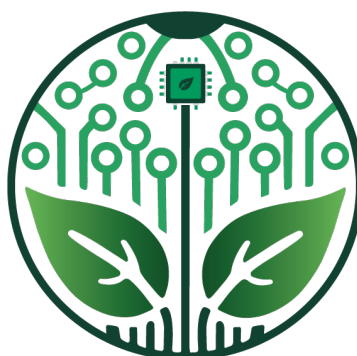




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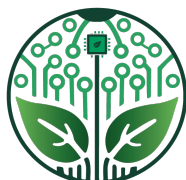
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LESSON PLAN

Sustainable chemistry: green reactions

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Disclaimer



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1. TITLE

Sustainable chemistry: green reactions

2. GRADE LEVEL

- ISCED Level 3 – Upper Secondary Education (ages 15–18)

3. SUBJECT AREA

- Sciences
- Environmental Studies

4. TYPE

- Lesson Plan

5. DURATION

- 2 x 40-minute classes

6. LEARNING OBJECTIVES

- O1- Explain how chemical reactions can harm the environment.
- O2- Understand how AI can optimize chemical reactions to reduce resource consumption.
- O3- Design a more sustainable chemical reactions using AI tools or simulations.

7. Key Competences Developed

- Mathematical competence and competence in STEM
- Digital competence



8. Prior Knowledge / Prerequisites

Chemistry knowledge taught in primary education, basic digital skills.

9. Lesson/Project Outline

Phase 1 – Introduction (Engage & Contextualize)

Students interact with the teacher and call out example of harmful chemical process such as plastic synthesis, use of fertilizers, detergents etc. and their impact on environment.

Teacher present students with the 12 principles of the green chemistry. Students are divided in small groups, and each group is assigned with 3 principles of green chemistry. Students discuss among themselves what each principle means in practice and come up with short examples of how they could be applied in real life chemical process.

Each group presents their assigned principles, their interpretation and examples of practical application.

Outputs: group explanations and justifications of assigned principles.

Resource (name)	Link (to the folder on Teams)
12 principles of green chemistry https://www.acs.org/green-chemistry-sustainability/principles/12-principles-of-green-chemistry.html	

Phase 2 – Exploration (Investigate & Compare)

Students analyze chemical reactions, materials, processes to understand how waste is generated, energy use, sustainability challenges. They will brainstorm how AI could help optimize these processes.

Activities:

Students are presented with examples of chemical processes from phase 1. They identify materials used, energy required, waste generated by them. Students link the processes to one of the 12 green chemistry principles. Groups discuss which principles aren't applied in the examples and how that affects sustainability.



Teacher introduce students to simple simulation tools that predict reactions. Students test the simulation, input variables, observe predicted changes, discuss how AI could help green chemistry principles to improve the process.

Outputs: students note on reaction efficiency and environmental impact.

Resource (name)	Link (to the folder on Teams)
PhET colorado https://phet.colorado.edu/en/simulations/filter?type=html	

Phase 3 – Application (Hands-On Practice)

In small groups students select a chemical reaction product such as soap, fertilizer, bioplastic etc. and propose optimizations using AI predictions.

Their proposal should include

How to reduce waste, lower energy consumption, improve sustainability of raw materials.

They create a short visual presentation explaining the optimized reaction and benefits it has.

Outputs: AI assisted reaction proposal, visual presentation, short explanation linking AI to process optimization.

Resource (name)	Link (to the folder on Teams)

Phase 4 – Reflection & Consolidation (Present & Connect)

Groups present their AI-assisted proposals. Class discussion on questions:

Which optimization had the biggest impact on sustainability?

What are the limit of using AI in chemistry?

How could this approach be applied in industry?

Outputs: Group presentations.

Resource (name)	Link (to the folder on Teams)



10. Assessment Criteria

Participation in discussions and group work, uses of chemical reaction simulations, clarity of visual output.

Resource (name)	Link (to the folder on Teams)

11. Teaching Materials

Name	Type (Developed/Existing)	Link	Role in the lesson

12. External Resources and References

Resource (name)	Link (external or to the folder on Teams)
12 principles of green chemistry	https://www.acs.org/green-chemistry-sustainability/principles/12-principles-of-green-chemistry.html
PhET colorado	https://phet.colorado.edu/en/simulations/filter?type=html