

# Principles of Green Chemistry

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# Principles of Green Chemistry

- **Green Chemistry**
- Branch of chemistry that deals with design of products and processes that minimize or eliminate the use and generation of hazardous substances
- The term Green chemistry and sustainable chemistry are used interchangeably
- It was started as a part of strategy to address environmental problems
- In 1998, Paul Anastas and John C. Warner formulated principles of green chemistry
- The 12 principles address reducing the environmental and health impacts of chemical production

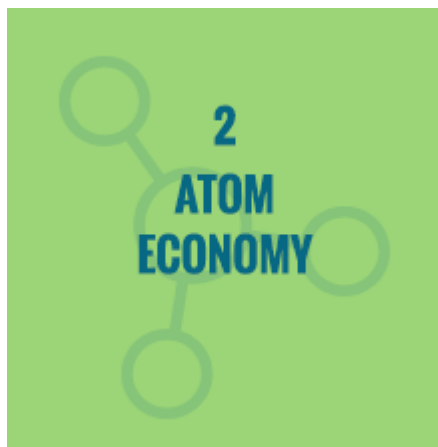


# Concepts covered

- Design of process to maximize the amount of raw material that ends up in the product
- Use of renewable material feedstocks and energy sources
- Use of safe, environmentally benign substances, including solvents, whenever possible
- Design of energy efficient processes
- Avoiding the production of waste, which is viewed as the ideal form of waste management

# 12 Principles of Green Chemistry

1. Prevention: Preventing waste is better than treating or cleaning up waste after it is created.
2. **Atom economy**: Synthetic methods should try to maximize the incorporation of all materials used in the process into the final product. This means that less waste will be generated as a result.
3. Less hazardous chemical syntheses: Synthetic methods should avoid using or generating substances toxic to humans and/or the environment.



# 12 Principles of Green Chemistry

4. **Designing safer chemicals:** Chemical products should be designed to achieve their desired function while being as non-toxic as possible.
5. **Safer solvents and auxiliaries:** Auxiliary substances should be avoided wherever possible, and as non-hazardous as possible when they must be used.
6. **Design for energy efficiency:** Energy requirements should be minimized, and processes should be conducted at ambient temperature and pressure whenever possible.

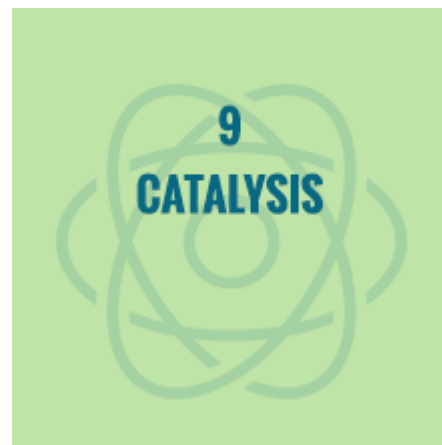
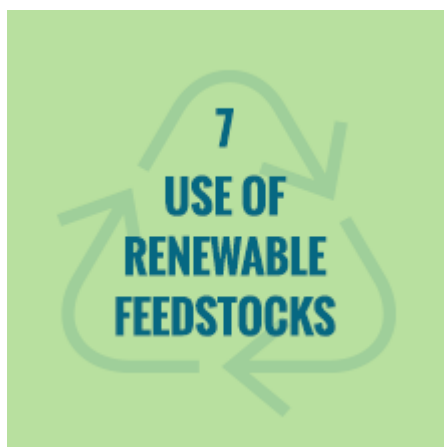


# 12 Principles of Green Chemistry

7. **Use of renewable feedstocks:** Whenever it is practical to do so, renewable feedstocks or raw materials are preferable to non-renewable ones.

8. **Reduce derivatives:** Unnecessary generation of derivatives—such as the use of protecting groups—should be minimized or avoided if possible; such steps require additional reagents and may generate additional waste.

9. **Catalysis:** Catalytic reagents that can be used in small quantities to repeat a reaction are superior to stoichiometric reagents (ones that are consumed in a reaction).



# 12 Principles of Green Chemistry

10. Design for degradation: Chemical products should be designed so that they should break down into non-harmful products after their function is over

11. Real-time analysis for pollution prevention: Analytical methodologies need to be further developed to permit real-time, in-process monitoring and control *before* hazardous substances form.

12. Inherently safer chemistry for accident prevention: Whenever possible, the substances in a process, and the forms of those substances, should be chosen to minimize risks such as explosions, fires, and accidental releases.



**THANK YOU**

**Any Queries ??...**

THANK YOU