-} \rightarrow 2\ O^{2-}$
7. $2\ H^{+} + 2\ e^{-} \rightarrow H_2$
8. $Cu \rightarrow Cu^{2+} + 2\ e^{-}$
9. $Al \rightarrow Al^{3+} + 3\ e^{-}$
10. $Sn^{4+} + 2\ e^{-} \rightarrow Sn^{2+}$

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1. $Na \rightarrow Na^{+} + e^{-}$ (oxidation)

2. $Br_2 + 2\ e^{-} \rightarrow 2\ Br^{-}$ (reduction)

3. $Fe^{3+} + e^{-} \rightarrow Fe^{2+}$ (reduction)

4. $Ca \rightarrow Ca^{2+} + 2\ e^{-}$ (oxidation)

5. $2\ Cl^{-} \rightarrow Cl_2 + 2\ e^{-}$ (oxidation)

6. $O_2 + 4\ e^{-} \rightarrow 2\ O^{2-}$ (reduction)

7. $2\ H^{+} + 2\ e^{-} \rightarrow H_2$ (reduction)

8. $Cu \rightarrow Cu^{2+} + 2\ e^{-}$ (oxidation)

9. $Al \rightarrow Al^{3+} + 3\ e^{-}$ (oxidation)

10. $Sn^{4+} + 2\ e^{-} \rightarrow Sn^{2+}$ (reduction)

Oxidation Activity (hard)

Write a half-equation for the oxidation of Fe(II) to Fe(III):

Write the half-equation for the reduction of $Cr_2O_7^{2-}$ to Cr^{3+}:

Combine the two half-equations above to form a balanced overall redox equation:

Oxidation Activity (hard)

Write the half-equation for the oxidation of Cu to Cu^{2+}:

Write the half-equation for the reduction of MnO_4^- to Mn^{2+}:

Combine the two half-equations above to form a balanced overall redox equation:

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Oxidation Activity (hard)

Write the half-equation for the oxidation of Fe(II) to Fe (III):

$Fe^{2+} \rightarrow Fe^{3+} + e^{-}$ (oxidation)

Write the half-equation for the reduction of $Cr_2O_7^{2-}$ to Cr^{3+}:

$Cr_2O_7^{2-} + 14\ H^{+} + 6\ e^{-} \rightarrow 2\ Cr^{3+} + 7\ H_2O$ (reduction)

Combine the two half-equations above to form a balanced overall redox equation:

Balancing both equations

$6\ Fe^{2+} \rightarrow 6\ Fe^{3+} + 6\ e^{-}$

$Cr_2O_7^{2-} + 14\ H^{+} + 6\ e^{-} \rightarrow 2\ Cr^{3+} + 7\ H_2O$

Combining both equations:

$6\ Fe^{2+} + Cr_2O_7^{2-} + 14\ H^{+} \rightarrow 2\ Cr^{3+} + 7\ H_2O + 6\ Fe^{3+}$

Oxidation Activity (hard)

Write the half-equation for the oxidation of Cu to Cu^{2+}:

$Cu \rightarrow Cu^{2+} + 2\,e^{-}$ (oxidation)

Write the half equation for MnO_4^{-} to Mn^{2+}:

$MnO_4^{-} + 8\,H^{+} + 5\,e^{-} \rightarrow Mn^{2+} + 4\,H_2O$ (reduction)

Combine the two half-equations above to form a balanced overall redox equation:

Balancing both equations:

$5\,Cu \rightarrow 5\,Cu^{2+} + 10\,e^{-}$

$2\,MnO_4^{-} + 16\,H^{+} + 10\,e^{-} \rightarrow 2\,Mn^{2+} + 8\,H_2O$

Combining both equations:

$5\,Cu + 2\,MnO_4^{-} + 16\,H^{+} \rightarrow 5\,Cu^{2+} + 8\,H_2O + 2\,Mn^{2+}$

Polymer Activity (Hard)

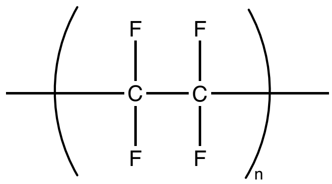
1. Using the words given in the box below, fill out the missing gaps in the passage.

Polyethylene, Polymers, Organic, Large, Basic, Several

Monomers forms the ________________ unit for polymers. ________________ amounts of monomers can join to make a long chain of ________________. These are usually formed from ________________ molecules: alcohols, esters, carboxylic acids.

Polymers are formed from ________________ monomers joined together. Polymers can be natural such as DNA, or they can be man-made such as ________________.

2. The diagram below shows Teflon. Draw the monomer and repeating unit for Teflon.



Monomer: Repeating Unit:

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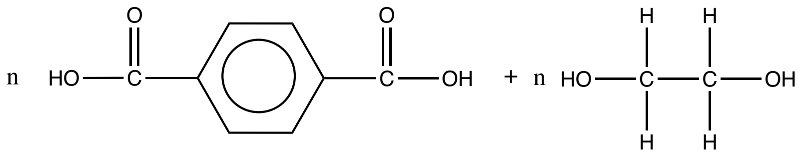
Polymer Activity Continued

3. The diagram below shows benzene-1,4-dicarboxylic acid and ethane-1,2-diol. Draw the product formed from this condensation polymerisation reaction.



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Polymer Activity

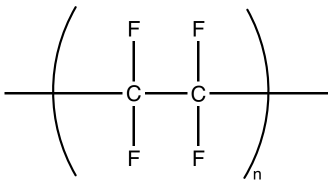
1. Using the words given in the box below, fill out the missing gaps in the passage.

Polyethylene, Polymers, Organic, Large, Basic, Several

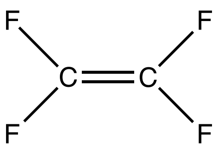
Monomers forms the basic unit for polymers. Large amounts of monomers can join to make a long chain of polymers. These are usually formed from organic molecules: alcohols, esters, carboxylic acids.

Polymers are formed from several monomers joined together. Polymers can be natural such as DNA, or they can be man-made such as polyethylene.

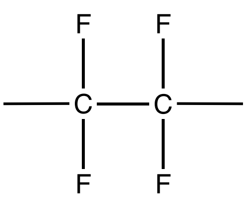
2. The diagram below shows Teflon. Draw the monomer and repeating unit for Teflon.



Monomer

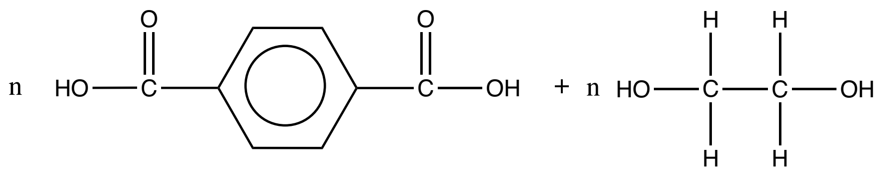


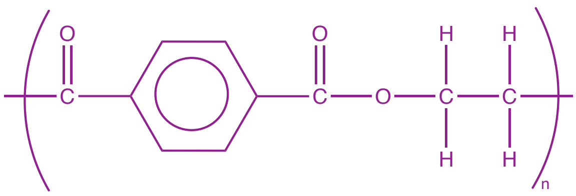
Repeating Unit:



Polymer Activity Continued

3. The diagram below shows ethanoic acid and methanol. Draw the product formed from this condensation polymerisation reaction.





+ 2n H_2O

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