

Biodegradable Balancing

Student Worksheet

Procedure: Balance the following equations that use common household constituents found in wastewater treatment plants.

- Acetic Acid (vinegar)

$$\text{CH}_3\text{COOH} + 2\text{O}_2 \xrightarrow{\text{Microorganisms}} \text{CO}_2 + \text{H}_2\text{O}$$
- Acetone (nail polish remover, will not stay in solution—very volatile)

$$\text{CH}_3\text{COCH}_3 + 4\text{O}_2 \xrightarrow{\text{Microorganisms}} \text{CO}_2 + \text{H}_2\text{O}$$
- Citric Acid (orange juice)

$$2\text{C}_6\text{H}_8\text{O}_7 + 9\text{O}_2 \xrightarrow{\text{Microorganisms}} \text{CO}_2 + \text{H}_2\text{O}$$
- Sucrose (sugar)

$$\text{C}_{12}\text{H}_{22}\text{O}_{11} + 12\text{O}_2 \xrightarrow{\text{Microorganisms}} \text{CO}_2 + \text{H}_2\text{O}$$
- Benzene (a component of gasoline)

$$2\text{C}_6\text{H}_6 + 15\text{O}_2 \xrightarrow{\text{Microorganisms}} \text{CO}_2 + \text{H}_2\text{O}$$
- Phenol (present in mouthwash, toxic to microorganisms at low concentrations)

$$\text{C}_6\text{H}_5\text{OH} + 7\text{O}_2 \xrightarrow{\text{Microorganisms}} \text{CO}_2 + \text{H}_2\text{O}$$
- Naphthalene (mothballs, will sublime rather than dissolve)

$$\text{C}_{10}\text{H}_8 + 12\text{O}_2 \xrightarrow{\text{Microorganisms}} \text{CO}_2 + \text{H}_2\text{O}$$
- Uric Acid

$$2\text{C}_5\text{H}_4\text{N}_4\text{O}_3 + 9\text{O}_2 \xrightarrow{\text{Microorganisms}} \text{CO}_2 + \text{H}_2\text{O} + \text{N}_2$$

Some of these compounds will not be effectively treated with biological stabilization.
- Caffeine

$$2\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2 + 19\text{O}_2 \xrightarrow{\text{Microorganisms}} \text{CO}_2 + \text{H}_2\text{O} + \text{N}_2$$

Biodegradable Balancing

Student Worksheet (continued)

10. Acetylsalicylic Acid (aspirin)



11. Vitamin A



12. Vitamin B₁ (thiamine)



13. Ascorbic Acid (Vitamin C)



14. Vitamin D₂



15. Tocopherol (Vitamin E)



16. Riboflavin (Vitamin B₂)



17. Alanine (a constituent of most proteins)



18. Stearic Acid (soap)



19. Ethanol (the alcohol contained in beer, wine, etc.)



20. Starch



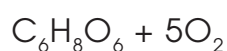
Biodegradable Balancing

Answer Key

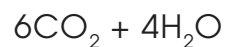
1. Acetic Acid (vinegar)
 $\text{CH}_3\text{COOH} + 2\text{O}_2 \xrightarrow{\text{Microorganisms}} 2\text{CO}_2 + 2\text{H}_2\text{O}$
2. Acetone (nail polish remover)
 $\text{CH}_3\text{COCH}_3 + 4\text{O}_2 \xrightarrow{\text{Microorganisms}} 3\text{CO}_2 + 3\text{H}_2\text{O}$
3. Citric Acid (orange juice)
 $2\text{C}_6\text{H}_8\text{O}_7 + 9\text{O}_2 \xrightarrow{\text{Microorganisms}} 12\text{CO}_2 + 8\text{H}_2\text{O}$
4. Sucrose (sugar)
 $\text{C}_{12}\text{H}_{22}\text{O}_{11} + 12\text{O}_2 \xrightarrow{\text{Microorganisms}} 12\text{CO}_2 + 11\text{H}_2\text{O}$
5. Benzene (a component of gasoline)
 $2\text{C}_6\text{H}_6 + 15\text{O}_2 \xrightarrow{\text{Microorganisms}} 12\text{CO}_2 + 6\text{H}_2\text{O}$
6. Phenol (present in mouthwash)
 $\text{C}_6\text{H}_5\text{OH} + 7\text{O}_2 \xrightarrow{\text{Microorganisms}} 6\text{CO}_2 + 3\text{H}_2\text{O}$
7. Naphthalene (mothballs)
 $\text{C}_{10}\text{H}_8 + 12\text{O}_2 \xrightarrow{\text{Microorganisms}} 10\text{CO}_2 + 4\text{H}_2\text{O}$
8. Uric Acid
 $2\text{C}_5\text{H}_4\text{N}_4\text{O}_3 + 9\text{O}_2 \xrightarrow{\text{Microorganisms}} 10\text{CO}_2 + 4\text{H}_2\text{O} + 4\text{N}_2$
9. Caffeine
 $2\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2 + 19\text{O}_2 \xrightarrow{\text{Microorganisms}} 16\text{CO}_2 + 10\text{H}_2\text{O} + 4\text{N}_2$
10. Acetylsalicylic Acid (aspirin)
 $\text{CH}_3\text{COOC}_6\text{H}_4\text{COOH} + 9\text{O}_2 \xrightarrow{\text{Microorganisms}} 9\text{CO}_2 + 4\text{H}_2\text{O}$
11. Vitamin A
 $\text{C}_{20}\text{H}_{29}\text{OH} + 27\text{O}_2 \xrightarrow{\text{Microorganisms}} 20\text{CO}_2 + 15\text{H}_2\text{O}$
12. Vitamin B₁ (thiamine)
 $2\text{C}_{12}\text{H}_{17}\text{N}_4\text{SOCl} + 31\text{O}_2 \xrightarrow{\text{Microorganisms}} 24\text{CO}_2 + 16\text{H}_2\text{O} + 4\text{N}_2 + \text{S}_2 + 2\text{HCl}$

Answer Key (continued)

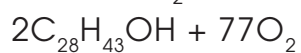
13. Ascorbic Acid (Vitamin C)



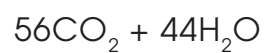
Microorganisms
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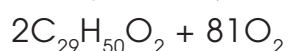
14. Vitamin D₂



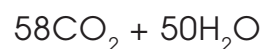
Microorganisms
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15. Tocopherol (Vitamin E)



Microorganisms
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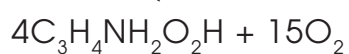
16. Riboflavin (Vitamin B₂)



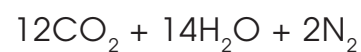
Microorganisms
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17. Alanine (a constituent of most proteins)



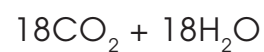
Microorganisms
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18. Stearic Acid (soap)



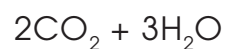
Microorganisms
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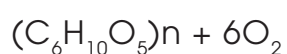
19. Ethanol (the alcohol contained in beer, wine, etc.)



Microorganisms
→



20. Starch



where $n = 1$

Microorganisms
→

